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# Construction of Emergency Management System for Rail Transit Operation Safety under Network Integration Conditions

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## Abstract

China has entered a new stage of rapid development of urban rail transit, and in recent years, the operating mileage of rail transit has increased rapidly. At the same time, China is promoting the integration of the four networks, and the planning, construction, and operation management of rail transit are facing new challenges and opportunities. The safety emergency issues of multi-level, multi network, and multi-mode rail transit are increasingly being valued. Based on this, this paper focuses on the construction of an emergency management system for rail transit operation safety under network integration conditions, mainly exploring the connotation, goals, and mission of rail transit safety emergency management, and formulating a system framework for rail transit safety emergency management.

**Keywords:** rail transit, emergency management, system planning, resilience, smart operation and maintenance, network optimization.

## 1 Introduction

China has entered a new stage of rapid development of urban rail transit since the 21st century, with a five-year cycle, the line scale has doubled in successive growth, and the rail transit operation mileage has jumped to the first place in the world since 2016. By the end of 2020, 45 cities in the country's mainland will have opened rail transit lines, with 7,978 kilometers of lines completed and open to traffic across the country, and more than 7,000 kilometers of mileage approved by the state to be under construction and to be constructed, with more and more cities stepping into the stage

of networked operation. The mileage of rail transit in Shanghai, Beijing and Guangzhou is more than 500km, and Shanghai has become the city with the longest urban rail transit line in the world. At the same time, China is promoting the "four-network integration" of high-speed rail, intercity rail, urban rail and urban rail transit, which, as a green, low-carbon, efficient and fast mode of travel, as well as the backbone network of public transportation, will further facilitate the travel of the residents and enhance the operational efficiency and quality of urban transportation infrastructure under the conditions of further integration and operation. The four-network integration will further facilitate residents' travel and enhance the operational efficiency and quality of urban transportation infrastructure under the conditions of further integration.

As the passenger volume and intensity of rail transit continue to rise, the safety and emergency work of rail transit is becoming more and more important. The overall development of urban rail transit is rapid, but the operation and management work is facing a series of challenges, especially in the new development stage of the national implementation of the "four-network integration", such as: the degree of network integration, the function of passenger flow relief, transportation synergies are not good, the degree of network integration needs to be improved; fire, epidemic and other large-scale emergencies, the ability to resist disaster and risk The ability is not strong, the ability to cope with transport risks needs to be improved; the standard system is not sound enough, the quality of standards needs to be improved, the level of industry standardization needs to be improved and so on. At present, only some domestic scholars are concerned about these issues and carry out specialized research<sup>[1-4]</sup>.

At present, China's rail transit development is still in an important strategic opportunity period, but the opportunities and challenges have new development changes, rail transit needs to highlight and improve the three major functional positioning, that is, focusing on improving the travel experience of the transportation attributes, enhance the urban service level of the city's urban attributes, pay attention to sustainable development and policy support of the public welfare attributes. Recently, China's national level has intensively released a series of policies and requirements related to the development of rail transit, among which, safety and emergency work is also an important content consensus, discussing the ideas and paths of the construction of emergency management system, which has an important pointing role in enhancing the level of operation and safety and emergency management of the rail transit industry, and the level of resilience of the operation of rail transit network.

## **2 The Connotation, Objectives and Mission of Rail Transportation Safety and Emergency Management**

The rail transit industry urgently needs to build a safety and emergency management system for the rail transit industry that is adapted to the new era and modernized as soon as possible. Strengthening the research on safety and emergency response of rail transit is conducive to further enhancing the service of urban rail transit to the people and the country, and promoting the healthy and sustainable development of the

industry. Especially in the next step of promoting the process of "four-network integration" in China, the safety and emergency of multi-level, multi-network and multi-mode rail transit is becoming more and more important.

The safety and emergency management of rail transit is carried out throughout the operation and management work. Emergency management "should" and "emergency" two parts are interrelated, to strengthen the sorting and analysis of "emergency" events and find out the "should" treatment plan. We need to strengthen the analysis of "emergency" events and identify "response" solutions. Such events are risks before they occur, hazards during the process, and emergencies after they occur. Sorting out the safety emergency list is an important core work of safety emergency management, efforts should be made to gradually summarize the risk potential or impact of emergency events or emergency case base in rail transit operations<sup>[5]</sup>. Operation management needs to make actual operation deduction for emergency events, give and continuously optimize the emergency event handling scheme or plan.

The establishment of emergency management system for rail transit should strengthen the research on the boundary, scope and work content of emergency management, widely and multi-dimensionally strengthen the combing of the list of safety and emergency management objects, and according to the actual operational needs, according to the concept of hierarchical management of emergency plans, operational systems, standards and norms, regulatory systems, etc., which shall be compiled, and shall strengthen the post-evaluation of the emergency disposal work. Attention should be paid to the optimization and integration on the basis of the existing operation management system, avoiding the creation of another stove and increasing the burden of operation, such as making full use of the existing various types of electromechanical equipment and operation management system, and optimizing and upgrading them with the goal of safety and emergency response.

### **3 The Institutional Framework for Rail Transit Safety and Emergency Management**

Rail transit is a complex giant system, and each type of rail transit mode network in the "four-network integration" is an important giant transportation network. Safety and emergency management is a systematic work, covering the whole life span, the whole system and the whole range of rail transit industry, safety is the goal, emergency is the remedy, technology is the means, management is the guarantee, need to build a systematic management thinking, to strengthen the preparation of the plan, the process of monitoring and the operation of the system. Intelligent urban rail has been rapidly applied, which empowers the rail transit industry to provide better and more accurate passenger services, and improves the system operation control and emergency response capability, but brings new challenges to emergency response decision-making; station-city integration breaks the traditional concept of taking the rail transit station as the focus of safety and emergency response, and expands the work boundary to the area around the station, the station's superstructure, and the immediately adjacent development of the commercial complex, etc., so as to make it a comprehensive Emergency management, related safety emergency work is more

complex. All of the above aspects require further improving and perfecting the construction of rail transit safety emergency response system.

(1)Construction of a safety and emergency management system based on the whole life cycle of rail transit construction and operation

The concepts and specific requirements of safety and emergency management should be integrated into the planning, design and operation work, and the emergency planning and design should be shifted from the metro-oriented professional design to the operation-oriented scenario, including the top-level design, preliminary design, project bidding, etc., should be integrated into the consideration of the operation scenario, and the design and planning of the rail transit projects should be carried out from the operation scenario, so as to strengthen the demand-oriented role of the operation, and to realize the support and services provided by the engineering technology for the operation. Provide support and service for operation. It is necessary to absorb more experts from within and outside the industry to actively make suggestions and improve the safety and emergency work.

For design units, emergency evacuation and rescue should be incorporated into the systematic consideration of design work from the front-end of planning and design to support the realization of building our emergency management information system. In this regard, the design unit should strengthen the following work: firstly, to play the supporting role of science and technology in the construction of emergency management system; secondly, to strengthen the planning, design and research on the whole process of the rail transit network of the emergency management problems in the design work; thirdly, to utilize the Internet of Things technology, to build the omni-directional, three-dimensional, non-blind cross-industry, cross-network coordinated emergency management system, and to do a good job of the top-level planning and put it into practice step by step.

In order to support the operation and maintenance of rail transit, for the later operation of the work of the service point monitoring work to be moved forward, the bridge and building structure of the monitoring system, the protected area monitoring equipment, in the design phase of the overall consideration of the deployment, the implementation of pre-embedded during the construction of the construction and carry out monitoring, operation and maintenance phase of the relevant monitoring system should continue to be retained and continue to monitor, rather than with the completion of the construction task is completely dismantled.

At present, the advancement of intelligent urban rail construction is working fast and has become an industry hotspot; station-city integration and diversified investment and financing are also developing rapidly. With regard to the above new trends in construction and operation management, it is necessary to strengthen the special research on emergency management work to ensure that the requirements of the new situation are adapted.

(2)Establishment of a joint response mechanism for rail transit technology and equipment based on the concept of intelligent operation and maintenance

The rail transit technology and equipment linkage response mechanism is the top pillar of safety and emergency management. Rail transportation operation in the safety emergency disposal, are based on the operation of the system of the infrastructure, safety emergency equipment, existing vehicles and operation and control systems and other synergistic effect, reduce the loss of emergency situations and potential risks. Among them, based on the established system equipment and facilities is an important means to realize the emergency disposal measures, to strengthen the rail transit system safety emergency technology and equipment research and development and application, to enhance the overall safety level of the rail transit system, especially in the networked operation conditions have been implemented and continue to promote the power supply, maintenance, and other facilities and systems across the line of common use. To this end, it is necessary to promote work including, but not limited to, the following:

①Research on the construction of a comprehensive platform for intelligent operation and maintenance under the conditions of "four-network convergence". It will build intelligent operation and maintenance management systems for equipment systems and operation and control systems, as well as monitoring and data sensing capabilities for the service performance and health status of infrastructures, so as to enhance the safety and emergency response level and disposal capability of the entire rail transit system.

②Build and strengthen situation safety emergency response systems and strategies for fire safety, public safety and disaster prevention and mitigation.

③Rapid development of new rounds of municipal railroads and development of municipal railroad train equipment with high-efficiency emergency evacuation capability.

④Strengthen system design and equipment manufacturing for fail-safe orientation. Clarify unified fire emergency communication specifications and implement them into planning and design programs from the early stages of construction.

⑤Strengthen the application and promotion of digital technology in emergency management in conjunction with rail transit equipment systems and infrastructure systems, such as BIM technology, CIM technology and twinning applications, to develop digital emergency plans and use them to guide actual emergency management.

⑥Establishment of a mechanism for the maintenance and disposal of equipment and facilities. The focus is on building an emergency response linkage mechanism to cope with equipment failure states, formulating regulations on maintenance and disposal time, relevant regulations on the management of emergency materials and equipment utilization, standardizing the standard disposal steps and time in emergency situations, and forming a standardized system or management approach. Engineering legacy problems in the construction phase can cause bottlenecks in handling emergency problems in the later stage. For this reason, it is necessary to

strengthen the correlation analysis of construction and operation failures, and through data analysis, handle them in advance, so that when failures occur, it is possible to quickly locate the causes of failures and the steps to be taken, and make clear the responsibilities of the personnel who deal with the failures, so as to improve the efficiency. In addition, it is necessary to strengthen the research and correlation analysis of multi-professional fault emergency disposal, standardize the synchronization and data label standardization and unification of various professions, especially the core key equipment, in order to effectively improve the efficiency of emergency disposal.

(3)All-round improvement of rail transit operation and maintenance and operation management safety and emergency response level

At present, the rail transit safety and emergency management work lacks a systematic and comprehensive basis for work, lack of scientific and complete industry standards and norms, the existing laws and regulations, standards system is not sound, the main body of responsibility for safety and emergency management, division of responsibilities, work interface and so on lack of a clear definition or provisions. Rail transit operation safety and urban management of public safety cross, the lack of practical work basis and guidance.

In the rapid development of rail transit station-city integration, seamless connection between rail transit and other modes of transportation to become a transportation hub, as well as the subway station plaza and related ancillary facilities gradually assume the function of part of the urban public space, etc., the safety and emergency management of rail transit operation has been overlapped with the urban public safety emergency management of the space and time and the intersection of duties. In addition, when the rail transit operation enterprises perform their daily operation duties, the related emergency management requirements are not clear enough, the associated knowledge is lacking, the informationization means is lacking, the emergency plan is not done well enough, involving the rail transit station and the urban space articulation area, except for the Ministry of Public Security has the related requirements of public safety, other regulations are also relatively few, which is also a safety emergency management and disposal of the rail transit industry in terms of Challenges. For this reason, the need:

①Establishment of rail transit safety emergency management standard system. Establishing a standard system is the first work of rail transit emergency management. Sort out the existing laws, regulations and standards and norms, covering the construction stage and operation period, reflecting the concepts of prevention and reserve, detection and early warning, recovery and reconstruction, and other work. At the same time, with the social and economic development, the new demand for residents' travel service and the construction of intelligent urban rail, as well as the new development trend of station-city integration, etc., which brings new challenges and topics to the rail transit operation safety emergency management, the construction of rail transit safety emergency system needs to conform to and support the future development requirements. It is necessary to strengthen the systematic research on the

emergency response system of rail transit, including relevant systems, guidelines, systems and plans, especially to effectively solve the practical difficulties that most types of emergency response plans cannot be rehearsed.

②Strengthen the standardized management and research of emergency plans. Emergency plans include comprehensive emergency plans and special emergency plans. Due to various reasons, the emergency plans and disposal plans of various regions and local railway operating enterprises are different now, and the number of various types of emergency plans is large and covers a wide range, so the practical experience of various regions should be integrated for integration and unification. Regions are different, city scale is different, but the way of rail transit operation is basically the same, on the one hand, we should carry out a systematic study of the emergency plan system required for normalized operation, determine the specific categories, number, content, to ensure that the operation of the required plans are not missing, and effectively escort the operation of the rail group; on the other hand, for the temporary, phased emergency plans, do a good job of dynamic research and analysis, and timely updated! On the other hand, for the temporary, stage emergency plan, do dynamic research and analysis, timely update. For example, the Hong Kong MTR Corporation through its safety and quality department unified management of comprehensive emergency plan, each year requires each department to update, combing, according to their own industry and professional characteristics of the plan submitted to the preparation and updating plan. Most of the specialized plans are managed by maintenance staff, and reviewed by relevant technical staff, with a clear division of roles among various personnel. Unified management and assessment of emergency drills, with a general command group and on-site command group, weekly release of the list of emergency repair teams, emergency management personnel have a strict assessment mechanism, standardized emergency rescue process; the implementation of the plan is also very strict, the specific implementation of the process of stationing on-site observers to check the implementation of the accident to survey, record and summarize.

③The rail transit has entered the stage of networked operation, the emergency innovation under networked operation needs to quickly grasp the network status of the whole network operation, the distribution of passenger flow as well as the establishment of efficient command and control system, and it needs to help the operating enterprises to establish the system perception and linkage ability. It is necessary to establish a systematic and perfect operation emergency response mechanism, strengthen the comprehensive research on hierarchical early warning system, emergency drill method, emergency response mechanism and system, and emergency disposal means, implement the collaboration mechanism with local governments and enterprises, improve the information release channel and release mechanism, and strengthen the innovation of emergency management by combining with the establishment of the 3C command system and the application of intelligent sensing and data transmission technology. It has strengthened the emergency response mechanism in the event of equipment failure, studied and standardized the steps, time and deployment of equipment and materials for emergency treatment in the event of

equipment emergencies, and established standardized emergency treatment procedures and norms.

④Comprehensive transportation hubs, including rail transit modes, whose emergency management involves multiple departments such as ground transportation, railroads and even aviation, as well as local administrative units, have a more complex safety and emergency management situation, and need to accelerate the establishment of an emergency management standard system for the transportation hubs to improve the safety and emergency management of the transportation hubs.

⑤Strengthen the cultivation of safety and emergency management professionals in the rail transit industry. The lack of talents directly causes the lack of professionalism in the internal management documents of the industry enterprises, the documents of each department have certain inconsistency with each other, and the capacity of the main body of the emergency information transmission and command is in urgent need of improvement and upgrading.

⑥Comprehensively build and form an information system for emergency management, focusing on the supportive role of science and technology, including the design of emergency response issues, research and other related technical issues; improving the formulation of measures for the entire process of emergency management; and applying good Internet of Things technology to realize synergies across networks, districts and enterprises.

⑦To carry out post-evaluation of emergency response in rail transit operations, summarize practical experience and further enhance the effectiveness and efficiency of emergency response.

## **4 Conclusions**

Overall, the "four networks convergence" will bring new challenges and opportunities to China's current rail transit planning and construction, operation and management, and overall enhance the status and role of rail transit in the national transportation infrastructure system. The rail transit industry should gather industry consensus as soon as possible, serve industry demand, focus on industry pain points, make concerted efforts to strengthen research, and actively expand the demonstration of breakthroughs. First, actively improve the industry safety and emergency laws and regulations and standards and norms system; second is to strengthen the rail transit operation warning system and exercise methods and emergency response mechanism system research and improvement; third is to strengthen the rail transit emergency management, innovative technology and research and industry demonstration and application; fourth is in the existing operation and management norms and standards system on the basis of further optimization and integration of building safety and emergency response system, and combined with the next in the smart city rail, station city, and the next in the industry. The next step in the wisdom of the city rail, station city integration development trend of integration and coordination, the formation of synergistic effect; Fifth is to strengthen the rail transit safety emergency disposal



management research base construction, boost the emergency management work of the plan and organization of the objectives and nodes.

The systematic design and management of safety and emergency response for the whole life cycle of rail transit is crucial, and it is necessary to attach great importance to and do a good job in safety and emergency response to prevent major accidents. Rail transit is an infrastructure for urban operation and management, which involves the travel convenience and safety needs of the public, and requires government departments to take the lead, and government, industry, academia, research and use to collaborate, strengthen the analysis and research of the industry, and release the relevant issues, research directions and tasks proposed by experts from all aspects in a timely manner, so as to drive more institutions and scholars to participate in the research of safety and emergency management in the rail transit industry; actively strengthen the publicity and training It also helps operating enterprises to establish emergency management systems and regularly organizes education and training services in the field of emergency management; researches and implements emergency plans and drills for urban rail transit operations; strengthens special inspections on safety and emergency management of urban rail transit to ensure that various policies and regulations are implemented and enforced in actual operation and management work.

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