Journal of Architectural Research and Development, 2023, Volume 7, Issue 4
http://ojs.bbwpublisher.com/index.php/JARD
ISSN Online: 2208-3537
ISSN Print: 2208-3529

Function Analysis of Urban Rail Transit Smart Station

Can Chen*

Chongqing Energy College, Chongqing 402260, China

***Corresponding author:** Can Chen, 422209918@qq.com

Abstract: In order to make rail transit smart stations serve passengers better, the potential of smart stations should be optimized to reduce time cost, and relieve traffic congestion. In this paper, the construction of smart stations based on the management experience of a subway station and the benefits of smart stations were analyzed and discussed. The construction of smart stations, as well as the key technologies for the construction of smart stations, will aid in the automation and intelligent management of subway stations.

Keywords: Urban rail transit; Smart station; Function analysis

Online publication: July 28, 2023

1. Introduction

During the initial stage of the development of urban rail transit in China, traditional computer control systems were mainly used in subway stations, the information and facilities in the stations were also managed manually. At the time, computer system applications had lower standard, thus the station management functions and station operation organization was also relatively backward. With the increase of subway operating lines and the continuous expansion of the functional requirements of subway stations, the automation and intelligent management of subway stations have become more popular. The rapid development of computer and communication technology promoted the use of various smart devices in the stations. Subway stations have also begun to adopt facilities and equipment such as intelligent lighting, intelligent security, intelligent comfort service, intelligent entertainment system, and intelligent passenger flow statistics and analysis. Through the use of various facilities, passengers can share and exchange information with the subway operation and dispatch center [1-6]. At present, many cities in China have begun the construction of smart transportation systems in urban rail transit networks. In order to better improve customer service, more stations will need to adopt the practice of intelligent management and make good use of these intelligent facilities and equipment.

2. Smart station

The current trend of urban rail transit construction is the construction of smart stations. With the continuous development of urban rail transit, the use of various equipment and facilities will also increase, which will lead to the development of smart stations. Smart station refers to the intelligent and automatic management of subway stations based on new technology, where the information sharing between intelligent systems is achieved through network transmission [7-11]. The construction of smart stations can be done using various methods, which can be analyzed as such:

2.1. Based on existing equipment

Currently, many kinds of equipment are being used in China's subway stations, however most of them are designed on the basis of traditional computer control systems. With the advancement of science and technology, this kind of equipment can no longer meet the needs of modern subway operation and management. Therefore, when constructing a smart station, the existing equipment can still be used as the basis, but upgraded and transformed when necessary. This method can not only effectively reduce costs, but also help improve the level of smart station construction (**Figure 1**).

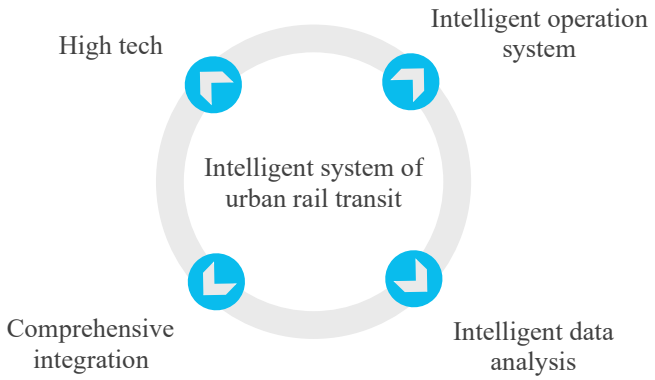

Figure 1. Urban rail transit smart system

2.2. Focusing on software development

Currently, various kinds of computer control systems and communication systems are being used in China's subway stations, however these systems cannot keep up with the standard of China's subway industry development. When building smart stations, software development should be the core focus, only when the software development is successful can the subway management and control functions be achieved.

2.3. Using the computer network as the platform

Currently, most of the computer control systems used in China's subway stations are connected via local area network or wide area network with external communication systems through the Ethernet. In the construction of smart stations, the computer network should be used as the platform, and the existing communication means should be used to exchange and share data. This allows the informatization, intelligence and networking of the subway operation management. Moreover, virtual reality technology is the current new emerging technology in China. It combines various equipment systems with computer network technology, and can simulate equipment systems through virtual reality technology. In this way, functions such as monitoring, management and maintenance of subway operation equipment can be achieved, and users can remotely operate and control subway equipment.

2.4. Using big data analysis

Currently, the equipment systems used in China's subway stations are usually managed manually, however due to the lack of scientific and logical management methods by managers, problems such as low management efficiency and waste of resources have emerged. Therefore, during the construction of smart stations, big data analysis should be used as a means to carry out intelligent and automatic management along with scheduling management of equipment systems.

2.5. Customer service satisfaction as priority

With the development and progression of society and economy, people have begun to hold higher standards for subway travel. Therefore, during the construction of smart stations, customer service satisfaction should be the prioritized, and existing resources should be fully utilized for functional development and intelligent design [12].

According to the analysis above, a variety of methods and technical means should be included in the construction of smart stations to keep up with society's development.

3. Construction of smart stations

3.1. Intelligent lighting

LED lighting is energy-saving, environmentally friendly, and has a long lifespan of more than 15 years, thus it should be used to illuminate the stations. The intelligent lighting system of the station can be divided into two parts: ambient lighting and equipment lighting. Ambient lighting can be used to light up public areas in the stations, such as station halls and platforms whereas equipment lighting can light up equipment rooms in stations.

3.2. Intelligent security

The number of passengers has gradually increased with the development of the urban rail transit network. In order to ensure the safety of passengers, equipment such as escalators and vertical elevators have also been installed at stations. By installing automatic emergency braking system (AES) in escalators and vertical elevators, passengers can pass through the platform safely and quickly during emergency situations. Since the system is installed according to the number of passengers and the direction of travel, its installation location is also different. Under normal circumstances, the station only needs to install one AES in the station hall to meet the safety needs of passengers. In case of emergency, the device can be operated through the manual button panel installed in the station hall. As for the vertical elevator, due to its complex structure, it has a higher requirement for the platform layout, so the system would be set in the platform area between the first basement and the second basement.

3.3. Intelligent comfort service

Since there are equipment and facilities such as escalators and vertical elevators in the station, by installing corresponding sensors and controllers on these equipment, real-time monitoring and statistical analysis of the number of passengers can be done. At the same time, installing facial recognition equipment in the stations allows the identification of passengers, which can help with the recording of passenger information. Information such as current passenger flow, boarding, and landing situations in the station can be fed back to passengers in real time after being collected via the facial recognition equipment.

3.4. Intelligent entertainment system

There are multiple public entertainment areas and vending machines in the station. Remote control of these equipment and facilities can be achieved through wireless controllers or wireless network equipment that are set up in the station [13]. At the same time, these equipment and facilities can also provide passengers with entertainment and convenient services.

3.5. Intelligent passenger flow statistics and analysis

The stations can adopt an intelligent passenger flow statistical analysis system based on mobile Internet technology. Through this system, the real-time collection and statistical analysis of the number of passengers in the subway station and the situation of passengers entering and leaving the station can be

achieved. At the same time, the system can also provide effective data support as a decision-making basis for subway operating companies. Currently, the stations already have relatively complete intelligent equipment and systems, and its functions and performance are also being continuously improved.

4. Key technologies

4.1. Information system for passengers

To solve the issue of lack of information due to the absence of guidance devices, the first thing that could be done is to establish a notification and announcement system. The original passenger information system can be remained, and the new notification system should be installed for the background management platform and front-end equipment terminals. These platforms can access a unified platform of smart stations for equipment status and data, and accept real-time instructions from the intelligent platform, to achieve an inter-system interaction.

To further provide information for passengers, an intelligent light indication management system could be implemented. Not only can this system provide status reporting while interacting between systems, it can also be remotely managed in real-time to control the display and lighting effects when needed.

Another method to improve the information system for passengers is the real-time guidance system. In this system, there is an independent camera set up at each exit to obtain real-time images. 4 sets of real-time guidance screens should be set up in the paid area (area with boom where gates parking fee is needed) and free areas (the area without boom gates where no parking fee is needed) to help passengers understand the route. The behind-the-scenes management system should work to manage the equipment, process the collected information, and use AR enhancement to analyze the data that cannot be obtained. The data can then be displayed for the passengers on the screen.

A guidance system is installed on the doors to guide passengers. It includes a back-end management platform and a front-end display system.

4.2. Intelligent security check

The X-ray security detector will collect video recordings of passengers' baggage and the original baggage inspection data, then the intelligent analysis instrument will identify whether there is any illegal or prohibited items in the baggage. The body temperature detection door will also help collect passenger data like facial recognition, body temperature, whether the passenger is carrying metal items, etc. The system collects the relevant data from baggage inspections even when an employee gets off their shift, forming a complete closed loop in the detection process. In addition, the security inspection machine can also be used for data collection, storage, upload of personnel data, equipment data, business data, etc.

The multi-dimensional information obtained can then be used as a foundation in order to improve the subway safety inspection process to meet the set requirements. Various types of safety inspection services can be done (personnel management, equipment management, event management, etc.) to improve the effectiveness of the entire rail transit safety inspection service management.

4.3. Intelligent operation management system

The intelligent operation management system is the main component of a smart station. It is a comprehensive command platform for the station's daily operation, employee management, emergency management, resource management, and deployment management. This system integrates the sensor data, equipment status data, fault data, and human error data of each main equipment, and allows the remote control of each subsystem and sub-module. Based on lightweight Building Information Modelling technology, a three-dimensional interactive platform can be built to comprehensively display the location and detection information of important mechanical and electrical devices such as personnel location, crowd

density distribution, environmental control, fire protection, gate control, and alarm information, and job information.

4.4. Hyperconverged infrastructure construction

During the construction of a hyperconverged infrastructure for the smart station, we configured the 4-node hyperconverged all-in-one machine and built a software-defined computing, storage, and network resource pool to transfer the main business applications to a hyperconverged platform. Management hyperconvergence refers to an automated hyperconverged management platform, which can conduct unified management of resources such as computing, storage, network and security, including virtual machines, storage and other advanced attributes. Furthermore, the relevant information can be displayed on a big screen, which allows users to have a better understanding about the resource usage status of the hyperconverged cluster. It can also customize and monitor the status of the business virtual machines.

The collaboration of various systems will lead to a stable and efficient operation of smart stations. If the inter-system collaborative interaction cannot be formed, the true potential of smart stations cannot be reflected. Therefore, it is necessary to conduct in-depth research on the characteristics of each system, clarify their internal relations, and use the network as the basis to achieve an efficient and functional connection, so that the functions of smart stations can be utilized to the greatest extent.

5. Conclusion

With the rapid development of China's urban rail transit, the scale of the stations has expanded which increased the stations' functional requirements and passengers have begun to hold higher expectations for customer service quality. The main issue here is how to organically combine the construction of smart stations with the operation and management of subways in a refined manner. It requires the joint participation of subway operation and management departments, rail transit construction units, and equipment suppliers. When all necessary units can cooperate in the project construction process, the intelligence level of subway operation management be improved. As a response, the operation efficiency and passenger satisfaction of the subway operation can be improved. This is one of the important factors for the development of smart transportation in the future.

Disclosure statement

The author declares no conflict of interest.

References

[1] Luo C, 2022, Collaborative Management Mode and Technology Application of Urban Rail Transit Stations. Digital Technology and Application, 40(12): 74–76.

[2] Chen X, 2022, Scene Linkage Design of Urban Rail Transit Smart Station Comprehensive Transportation Management Platform. Modern Urban Rail Transit, 2022(12): 83–87.

[3] Liu S, Zhang J, Wang W, 2022, Research on Functional Requirements of Rail Transit Smart Stations. Journal of Zhengzhou Railway Vocational and Technical College, 34(04): 27–29.

[4] Fang Y, 2022, Research on Intensive Arrangement Scheme of Urban Rail Transit Smart Station Facilities and Equipment. Modern Urban Rail Transit, 2022(06): 17–20.

[5] Chen K, Xu B, 2022, Construction and Implementation of Urban Rail Transit-Smart Stations. Metallurgical Automation, 46(S1): 198–199.

[6] Wang Y, 2022, Analysis of Smart Station Business. Inner Mongolia Science and Technology and

Economy, 2022(05): 63–64.

[7] Zhang W, 2021, Functional Requirements Analysis of Urban Rail Transit Smart Stations. Electronic Technology, 50(12): 260–261.

[8] Wu M, 2021, Discussion on the Functions of Urban Rail Transit Smart Stations. Modern Urban Rail Transit, 2021(07): 15–21.

[9] Zhou G, 2021, Research on the Theory and Method of Short-term Passenger Flow Forecasting of Urban Rail Transit under Multiple Scenarios, dissertation, Beijing Jiaotong University.

[10] Zhou M, 2021, Research on Smart Station Construction of Urban Rail Transit. Locomotive Electric Transmission, 2021(03): 118–124.

[11] Guo X, 2020, Prospect Analysis on the Development of Smart Stations in Urban Rail Transit. SME Management and Technology (Mid-day Journal), 2020(07): 124–125.

[12] Liu L, 2019, Invulnerability Analysis of Urban Rail Transit Network Structure and Function Based on Failure of Important Stations, dissertation, Beijing Jiaotong University.

[13] Li A, Zhang F, 2009, Analysis of the Realization of IBP Panel Functions in Urban Rail Transit Stations. Modern Urban Rail Transit, 2009(01): 10–12.