Problems and Measures of Passenger Organization in Guangzhou Metro Stations

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Abstract. Along with the rapidly increasing pressure of urban transportation, China’s subway operation is facing the challenge of high-density passenger flow. In order to improve the level of subway operation and ensure its safety, it is necessary to analyze and study the operation status of the metro station under the condition of high-density passenger flow, and propose the corresponding improvement scheme. Taking Guangzhou Metro as the study object, this paper discusses and analyzes the operation and management status of Guangzhou Metro Station. And combined with the risks and deficiencies in the operation and organization of Guangzhou metro, effective improvement measures are proposed in this paper.

Operation Status of Guangzhou Metro

The first line of Guangzhou Metro opened on June 28, 1997, and Guangzhou became the fourth city in mainland China to open and operate the subway.

As of April 26, 2018, Guangzhou Metro has 13 operating routes, with 391.6 km and 207 stations in total, whose opening mileage ranks third in China and fourth in the world. As of July 24, 2018, Guangzhou Metro Line Network had transported 1.645 billion passengers safely, with an average daily passenger volume of 802.58 million, an increase of 7.88\% over the same period of 2017 (7.4393 million). The daily maximum passenger flow was 10 million 25 thousand and 700, of which, the passenger volume of line 1, 2, 3 and 5 all exceeded 1 million 200 thousand. In addition, line 3 (including the northern extension section) transported 2.44 million passengers, line 4 transported 508,000 passengers, line 6 transported 1.053 million passengers, Guangfo line transported 400,000 passengers, the passenger flow of above lines all reached the highest level in history.

Difficulties That Passenger Transport Organization Is Facing

On the whole, Guangzhou Metro has been operated for a long time, with complex lines, increasing large passenger volume. All these have brought great difficulties to the passenger transport organization of the subway. At present, the problems confronted by passenger transport organization mainly lie in three aspects: the rising demand for passenger transport, the contradiction between the early planning of subway stations and the existing passenger flow scale, and the mismatch between the capacity and volume of some lines. The solution of these three problems is the key to the safe and stable operation of Guangzhou Metro and the rise of the overall passenger service level.

Passenger Demand and Passenger Transport Organization’s Risk Are Increasing

In recent years, with the soaring passenger volume in Guangzhou metro, the passenger transport organization is facing more risks. When the passenger flow in the subway station is large, the throng will crowd and move. If someone accidentally falls, the people behind will continue to move forward and uncontrollably trample people who falls. It will exacerbate panic, eventually lead to mass casualties. In the subway operation, especially in the rush hour, a large number of crowds will inevitably reduce the comfort of passengers and cause anxiety of the crowd. If the passenger flow cannot be effectively controlled, crowds in the process of crowding and collision are prone to quarrel.
and push each other due to queuing, occupying seats and other issues. Under the condition of high-density passenger flow, once a security problem occurs, it is bound to cause greater panic and more serious consequences.

**Early Planning of Subway Stations Cannot Meet Present Passenger Demand**

Guangzhou metro stations, such as Yangji Station and Huangsha Station, which were built in the early days of Guangzhou Metro, did not fully consider the growth of passenger flow in the future, so adequate transfer and expansion reserve had not been made. On one hand, the existing stations are constrained by the design capacity of the metro station and the capacity of key equipments, and the continuous increase of passenger flow brings a large number of operational risks to the metro; on the other hand, inadequate early planning also brings difficulties for the subsequent construction of new lines and the expansion of existing metro stations. To a great extent, the winding transfer channel after expansion and complex structure of subway station also restrict the capacity of key facilities in subway stations, which is not conducive to the organization of high-density passenger flow and the development of risk prevention and control work.

**The Contradiction between Capacity and Volume Is Becoming Increasingly Prominent**

The passenger flow of Guangzhou Metro is unevenly distributed all day in space and time. In terms of time, the passenger flow of working day appears "tide phenomenon" obviously. The passenger flow is so large in peak period that the transport capacity cannot meet the passenger transport demand, and it is hard for passengers to get on and off the train. In the aspect of space, the passenger transportation intensity of main lines, such as the first, second, third, fifth and eighth lines, is much higher than that of Guangfo line and suburban lines, which result in high passenger density and crowding on some lines of Guangzhou Metro, and the transport capacity of some lines has not been fully utilized.

**Suggestions for Improvement**

**Reasonable Layout of New Line Construction**

In the light of the existing problems of the mismatch between stations and lines in the early stage of subway construction and the actual passenger transport demand at present, when planning and constructing the new lines and stations, the relevant departments and units should combine the law of historical subway passenger flow growth with the overall urban planning and layout of Guangzhou, so as to reserve enough space for the new passenger flow brought by new lines in the future. At the same time, the metro operators can participate in the planning process as soon as possible, and put forward more conducive recommendations to operational management according to actual situation and their experience.

**Response Measures for Existing Stations during Peak Period**

**Consummation of Passageway and the Passenger Drop Facilities.** In order to avoid gathering large-scale passenger flow in the same place in a short time, the station should try to control the moving speed of inbound, outbound and transfer passenger flow, which puts forward requirements for the overall management of passengers. Without large-scale renovation of existing buildings, the station can better guide and evacuate passenger flow by strictly dividing up and down, entering and leaving passageways, and adjusting the operation direction of escalators according to actual passenger flow. The existence of cross passenger flow and hedging passenger flow is an important factor that affects the forward speed of crowd. Strictly dividing the direction of advance, reducing the circuitous passenger flow, and strengthening manual guidance or broadcasting guidance at key facilities such as forks, entrances and exits, can effectively reduce these two kinds of passenger flows. In the morning and evening rush hours, a large number of passengers travel in the opposite direction, and due to land size and other constraints, passenger alighting facilities in many stations are composed by stairs and
one-way escalator composition, which will cause the waste of resources. Timely change the direction of escalators can be better use of resources.

**Improve the Sign System.** With the increase of the city size of Guangzhou, subway construction has been in progress all the time, many old stations have become transfer stations, which also gives a challenge to the sign system of these stations except for the above mentioned pressure of increasing passenger flow. In such a closed underground space as a station, people's perception of space will be confused, coupled with the intricacy of the interchange station channel, the direction of identification becomes more difficult. In this case, a convenient, fast and accurate sign system is particularly important. However, some stations do not change the overall station identification system after adding the transfer channel between different lines, but only add the channel identification on the basis of the original sign system. Passengers will not go wrong if only they follow the signs, but they will take a long road. Signs do not point to the fastest solution, which increases unnecessary travel time for passengers, and may even cause passengers’ detention during rush hours.

**Train Operation Adjustments.** In the peak period, there is a great distribution of passenger flow in different lines and different sections of the line as well as between the two directions of the line. It is quite unreasonable to run the same frequency trains equally in these lines, sections or directions. Therefore, dispatchers can start from the overall subway network level, shunt trains from not busy sections to busy sections, while putting more spare cars and other idle trains into use. These adjustments can alleviate the pressure of passenger flow in busy sections, and reduce the waste of transport capacity. In addition, the arrival time of the subway train can be as close as possible to the passengers' arrival time and transfer time, so that the time spent by passengers in stations is equal to "travel time".

**Cooperation with Ground Bus System.** Subway and bus are two kinds of public transport for people to travel in the city. Their passenger groups are overlapped in a large range, so they can match each other and provide overall transport products. They can try to cooperate in two aspects. On the one hand, they can open "parallel bus" whose routes are the same as the busy subway lines and sections to share the peak passenger flow with each other. On the other hand, they can make a good connection between busy and non-busy subway lines via ground bus system to balance the passenger flow pressure between different subway lines.

**Peak-load Price.** Operators can implement peak price to guide people to travel in peak load. For example, Longhua Line of Shenzhen Metro takes a discount that passengers can take subway once for free every 4 times during the flat hump period; metro fares are one-third higher than normal fares during rush hours from 6:00a.m. to 9:30a.m. and from 3:30 p.m. to 6:30 p.m. in Washington, except for public holidays; in cities such as Shanghai and Suzhou, passengers who over 70 years old can't enjoy free fares during the rush hours. These cities implement the measure that preferential policies for the elderly can be used only in the flat hump period to guide passengers not to travel in peak traffic.

**Enhance Interaction between Stations and Passengers.** On the one hand, broadening the passengers' information access channels and strengthening the link stations and passengers, so that passengers can know the passenger flow condition, malfunction and handling situation in time. The inconsistency between passengers and stations in information receiving is an important reason why passengers cannot understand some measures of the station, which may cause disputes and make the station cannot act in time. On the other hand, it is important to establish passenger information feedback mechanism. Operators can establish a network platform to collect passengers' opinions according to different categories of projects, obtain a clear direction of rectification, and facilitate the subsequent improvement of the corresponding equipment and facilities, thereby improving the overall service level of the subway.

**Improvement of Maintenance and Repair System**

In the 1990s, Guangzhou Metro was put into operation. It has been in operation for about 20 years now, and many types of equipment are aging that needs constant maintenance and replacement. In order to ensure that it will not affect the daily operation of the metro or increase the passenger flow
pressure at other stations without maintenance, operators need to adjust the maintenance system of the metro, carry out comprehensive and in-depth maintenance of key equipment and facilities, replace damaged parts timely, ensure the overall safety and stability of the metro, and reduce safety issues.

**Risk Prevention and Security Control**

Under the condition of high-density passenger flow, subway passenger organizations need to carry out more comprehensive and efficient safety prevention and control work to ensure passenger travel safety and experience. At present, video surveillance is the main mean to ensure the safety of passenger flow in urban rail stations in China. However, most of video surveillance systems need to be interpreted artificially, which leads to the lag of emergency response of passenger flow safety and cannot eliminate the hidden dangers in time. Therefore, the subway station should vigorously develop the intelligent passenger flow monitoring method based on video image analysis in order to obtain the real-time passenger flow state, passenger flow distribution of the network, the dynamic passenger flow situation of the rail transit network, and formulate the passenger flow relief plan for the congested section in time, so as to eliminate the hidden dangers of safety.

**Conclusion**

The subway is an important role in urban public transport that bears most of the passenger flow in the city. The subway station is the place where the large-scale passenger flow gathers and distributes. It is necessary to pass through stations for passengers who take the subway. How to ensure its safety and efficiency is the problem that the operator must face. With the continuous development of Guangzhou in the past 20 years, the metro mileage and passenger flow have increased continuously, and the operation environment is becoming more and more complex under the interweaving of old and new elements. In terms of the current passenger transport organizational difficulties, operators can implement both hard and soft measures to solve problems. While ensuring the safe and stable operation of the subway, they can start from planning new stations, renewing the signs of old stations, improving management methods, and maximize the use of train capacity and improve the overall operation and management level.

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