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Research on Urban Metro Emergency Dispatching Command System's Current Situation and Development Trend

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Abstract: The emergency dispatching command system ofurban rail transit, the work of each part is carried out quickly and orderly.The emergency dispatching command system is the core of the emergency system and plays the role of baton. Therefore, it is necessary to summarize and study the present situation and development trend of urban rail transit emergency dispatching command system. This paper mainly uses the comprehensive evaluation model to study the "intelligence", "stabilization" and "high efficiency" of the emergency dispatching command system of urban rail transit. The development trend of emergency dispatching command system of urban rail transit in the future is forecasted.

1. Introduction

Urban rail transit is composed of subway system, light rail system, monorail system, tram system, maglev system, automatic guide rail system and municipal rapid rail system. At present, China's urban rail transit has stepped into a new era of rapid development. With the rapid development of urban rail transit, its safety problem has gradually become the focus of attention from all walks of life. In train operation, similar signal system failure, station fire, earthquake, stampede accident, sudden increase in passenger flow and other emergencies occur from time to time. Therefore, the urban rail transit emergency scheduling command system is very important, the system will be lines needed for emergency system integration for an organic whole, after the incident, determine the nature of the event, quickly issued a warning, accident treatment, appease workers, such as urban rail transit emergency scheduling command system by issuing instructions, to make every part of the work fast and orderly, emergency scheduling command system is the core of emergency system, have the effect of the baton. As the most widely used system in the metro system, this paper takes the metro system as the main body to study the emergency command system of urban rail transit in China. Therefore, it is necessary to summarize and study the current situation and development trend of emergency dispatching and command system of urban rail transit.

This paper will discuss the research contents as follows: in Section1, this paper mainly introduces the subway development trend of each major city in China, and makes an overall data analysis from multiple dimensions; In Section2, this paper mainly discusses the relevant work of domestic and foreign experts and scholars on the current situation and development trend of urban

rail transit emergency dispatch and command system, and summarizes its research fields and research methods. In Section3, this paper establishes a comprehensive evaluation model, taking the research of various scholars as samples, so as to discuss the development trend of urban rail transit emergency dispatch and command. In Section 4, this paper summarizes the development trend and current situation.

2. Overview of Urban Rail Transit Development (URTD)

Table 1 Operating mileage and number of cities in 2020

City	Operating mileage/km	line/line	City	Operating mileage/km	line/line	City	Operating mileage/km	line/line
Shanghai	705	17	Changsha	102	4	Peach garden	36	1
Beijing	689	22	Changchun	100	5	Guiyang	35	1
Guangzhou	491	14	Ningbo	96	4	Changzhou	34	1
Nanjing	378	10	Hefei	94	3	Harbin	32	2
Wuhan	335	9	Shenyang	89	3	Urumqi	28	1
Chongqing	331	10	Kunming	88	4	Lanzhou	26	1
Shenzhen	304	8	Nanning	81	3	Hong Kong	23	1
Chengdu	302	7	Xiamen	72	2	Xuzhou	22	1
Tianjin	231	6	Wuxi	61	2	Foshan	21	1
Hong Kong	228	11	Nanchang	60	2	Macao	9	1
Qingdao	174	4	Fuzhou	56	2			
Suzhou	166	4	Wenzhou	54	1			
Xi'an	162	5	Jinan	48	2			
Dalian	158	4	Shijiazhuang	46	2			
Taipei	153	8	Kaohsiung	43	2			
Zhengzhou	151	5	Dongguan	38	1			

Table 2 Operating mileage and number of cities in 2019

City	Operati-ng mileage /km	line/line	City	Operating mileage/km	line/line	City	Operat-ing mileage/km	line/line
Shanghai	670	15	Hangzhou	115	3	Qingdao	45	2
Beijing	617	20	Kunming	89	3	Wulumuqi	44	1
Guangzhou	474	14	Shenyang	89	3	Changchun	39	2
Shenzhen	286	8	Changsha	82	3	Dongguan	38	1
Wuhan	264	8	Nanning	81	3	Guiyang	34	1
Chengdu	222	6	Ningbo	75	2	Xiamen	30	1
Chongqing	215	7	Wuxi	56	2	Shijiazhuang	28	2
Nanjing	176	5	Fuzhou	55	2	Jinan	26	1
Tianjin	167	5	Dalian	54	2	Foshan	22	1
Zhengzhou	134	4	HeFei	52	2			
Xi'an	123	4	Haerbin	50	2			
Suzhou	121	3	Nanchang	49	2			

1. The line length data of Guangzhou Foshan line is divided into geographical regions, and other data are included in Guangzhou;
2. As of the end of 2018, the projects that have not been approved will not be included in the planned mileage of Metro;

3. The data does not include Hong Kong, Macao and Taiwan.

China's subway system has developed rapidly in recent decades. Not only has the total number of subway miles grown rapidly and steadily, but also more and more cities have built and opened subways. Metro carries a large amount of urban commuter passenger flow due to its low energy consumption, high travel efficiency and large per unit passenger load. As of December 31, 2010, only 13 cities in China had completed and opened subways. By December 1, 2020, 35 cities, 31 cities in mainland China and 4 cities in Hong Kong, Macao and Taiwan with nearly 200 subway lines have been completed and put into operation.

According to the comparison and analysis of the data in Table 1 and Table 2, compared with 2019, the total mileage of subway operation in Shanghai, Beijing, Guangzhou and other cities has increased, and the lines in Hefei, Shanghai and other places have also increased. Moreover, urban rail transit in China has been convenient for many Chinese people.

And in 2019, China's seven metro daily passenger loads per kilometer of the city is close to ten thousand, 16 cities metro daily more than ten thousand passengers per kilometer, even two cities of shenzhen and xi 'an daily more than twenty thousand passengers per kilometer, in addition, 12 Chinese cities metro daily traffic millions, 17 cities average daily traffic to break. Thus it can be seen that the popularity of urban rail transit in China is high.

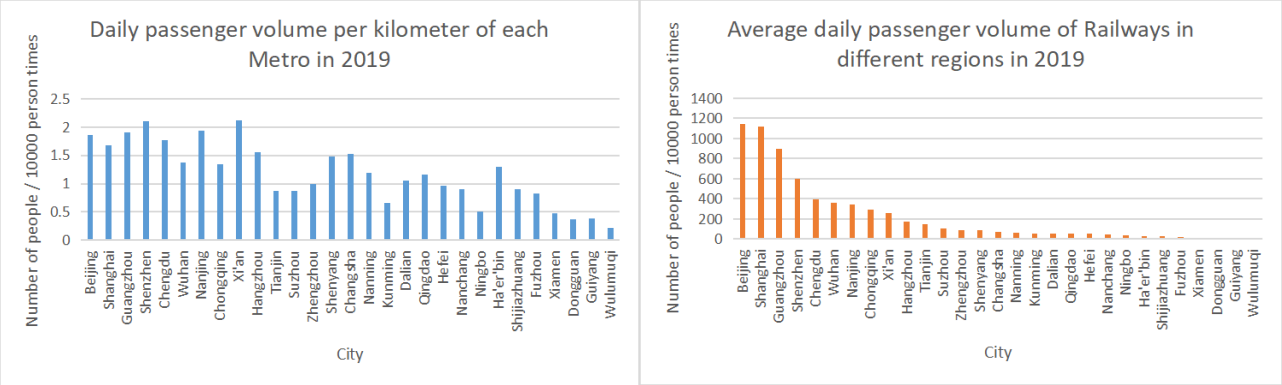

Figure. 1 Daily passenger volume and Average daily passenger per volume kilometer of each Metro in 2019

Among them, China's urban subway emergency management has been transformed from "artificial" to "automatic". PIS (passenger information system), GIS (geographic information system), FAS (fire management system) and other systems cooperate with each other to form an emergency management system under the command of the emergency dispatching command system. The emergency dispatching command system of urban rail transit is the core of its emergency system, which enhances the coordination and linkage of all departments, so that all departments can play their roles in time, cooperate with each other, enhance efficiency, and minimize the loss of emergencies. The emergency dispatch and command system of Urban rail transit in China is bound to develop into an "intelligent" one, and the formation of an "intelligent" and "artificial" emergency dispatch and command system is one of the future development trends.The early warning system is an important part of urban rail transit emergency dispatching command system, but the accuracy and effectiveness of automatic early warning function and safety prevention and control function. It still needs to be improved.Early warning system is an important part of urban rail transit emergency dispatching command system, but the accuracy and effectiveness of automatic early warning function and safety prevention and control function still

need to be improved. In addition, the formulation and audit of emergency plans should also tend to be electronic.

3. Related Work

With the rapid development of urban rail transit in China, the research on its safety is deepening. Therefore, the research on urban rail transit emergency dispatch and command system is increasing day by day. For the urban rail transit dispatch and command system, there are mainly "digital", "information", "intelligent" and other development trends. In addition, there are also related researches on the maintenance of circuit system to ensure its normal operation.

By combining theory with practice, Hu Hua et al. [1] not only evaluated the development of urban rail transit in China, but also designed the software and hardware structure of urban rail transit emergency dispatch command system, making an important contribution to the development of urban rail transit emergency command system in China. Jia Wenzheng et al. [2] proposed a specific demonstration of the functions of the emergency command system by constructing scenarios, describing tasks and functions based on scenario analysis. Ji Xin et al. [3] studied the business objectives and system framework of the emergency command system through qualitative analysis, and put forward reasonable methods in the aspect of subway operation and management. History Shenzhuo [4] also used the qualitative analysis method, studied the double-channel information transmission mechanism, and highlighted the core role of the system.

LAN Huifeng et al. [5] deeply discussed the advantages of the emergency command system of Qingdao metro network through example demonstration, construction of mapping and other methods, and provided a reference case for the emergency command system of other regions. Chen Jiamin [6] expounded the application of GIS in the dispatching command system through qualitative analysis, and showed the importance of GIS system. Xiong Guoqiang [7] analyzed the emergency evacuation of subway in case of emergency by means of model establishment and empirical analysis, highlighting the importance of releasing real-time information.

To sum up, studies have been made on the functions, systems, core functions and information transmission of urban rail transit emergency dispatch and command.

4. Comprehensive evaluation model of the URTD

Table 3 Basic data and analysis results of urban passenger flow and line length

City	Peak passenger flow of single line (10000 person times / hour)	The length of the line(km)	Lines (lines)	Total line length (km)
Beijing	6.06	52.9	22	689
Shanghai	5.84	82.4	17	705
Guangzhou	6.43	64.41	14	491
Shenzhen	5.29	40.98	8	304
Tianjin	1.83	42	6	231
City	Positive ideal distanceD	Negative ideal distanceD-	Relative proximityC	result
Beijing	0.718	1.692	0.702	2
Shanghai	0.338	1.798	0.842	1
Guangzhou	0.802	1.368	0.631	3
Shenzhen	1.595	0.778	0.328	4
Tianjin	1.988	0.025	0.012	5

The pressure on the emergency dispatch command system of subway is enormous, and the pressure on the emergency dispatch system will increase with the increase of passenger flow in the peak period. The pressures on different regions may seem different, but they are very similar. This article is based on a single line peak traffic (m/h), the line length (km), with the line (article), line the total length (km) is built up based on TOPSIS analysis method of comprehensive evaluation model of urban rail transit emergency development tendency, and it is concluded that the ideal distance of positive and negative ideal distance and relatively close to analysis and sorting results as shown in table 3:

Table 4 Research on system development

name	frequency	present situation	trend	result
Intellectualization	12	8	4	1
High efficiency	7	4	3	3
Stabilization	10	7	3	2

At present, the pressure of the emergency dispatch command system mainly comes from how to ensure the correctness and efficiency of the emergency dispatch decision. This requires the intelligent development of the emergency dispatch command system, so the system must ensure the operation of "intelligent", "efficient" and "stable". When the early warning system carries out the early warning, the emergency dispatching command system should immediately specify the emergency plan, and then assign tasks to each subsystem, which can quickly execute tasks.

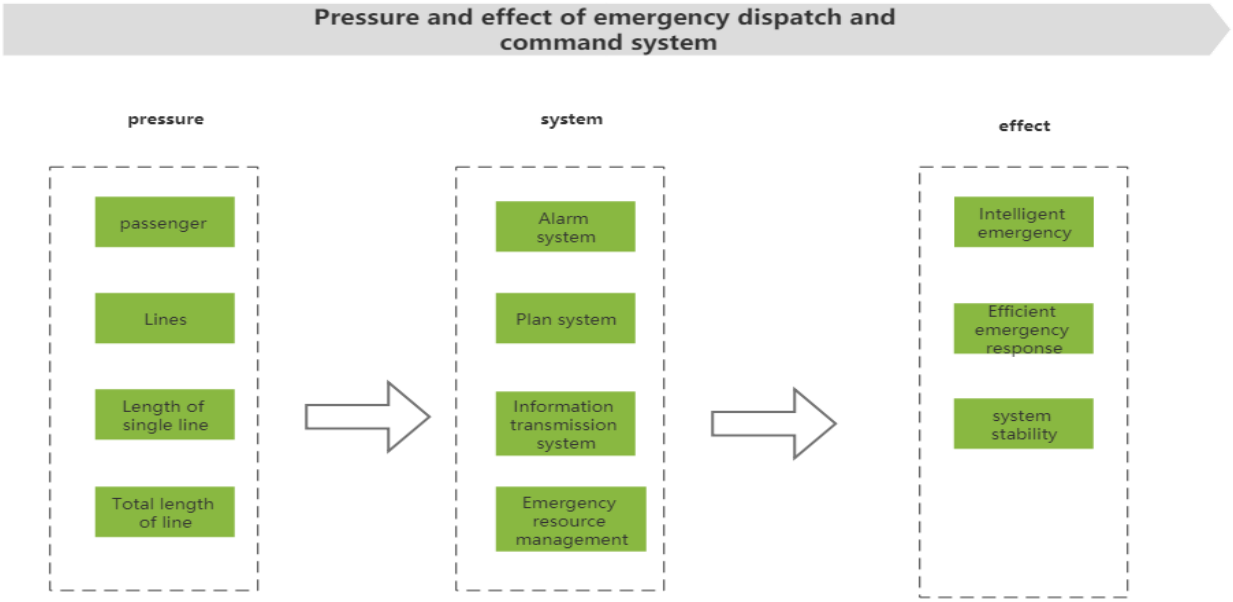

Figure. 2 Pressure and effect of Urban Rail Transit

Intelligent information release, intelligent security early warning, intelligent plan formulation, intelligent security prevention and control, intelligent subsystems and intelligent system coordination are important aspects of system intelligence. The TOPSIS comprehensive evaluation method was used to analyze the data (as shown in Table 5), and the six aspects were studied. First, the research frequency, advantages and disadvantages of the research data were statistically analyzed, followed by the same-trending processing, followed by the normalization processing of

the data, and finally, the research trend was analyzed through its similarity degree.

Nowadays, the most important research on the emergency dispatching command system of urban rail transit is the intellectualization, among which the most important is the research on the system coordination intellectualization. The operation of the system should not be independent, but should cooperate with and support each other, and integrate GIS, PIS, electronic communication and other technical means to establish a scientific and intelligent emergency dispatch and command system of urban rail transit.

Table 5 Analysis of "intelligent" data of urban rail transit emergency dispatching command system

Name	Frequency	Advantage	Shortcoming	Positive ideal distanceD	Negative ideal distanceD-	Relative proximityC	Result
Intelligent information release	15	12	3	1.015	0.825	0.448	3
Intelligent security early warning	6	2	4	1.676	0.1	0.056	6
Intelligent planning	20	14	6	1.054	1.08	0.506	2
Intelligent security prevention and control	6	5	1	1.288	1.017	0.441	4
Intelligent subsystem	7	5	2	1.383	0.445	0.244	5
Intellectualization of system cooperation	24	18	6	1	1.414	0.586	1

The second is "stabilization". For efficient operation of the system, the first thing is to ensure its stable operation, which requires the combination of internal factors and external factors. Internally, its optimization function needs to fit the reality, and the adopted optimization strategy should be verified and practical. In the future, the sub-systems should be improved, the early warning system and security defense system should be optimized, the pre-plan should be informationized, etc., the external power supply methods should be diversified to ensure the sufficient electric quantity of the circuit, and the stable communication with the external security department should be ensured, etc. And the last is "high efficiency". Now the basic speed of subway can reach 85km/h, the running time is greatly reduced, the system should deal with problems quickly and efficiently, and the emergency warning should be quick. The formulation of preplan should be accurate and effective; The speed of receiving, dispatching and continuing alarm is accelerated to minimize the influence and solve the problem reasonably.

In a word, the future urban rail transit emergency dispatch command system is more inclined to improve the system the focus is on the improvement of the early warning system and the intellectualization of the pre-warning system. The early warning system can accurately and effectively send out the early warning, and the emergency dispatching and command system issues the task, and the emergency plan system specifies the emergency plan, so as to quickly complete the task and carry out more in-depth research in the aspects of realizing data sharing, multi-party cooperation and deepening intelligence.

5. Conclusion

Based on the establishment of the comprehensive evaluation model of urban rail transit emergency dispatch and command, this paper summarizes that the top three directions of its development trend are "intelligence", "stabilization" and "high efficiency". In future work, the development of evaluation indicators should take human factors into consideration, because the development trend of urban rail transit emergency dispatch and command must be the trend of the

organic combination of "artificial + machine intelligence". In addition, it is necessary to evaluate the current situation and trend of urban rail transit emergency dispatch combined with the construction time, social support and other factors of each city.

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