Transportation organization design of Tangshan West Comprehensive Passenger Terminal

Jingcheng Sun¹,a

College Of Transportation & Communication, Shanghai Maritime University, Shanghai, China

a e-mail: 202030610065@stu.shmtu.edu.cn

Abstract: Tangshan West Comprehensive Passenger Terminal is an important passenger terminal of Tangshan West Railway Station. The purpose of this paper is to make a scientific and reasonable transportation organization design for Tangshan West Comprehensive Passenger Terminal Station, in order to improve the passenger travel service capacity of Tangshan West Comprehensive Passenger Terminal Station, and provide a good travel experience for the passengers. Based on the analysis and introduction of the internal structure of Tangshan West Comprehensive Transportation Hub Station, the paper designs the traffic organization of Tangshan West Comprehensive Transportation Hub Station according to the existing design scheme. The author through to the passenger flow and traffic flow, traffic flow data of field investigation, and analyzes the passenger's behavior characteristics, and after consulting relevant literature, calculate and determine the passenger's travel of the law on passenger station may arrived. At the end of the article, the passenger emergency evacuation plan is proposed and the specific implementation content is designed according to the corresponding situation.

1. Introduction
Nowadays, with the rapid economic development, more and more people travel, the passenger reception and guidance capacity of the passenger station will face great challenges. With the increase of passenger flow, the scale of the passenger station is also expanding, and the composition of the internal structure and facilities of the passenger station is becoming more and more complex. The complexity of the passenger travel rules and the continuous improvement of the service function requirements of the passenger station make it difficult for the streamline planning of the passenger station to some extent. In the preparation of train schedules, as stated by Zeng(2017)¹, it is necessary to compile, adjust and optimize the transport plan by analyzing the spatial-temporal distribution of passenger flows and under the condition of reasonable transport equipment conditions, and adjust and implement the train diagram according to different situations, so as to realize the reasonable preparation of train schedules. In terms of culture, as stated by Wang (2021)², there are still big problems in the cultural construction of all transportation hubs, such as lack of clear cultural expression, insufficient cultural atmosphere in public space, and imperfect cultural facilities. Relevant units should strengthen the cultural construction of railway passenger transport hub, change their ideas, straighten out the management system, and solve the problems of cultural propaganda while planning the construction of transport hub. With the increase of travel pressure, passenger stations put forward higher requirements for safety protection. As described by Wang(2014)³, the construction of a new transportation hub for efficient operation often combines horizontal and vertical flows, mining,
utilization of underground space, evacuation and fire safety design of underground space to require updating. The station guide line, passenger flow diversion, station travel and baggage management, transfer management and other facilities as a complete system service system, to ensure that each link can provide passengers with safe, efficient, comfortable, convenient and high-quality services.

Therefore, it is particularly important to carry out reasonable planning and design for traffic organization. How to achieve the reasonable and orderly passenger flow inside and outside the station, through the scientific arrangement of the arrival schedule, to ensure that passenger flow, traffic flow and traffic flow do not interfere with each other, is the main problem to be solved in this subject. Such as Tang (2010)[4], high-speed railway passenger hub station is a kind of high speed railway introduced a new type of comprehensive passenger transport hub station, the hub is concentrated in the transition, intercity lines, Xiamen city, highway passenger transport, urban rail transit, urban public transport, such as transportation, but also pay attention to the parking lot, hotel, business services and other related transport infrastructure, It is the core of "zero distance transfer". As stated by Shang(2019)[5], public transport is a key component of sustainable transport. In China, state and local governments provide huge subsidies to encourage the use of public transport systems. However, high commuting demand has led to such an incredible phenomenon that passengers have to climb Windows to take buses during rush hours. The main design purpose of this paper is to make the bus hub station and long-distance bus station together, to achieve the shortest distance between Tangshan West Station "zero transfer" three functions.

2. Materials and Methods

2.1 Analysis of transfer rate of hub station

2.1.1 Per capita transfer facility area
The per capita transfer facility area is a measure of the passenger capacity of the passenger station and the efficiency and quality of the passenger transfer during the transfer connection, as well as the spatial comfort degree, the quality of the transfer environment and the reasonable utilization of the space in the station. It is a quantitative index to evaluate the adaptability of passenger equipment connection. That is,

\[ Y_1 = \frac{M_r}{Q_r} \]  

In this formula, Mr is the total area of transfer stations at the hub, and Qr is the total transfer passenger flow at the hub. It can be seen that the instantaneous passenger flow of the hub can be 3470 person-times, and the transfer area is 2900 square meters

\[ 2Y_1 = 1.67 \]

According to the standard, the best index of per capita transfer facility area is 1.69, so the transfer area of this hub station is in good condition.

2.2 Hybrid multi-objective programming model

2.2.1 Parameters are defined
Let n be a spatiotemporal node \((i, s, t_0)\) in the spatiotemporal network graph \(G(N, V)\). Here, the set \(n\) does not include two super nodes O and D. Z is an arc in the space-time network graph \(G(N, V)\), L; Is the set of i-type arcs in the space-time network, \(L_i \subseteq \{L_c, L_p, L_w, L_e, L_t\}\); \(A_0\) is the set of all arcs (the arc-head points to the arc-tail space-time node) that "reach" the space-time node in the space-time network; \(B_0\) is the set of all arcs "starting" from the space-time node (arc head and arc tail connect the space-time node) in the space-time network; \(A_0NL\) is the set of class I arcs of all "starting" space-time nodes in the space-time network; \(B_0NL\) is the set of all the I-type arcs "starting" from the space-time nodes in the space-time network. Let \(X\) be the actual passenger flow on arc \(l\); \(Y\) is the actual traffic flow on arc \(Z\).
2.2.2 Constraint equations

1) Constraint conditions of passenger flow

At the space-time node n, the number of passengers who want to get on the bus is satisfied,
\[ \sum_{i \in A_n \cap L_c} X_i = N_{n}^{q} \]  

(2)

It can also be known from the balance relation of total passenger flow that the relationship between the departure node O and the destination node D should meet the following two constraints,
\[ \sum_{n} \sum_{i \in A_n \cap L_c} X_i = \sum_{n} \sum_{i \in B_n \cap L_c} X_i \]  

(3)

\[ \sum_{n} \sum_{i \in B_n \cap L_c} X_i = \sum_{n} \sum_{q} N_{n}^{q} \]  

(4)

There are the following passenger capacity limitations for Arc l And x should also satisfy the constraint,
\[ X_l \leq C_{i,p} \quad l \in L_p \cup L_w \]  

\[ X_l \geq 0 \quad l \in L_c \cup L_p \cup L_w \cup L_e \cup L_t \]  

(5)

2) Traffic flow constraints

In the space-time section n, the limit of the number of available buses
\[ \sum_{i \in A_n \cap L_c} Y_i = M_n \]  

(6)

There are the following traffic capacity limitations for Arc L And Yl should satisfy the constraint,
\[ Y_l \leq C_{i,v} \quad l \in L_p \cup L_w \]  

\[ Y_l \geq 0 \quad l \in L_c \cup L_p \cup L_w \cup L_e \cup L_t \]  

(7)

3) Arc constraint

The relationship between the number of traffic flow and the number of passenger flow is as follows
\[ Y_l \geq X_l / C \quad l \in L_p \]  

(8)

2.2.3 The objective function

The goal of public transport enterprise operation is to maximize the economic benefits of enterprises as far as possible; At the same time, the goal of passengers is to maximize the bus service, that is, to maximize the social benefits of bus operation. In the objective function, the economic benefit and social benefit must be balanced. Firstly, P is defined as the operating flow cost of bus vehicles on bus routes corresponding to arc L in the temporal network diagram. R is defined as the fixed operating cost of a bus on a bus line corresponding to arc L. In addition, a utility coefficient that represents the satisfaction of bus passengers to bus service is defined as W, whose value is measured by the waiting and transfer time of passengers on bus lines corresponding to arc L. The longer the time, the smaller the value of the utility coefficient is, and vice versa. F is defined as the travel cost of passengers on a bus line corresponding to arc L,

For bus enterprises, the economic benefits of their operation can be expressed by the following
function

\[ Z_1 = \sum_{i \in L_p} X_i w_i^f - \sum_{i \in L_p} Y_i w_i - \sum_{i \in L_c} Y_i w_i^c \]  \tag{9}

For bus passengers, the quantified value of bus service, namely the social benefit of operation, can be expressed as,

\[ Z_2 = \sum_{i \in L_w \cup L_t} X_i w_i^g - \sum_{i \in L_p} X_i w_i^f \]  \tag{10}

Then the final objective function can be comprehensively expressed as

\[ \max \{ Z_1, Z_2 \} \]  \tag{11}

3. Results & Discussion

3.1 Passenger flow analysis

![Analysis of passenger flow characteristics](image)

Fig.1. Analysis of passenger flow characteristics

3.2 Passenger transfer method selection

![Passenger transfer method selection](image)

Fig.2. Passenger transfer method selection

3.3 Analysis results of passenger flow inside and outside the hub station

Tangshan West Comprehensive Transportation Hub Station is one of the important node facilities in the radiation network of Tangshan traffic system, and it is also an important component of the urban
internal traffic network. The completion of Tangshan West Hub Station has promoted the development of the surrounding commercial industries and created a good environment for the economic activities around the station, so it has brought huge passenger pressure to the station. The passenger flow of Tangshan comprehensive transportation hub can be divided into the following parts: transfer passenger flow and derived passenger flow within Tangshan, railway passenger flow of Tangshan West Railway Station, and medium and short distance passenger flow inside and outside Tangshan city. The passenger flow composition and behavior characteristics of each part are shown as follows. The passenger flow forecast of Tangshan West Railway Station is to further plan the construction scale of each transportation facility of Tangshan West Railway Station. The passenger flow composition of Tangshan West Comprehensive Transportation Hub Station is relatively complex, so it is unnecessary to make a concrete analysis of all the passenger flows around. However, the main factors influencing the transportation facilities should be analyzed in detail, and the transfer passenger flow influencing the transfer to the integrated transportation hub should be distinguished and selected in the prediction. In addition, passengers waiting in the waiting room, passengers buying and collecting tickets, and passengers' behavior of resting and walking are not taken into account in the specific forecast. In addition, most of the station service personnel, such as workers, traders and middlemen, have already completed their trips during the peak passenger season. These factors are generally excluded from peak traffic conflicts and station staff when specific forecasting surveys are conducted. Facilities such as the parking lot of the station were also completed in the early stage of the station design. The passenger terminal is adjacent to Tangshan West Railway Station, and the traffic pressure of the station is relatively large, so it is not suitable for the design of stop and ride. Therefore, the main passenger flow Tangshan West Station faces is the city bus passenger flow and the transfer between railway and bus passenger flow.

3.4 Security measures
1) When the passenger flow in the station is in the peak period and exceeds the capacity of the station. The internal management organization of the station of the vehicle dispatch center should effectively and timely deploy the transport force of the station and evacuate the passengers in time and effectively to prevent the detention of a large number of passengers.

2) When the bus cannot run in time due to bad weather, the station shall inform the passengers in time, and guide the passengers to leave the station in a safe and orderly way when the weather improves.

3) In case of other emergency, timely handling of the event, rapid response and evacuation should be guided in advance according to the specific situation. The evacuation and guidance of stranded passengers should adhere to the basic concept of people-oriented and safety first. To effectively play the functions of the station and its role, the first and most important thing is to ensure the safety of passengers' lives and property and reduce unnecessary losses caused by the evacuation process. The station leaders take the lead and the department leaders divide the work and implement the work according to their responsibilities and authority.

4. Conclusions
The comprehensive transportation hub station is an important part of the urban transportation system. The establishment of the comprehensive transportation hub station is conducive to the construction of a link between cities and cities, cities and towns, increase the operation of passenger flow between cities and cities, and improve the quality of passenger flow transportation between cities and towns. The development of the integrated transport station is not only related to the economic operation and cultural exchange of the city itself, but also plays an important role in the outward expansion and communication of the city.

Article through to the Tangshan economic as well as analysis of characteristics of passenger flow around west railway station, calculated using hybrid multi-objective programming for traffic diversion, and in reference to a large number of literature at home and abroad, objective and comprehensive
forecasts the scale of Tangshan west comprehensive passenger terminal passenger flow, and on the basis of the existing improvement station in passenger flow, traffic guide, passenger flow characteristics of the three aspects of the problems. The last part of the paper points out the possible situation and countermeasures of Tangshan West Hub Station in terms of security according to the safety measures of other stations

Reference
[1] Zeng. PL.(2017) Study on the Method of Urban Rail Transit Transportation Planning. Railway Technology Innovation.(03):18-24.
[2] Wang. WX.(2021) Study on the cultural construction route of Beijing railway passenger transport hub. Modern Marketing (Business Edition), (05):100-101
[3] Wang. FM.(2014) Safety Evacuation Design of Interchange Space in Integrated Transportation Hub Station. Zhejiang university.
[4] Tang. ZH.(2010) Streamline organization and analysis of comprehensive passenger terminal station. Southwest Jiaotong University.
[5] Hua-Yan Shang, Hai-Jun Huang, Wen-Xiang Wu. Bus timetabling considering passenger satisfaction: An empirical study in Beijing[J]. Computers & Industrial Engineering,2019,135.