The Enlightenment on Emergency Management of Elevator

Ziliang An\textsuperscript{1,a,*}, Ning Wang\textsuperscript{2,b}, Zhihui Li\textsuperscript{1}, Dingsong Bai\textsuperscript{2}, Ningli Gan\textsuperscript{1}, Yuxin Huang\textsuperscript{1}

\textsuperscript{1} School of electromechanical engineering and information, Shanghai Urban Construction Vocational College, 201415 Shanghai, China
\textsuperscript{2} School of Railway Transportation, Shanghai Institute of Technology, 201418 Shanghai, China
\textsuperscript{*email: anziliang@succ.edu.cn, \textsuperscript{b}email: 371641619@qq.com.}

Abstract. Elevator is not only a means of transportation for people, but also a symbol of national science and technology. With the hot topic in the field of elevator safety, the public awareness of elevator emergency management has increased remarkably. In response to the current fragmentation dilemma of elevators in China, elevator information management system is integrated by Multi department and the operating information is pushed by APP software, so the elevator accidents would be processed effectively.

1. Introduction
Elevators are the main vertical means of transportation inside the stairs. It is distributed in various locations of the building. Hence, effectively responding to elevator safety is the inescapable duty of the government\cite{1}. In addition to rescuing the trapped people in time, the significance also requires analysis and judgment through big data\cite{2}. Additionally, Special Equipment Supervision and Inspection Institute provides early-warning information for high failures. Improving the rescue efficiency of professional teams can reduce personnel injuries, so as to ensure public safety. Although it has obtained achievement in the government and emergency-management department\cite{3-6}, there is a lack of emergency management system and emergency-linkage mechanism of elevator. As for emergency management of elevator in China, it is imperative to build a robust emergency-linkage mechanism of elevator.

In this paper, the shortcomings of elevator emergency management are reviewed from kinds of literatures, accident reports, news, etc. The PHM (Prognostic and Health Management) and SCADA (Supervisory Control And Data Acquisition) of elevators is mainly aimed at the stage of operation, maintenance, service and information-supervision. In order to improve the emergency management system, four evaluation strategies are proposed.

2. Development in China
With the acceleration of urbanization, the number of elevators in China is growing rapidly at a rate of about 15% every year, as shown in Figure 1. China's annual output of elevators has reached one-third of the world, and China has now become the world's largest elevator manufacturer and user\cite{7-14}. Subsequently, the Chinese department handles an average of two or three elevator failures every day, sounding the alarm for elevator safety.
In order to strengthen the emergency management of elevator safety, the Chinese government issued relevant laws and regulations, as shown in Table 1. In 2003, the State Council first proposed to explore the safety supervision of special equipment. In 2014, it clearly put forward the service platform of elevator emergency in "Guiding Opinions on Promoting the Construction of Elevator Emergency Response Service Platform". In February 2018, the "Opinions of the General Office of the State Council on Strengthening Elevator Quality and Safety Work" was put forward, which clearly stated that elevator emergency rescue should be included in the emergency rescue system. In response to the new requirements of emergency management, various provinces have introduced supporting implementation measures. For example, the Shanghai and Jiangsu government issued "Implementation Opinions on Strengthening Elevator Quality and Safety Work".

Table 1 Elevator laws and regulations promulgated by the Chinese government

| Year | Bill Name | Content |
|------|-----------|---------|
| 2003 | 《Special Equipment Safety Supervision Regulations》 | Safety supervision of special equipment |
| 2014 | 《Special Equipment Safety Law of the People's Republic of China》 | Strengthen the safety of special equipment and prevent accidents of special equipment |
| | 《Guiding Opinions on Promoting the Construction of Elevator Emergency Response Service Platform》 | Improve emergency handling and service capabilities of special equipment such as elevators |
| 2015 | 《Notice on accelerating the construction of elevator emergency handling service platform》 | Promote the construction of elevator emergency handling service platform |
| 2018 | 《Opinions of the General Office of the State Council on Strengthening Elevator Quality and Safety Work》 | Proposed to incorporate elevator emergency rescue into the emergency rescue system |
| 2020 | 《Guiding Opinions of the General Office of the State Council on Comprehensively Promoting the Reconstruction of Old Communities in Cities and Towns》 | Install elevators in buildings where conditions permit, and coordinate elevator emergency rescue work |
In the past ten years, the government has continuously strengthened elevator safety work, and established a public service platform for elevator emergency rescue. In order to promote emergency management of elevator safety, state and society actively respond to the call. According to incomplete statistics, as of early 2020, 56.3% of cities in China have established emergency-rescue platforms of elevator safety. The remaining half of the cities, which 70% is second- and third-tier cities, did not take effective actions because of the lack of institutions, personnel, and funding. This means that since the national regulatory authorities put forward clear work goals in 2014, the situation of work progress is not optimistic. The government has invested a lot in the past year, but it still cannot establish a sound emergency management of elevator. This is due to a series of problems caused by regional differences, and negligence on emergency management. Government should increase their investment in emergency management of elevator to ensure the safety of people's lives.

3. Challenges and Opportunities
Elevator supervision system in the United States has been carried out for more than 100 years. Its background is based on enough practical experience. In contrast, China has only focused on emergency management of elevator in recent 30 years, so the development of theory and practice does not have enough experience. There are mainly the following challenges:

Firstly, a complete emergency management system of elevator has not been established. Each industry has its own management system, and relevant departments need to improve China's emergency management of elevator as soon as possible.

Secondly, there is a lack of emergency-linkage mechanism during the emergency response period. Emergency management of elevator involves the power of all sectors of society. The vertical emergency management system of China's emergency management department is relatively complete, but the division of horizontal responsibilities of each department is not clear enough.

Thirdly, the government lacks overall planning for emergency management of elevator. Elevator failures are characterized by unpredictability and complexity. The government only understands the emergency management of elevator as a technical task, and fails to see the integrity and linkage behind it.

Fourthly, professional teams of elevator emergency management pay attention to form and ignore substance. At present, there is a lack of professional teams that can integrate the elevator theory and practical experience.

Fifthly, the emergency management department lacks financial support. The financial funds proposed by the emergency management department are not approved in a timely manner, which prevents the dispatching work.

4. Evaluation Strategy
There are several ways to improve China's emergency management of elevator:

Firstly, it is necessary to establish a complete emergency management system in China. There needs to improve emergency plan laws and regulations, and emergency capacity building in the early warning stage. Otherwise there will identify potential elevator risks and evaluate the possibility of danger. In emergency preparation stage, it is particularly important for the establishment of an information platform and the provision of emergency equipment. In emergency response stage, coordination of various departments and real-time tracking of rescue conditions are the top priority. For the post-event recovery stage, summarizing the experience of rescue results is of great help in improving future emergency response capabilities.

Secondly, it is important to establish a service platform of elevator emergency. This platform is mainly built by the government, mobile communication company, and the elevator company. It is still in the construction stage. This requires the emergency communication equipment of the elevator to be led by the communication management department. The purpose is to provide reliable communication guarantee for timely rescue. It may also require state agencies and emergency management departments to formulate relevant emergency plans and emergency management training.
Thirdly, it is imperative to build a robust emergency-linkage mechanism of elevator, as shown in Figure 2. Elevator emergency work requires the cooperation of Special Equipment Supervision and Inspection Institute, elevator maintenance bureau, emergency management agency, housing construction agency, and medical emergency agency. For example, the housing construction agency may require the property company to post elevator emergency response signs. The Special Equipment Supervision and Inspection Institute shall cooperate with the safety rescue team of the emergency management agency to carry out elevator rescue training for safety personnel. The elevator emergency-linkage mechanism can solve emergency management of elevator problems to a large extent and improve social safety.

![Figure 2 Emergency-linkage mechanism of elevator](image)

Fourthly, the government should promptly approve the financial funds proposed by the emergency management department. This approach can not only improve the public safety system, but also reduce the probability of accidents. More financial funds are invested in emergency management training, drills and publicity. This requires the leadership of the human resources and social security departments and the cooperation of safety supervision agencies, which can improve the professional quality and technical capabilities of maintenance personnel.

5. Conclusion
Elevator emergency management is a comprehensive system, which covers government, elevator safety supervision, emergency management departments, etc. With the promulgation and enforcement of elevator emergency management regulations, the reliability of elevators has been greatly improved. But the government should to focus on coordination and efficiency to overcome the current fragmentation dilemma of China's elevators. The emergency management department forms a cooperative relationship with different departments by building a diversified emergency rescue system. In addition, it is necessary to build a sound and long-term emergency-linkage mechanism of elevator. The elevator emergency for the service platform needs to achieve the information disclosure, decision-making safety, and timely rescue. Only in this way can we build a comprehensive emergency management system to ensure the safety of people's lives and property.

References
[1] YANG Hua. Government Responsibility in Public Management of Elevator Safety Emergency. China Elevator, 2020,31(24):28-33.
[2] Song Tao, Wu Sheng, Deng Guang. Emergency rescue mechanism for elevator trapped people accident. Plant Maintenance Engineering, 2018(24):26-27.
[3] Zhang Xupeng, Qiu Zhimei. Research on elevator emergency handling capacity building. China Elevator, 2018, 29(10):33-35.

[4] Han Shuxin, Ma Shun, Li Zhong, Li Weizhong, Liu Songguo, Yuan Jianfeng. Research on Urban Elevator Emergency Rescue System and Mechanism. Journal of Safety Science and Technology, 2013, 9(02):145-150.

[5] Woon-Yong Kim and SoonGohn Kim and Seok-Gyu Park. The Implementation Model of the Emergency Video Call System for Deep-Depth and High-Rise Buildings Lifts. Indian Journal of Science and Technology, 2015, 8(25).

[6] He Huajin and Long Yinxin and Yu Wei. Design and Simulation of Elevator Emergency System Based on TIA Portal V15.1. Journal of Physics: Conference Series, 2021, 1802(4): 042089-.

[7] Announcement of the State Administration for Market Supervision and Administration on the Safety Status of National Special Equipment in 2020. China Special Equipment Safety, 2021, 37(04):1-4.

[8] Announcement of the State Administration for Market Supervision and Administration on the Safety Status of National Special Equipment in 2019. China Special Equipment Safety, 2020, 36(04):1-4.

[9] Announcement of the State Administration for Market Supervision and Administration on the Safety Status of National Special Equipment in 2018. China Special Equipment Safety, 2019, 35(04):1-4.

[10] Announcement of the State Administration for Market Supervision and Administration on the Safety Status of National Special Equipment in 2017. China Special Equipment Safety, 2018, 34(05):1-4.

[11] Announcement of the State Administration for Market Supervision and Administration on the Safety Status of National Special Equipment in 2016. China Special Equipment Safety, 2017, 33(04):1-5.

[12] Announcement of the State Administration for Market Supervision and Administration on the Safety Status of National Special Equipment in 2015. China Special Equipment Safety, 2016, 32(04):15-18+37.

[13] Announcement of the State Administration for Market Supervision and Administration on the Safety Status of National Special Equipment in 2014. China Special Equipment Safety, 2015, 31(05):1-5.

[14] Announcement of the State Administration for Market Supervision and Administration on the Safety Status of National Special Equipment in 2013. China Special Equipment Safety, 2014, 30(06):1-4.