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# Study on Optimization of Subway and Bus Lines

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**Abstract:** This study mainly combines the history of urban rail transit development and analyzes the location of rail transit. Based on the actual situation of different regions, the optimization mode of rail transit is put forward through analysis and research. At the end of the article, taking a specific city as an example, the correctness of the theory and method is verified by data analysis.

**Keywords:** Rail transit; System; Mode; Optimization

## 1. Introduction

At present, the development of rail transit has become an important part of the development strategy of many large cities. Rail transit adopts closed special channel operation mode, which has the incomparable convenience and punctuality of general open conventional bus. However, rail transit cannot provide "door-to-door" transportation services for most passengers, and its ability to collect and transport is inextricably linked to conventional public transport. Large cities have chosen to build an integrated urban public transport system which combines large capacity rail transit with conventional public transport [1]. The main competition of rail transit is individual transportation rather than regular public transport. However, the development of rail transit will have a great impact on the development of the urban public transport system and even the urban traffic structure, and it will also have a significant impact on the conventional bus lines along the track. Therefore, we must correctly deal with the spatial relationship between rail transit and existing conventional bus routes. In order to develop an integrated public transport system with wider service scope, larger scale and stronger competitiveness, the rapid and large transportation capacity of rail transit is fully played and the influence of rail transit on the regular bus passenger flow is reduced.

## 2. Function Orientation and Relationship Analysis of Rail Transit and Conventional Public Transport

### 2.1. The function orientation of rail transit and conventional public transport

According to the development experience of rail transit in large cities such as Singapore, Hongkong, Guangzhou and Shenzhen, the development of rail transit can be divided into three stages, such as initial development,

centralized development and mature development, such as three stages [2]. The function orientation of rail transit and bus transit is different with the different stages of urban rail transit development. In the initial stage of rail construction, there are few rail transit lines and short operating mileage, and only cover some passenger corridors. Public transport passenger traffic is mainly undertaken by conventional public transport, while rail and conventional bus share backbone functions. The proportion of rail transit in public transport mode is generally not more than 20%, while the regular bus traffic accounts for the majority.

During the large-scale rail construction stage, the rail transit network will be quickly constructed and cover the main passenger corridors of the city. The proportion of rail transit in public transport mode is generally over 20%, and not more than 40%. The bus system is gradually formed by the integration of the rail and the conventional bus. The backbone transport function is established. The regular bus is responsible for the main function of the passenger transport, and the functions of connecting, extending, supplemented and encrypted to the track.

### 2.2. The relationship between rail transit and conventional public transport

At present, the development of urban rail transit in China is at the initial stage of development or centralized development. In this stage, conventional public transportation still occupies the main position in the urban passenger transport system, and the urban public transport system is in the joint development or integration period of the rail transit and the ground bus. According to the relationship between the status and space of the rail transit and the conventional public transport in the public transport, the main relationship between the first, second stage and the conventional public transport can be summarized as the connection

relationship, the general competitive relationship and the strong competition relationship [3].

**2.2.1. Connection Relationship**

The rail transit mode has less attraction to the short distance passenger flow when the track is less than the conventional bus station. The two show a good complementarity, and the passenger flow competition is weak.

**2.2.2. General competitive relationship**

When the track and the common bus stand up to a certain range, the track speed advantage gradually appears, while the conventional bus still maintains a cheap advantage. Both of them have the equivalent attraction to the passenger flow, showing a general degree of competition.

**3. Urban Connection Line Network Planning Model**

**3.1. Track connection planning model**

According to the layout of the urban rail transit network, the traffic function of the railway station and the characteristics of passenger flow, the integrated scheme of the urban rail transit and the conventional public transportation is implemented. There is a strong complementarity between rail transit and conventional bus lines with fewer stations in the public transit area around the rail station. According to the traffic function and passenger flow characteristics of rail stations, the repeat sections of conventional buses and track networks should be retained, and the passenger trip structure along the lines should be improved. In areas where the track network is not covered, new lines should be added or existing lines should be adjusted to the terminal stations. In areas with less coverage, bus travel should be transformed into "regular bus + urban rail transit" mode. The regular bus route planning mode of track connection is shown in Table 1.

**Table 1. Rail Connection Routine Bus Route Planning Model**

Grade of railway station	Traffic function	Passenger flow characteristics	Suitable mode of bus connection
<b>Comprehensive hub station</b>	Important rail transit interchange stations and other large-scale passenger transport hub with other urban passenger transport modes and external transport hub	Large start / end traffic	A large number of start lines
<b>Traffic connection station</b>	Passenger transport hub with rail transit and conventional public transport between different lines of rail transit	The two attraction is very large	A large number of start lines
<b>Area connection station</b>	The hub of rail transit stations combined with conventional public transport hubs and large commercial centers, large residential areas and densely populated public building areas.	The two attraction is very large	Through a line with a small number of starting lines
<b>General transfer station</b>	The transfer points of general rail transit intermediate stations and regular buses are mainly for area traffic services	The direct attraction of passenger flow is more, and the change of passenger flow is less	Mainly through the transmission line

**3.2. The model of track competitive line planning**

**3.2.1. Planning principles**

The principle of moderation. On the basis of ensuring the matching of supply and demand along the track, the adjustment rate of conventional public transport should not be too large. We should properly maintain the state of transport supply that exceeds the demand, and provide a reasonable division of space and track for new passenger flow, attracting passenger flow and transferring passenger cars.

The principle of moderate competition. We should properly reserve the competitive relationship between rail and public transport and avoid one-sided consideration of track efficiency. Through moderate competition, this can maintain the intrinsic motivation of two ways to improve service quality voluntarily. Step by step principle. Past experience shows that the track has significant advantages in medium distance transportation.

The growth of passenger flow is not dependent on the adjustment of competition lines. Therefore, the emphasis of the adjustment should be taken into consideration of the actual impact of conventional public transport, which should not be implemented centrally before the impact is not fully reflected.

**3.2.2. Planning model**

If the track and the conventional bus line are too much, there is a certain competition between the track and the conventional bus mode, which is not conducive to the improvement of the overall efficiency of the public transport system. Therefore, it is necessary to moderately optimize the line of competition according to the above principles, and adopt four adjustment modes: Jumping station, truncation, evacuation and cancellation, so as to reduce duplication. The track competitive conventional bus route planning model is shown in Table 2.

**Table 2. Track Competitive Conventional Bus Route Planning Model**

The influence of adjusting mode and adjusting object on passenger flow	Influence of adjustment mode and adjustment object on line characteristics	The influence of the adjustment model	Adjustment of the effect of the object
Hopping station	A general competitive line or a strong competitive line	It has a competitive relationship with the track and station section, and has a larger complementary relationship with the non parallel stations	The impact on residents travel is very small, and services can be compensated by rail transit
Truncation	A general competitive line or a strong competitive line	At least one end has a competitive relationship with the track, and the volume of passenger flow in this section is relatively small	It has little impact on Residents' travel, and the service can be compensated by other conventional buses
Sucker	Strong competitive line	The middle part has a competitive relationship with the track, and the passenger flow in this section is relatively small	It has a certain impact on the residents' travel, but the service can be made up by other conventional buses

#### 4. Optimization and Adjustment Scheme of Rail Transit Network

Adhere to the development strategy of "bus priority" and build a public transport service system combining rail transit with conventional public transport. The cooperation between rail transit and conventional public transport will be strengthened, and the advantages of rail transit will be gradually expanded through reasonable bus connection schemes. Give full play to the characteristics of mass transit, fast, convenient, punctual, and comfortable, and improve the overall transport efficiency of public transportation, and then improve the overall attraction and service level of public transport.

#### 5. Conclusions

"Dislocation competition and mutual supplement" is the basic position of the coordinated development of urban rail transit and conventional traffic. Therefore, it is necessary to strengthen the rail connection in the optimization and adjustment of the urban connection line network. At the same time, in order to integrate the multimodal passenger transport mode, a passenger transport system supplemented by rail transit and regular bus is formed. In the follow-up work, we should further improve the slow line system and the bus connection system, and establish an integrated bus transfer system in accordance with the urban development orientation, in

order to solve the "last mile travel" problem of the citizens.

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