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Research on Monitoring and Pre-Warning Analysis of Subway Stampede Accident

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Abstract: In order to prevent the subway stampede accident, the basic characteristics of subway stampede accident were analyzed, the evolution process of subway stampede accident was summarized, and the key factor leading to subway stampede accident was determined to be crowd density, and the importance of building subway stampede accident Pre-warning system was clarified. By combing and constructing the linkage mechanism of subway stampede accident alarm, as the basic framework, a new subway stampede accident Pre-warning system is proposed and developed, which includes crowd density monitoring system, emergency evacuation system and broadcast information system. Through the crowd density monitoring system, the risk value of crowd crowding in the subway station can be quantified, and the Pre-warning information of subway stampede can be sent. The emergency evacuation system and the broadcast information system can quickly respond to evacuate the crowd, reduce the risk, and realize the control of the risk of subway stampede, which can effectively prevent the subway stampede.

Keywords: Subway Stampede Accidents, Pre-Warning Systen, Crowd Density

1. Introduction

The continuous advancement of urbanization in China has led to the imbalance between supply and demand of resources, especially in transportation resources, especially in subway. Due to the underground closed environment, the flow of people is relatively concentrated. If an emergency occurs, the evacuation order of people in the subway station will be disordered, and the risk of subway stampede accidents caused by crowd congestion and other factors is high. [1]

In view of the emergency mode of subway crowded stampede, it tends to deal with after the event, follow the principle of "people-oriented, first pass, then reply", and make every effort to rescue, so as to minimize the impact and loss. [2] At the same time, many scholars have done a lot of research on subway stampede accidents, which has laid a rich theoretical foundation for emergency management of subway crowding and stampede events. For example, Gu Zongchao et al., studied the influence of crowd movement trajectory and path dependence in a specific space on subway stampede accidents. [3] Sun Guilei et al. constructed a subway evacuation model to study the optimal evacuation path. [4] The existing emergency management system and theoretical research of subway crowding and stampede events all focus on the post-processing of subway crowding and stampede events, ignoring the pre-prevention of subway stampede accidents, especially the research of subway stampede accident Pre-warning system.

In view of this, the author intends to summarize the evolution process of subway stampede accidents, determine the key factors that lead to subway stampede accidents, and try to build a new subway stampede accident Pre-warning system based on these factors, in order to promote the transformation of subway stampede accident emergency mode to pre-prevention.

2. Accident Alarm Linkage Mechanism

The occurrence of subway crowded stampede is inevitably the result of the joint action of many factors. This paper studies and analyzes the subway stampede accident, tries to restore the evolution process of the subway stampede accident, and finds the key factors that lead to the subway stampede

accident. Aiming at these factors, an accident alarm linkage mechanism is constructed to provide technical support for the subway stampede accident Pre-warning system.

2.1. Analysis of Subway Crowded Stampede Accident

When a stampede occurs in the subway, the rescue work is difficult due to the relatively closed underground environment and the restrictions of the surrounding construction structure. Statistics show that the subway stampede accidents mainly occurred at the entrance and exit escalators, inside the carriages and on the platform, and the accidents mainly occurred during the peak hours of work on weekdays, which were 8:00 ~ 10:00 in the morning and 17:00 ~ 19:00 in the evening. [5] The causes of the accident include equipment failure, sudden illness of people and the need to avoid falling objects in front of them.

Crowded and stampede accidents in the subway are usually caused by unexpected factors affecting the dense crowd, leading to panic among passengers who do not understand the situation and causing crowd disturbance and chaos. The disorder gradually spreads to the surrounding crowd, and finally leads to the subway crowded and stampede accident. [6] Although the subway stampede accident occurs in a short time and does not have a wide range of injuries, the scope and impact of the accident often expand because the crowd involved in the subway stampede area cannot timely and scientifically respond to the emergency. [7] Therefore, it is urgent to monitor the pedestrian flow, personnel density, abnormal crowd behavior, and abnormal environmental changes in the subway, and to build a subway stampede accident alarm system combined with the tide and regularity of the subway large passenger flow. [8]

2.2. Construct Alarm Linkage Mechanism

Based on real-time monitoring data such as pedestrian flow and crowd density, the passenger flow analysis algorithm is used to calculate the number of passenger flow in key areas in real time. When the passenger flow exceeds the threshold, that is, when the crowd density is ρ=5, combined with relevant historical monitoring data, real-time data of passenger flow, real-time monitoring data of abnormal crowd behavior, three-dimensional reality model and other information, risk control measures are taken. In order to prevent the subway crowded stampede accident. [9]

The effective prevention of subway stampede is to control the crowd density before the accident, and control the total number of people in high-risk areas of the subway. Even if an emergency occurs, the limit of the number of people will not be reached. [10]

The subway crowd density monitoring system uses the system theory process model construction and system function concept. Through real-time monitoring signal collection, the crowd density change information in the area is fed back to the accident alarm system in time, and the monitoring value and the system set value are compared to decide whether to alarm, and then transmitted to the emergency evacuation system and broadcast information system. Using the crowd density data in the subway, the emergency evacuation route is formulated, and the evacuation instructions are executed by the broadcast information system, so as to reduce the risk of subway stampede accidents. Figure 1 shows the linkage mechanism of subway crowding and stampede alarm.

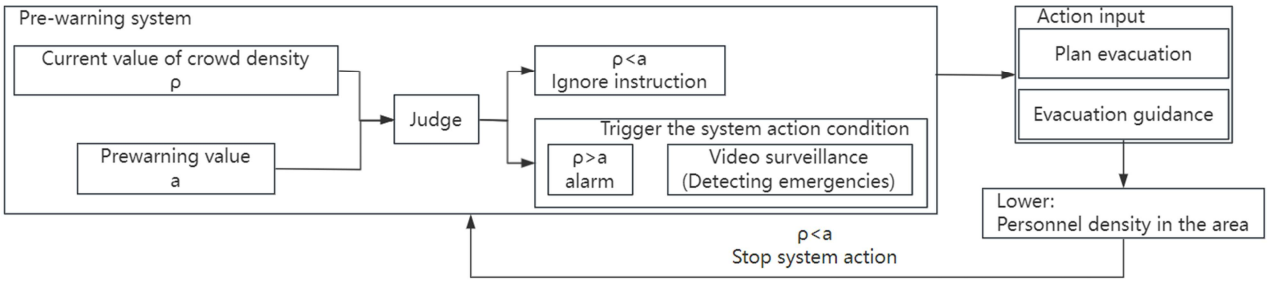

Figure 1. *Alarm Linkage Mechanism of Subway Stampede Accident.*

3. Subway Stampede Accident Warning System

According to the linkage mechanism of subway stampede alarm, a new subway stampede accident Pre-warning system can be developed, which includes crowd density monitoring system, emergency evacuation system and broadcast information system. [11] The crowd density monitoring system is used to monitor the crowd density in the subway station in real time, and determine whether the density of each monitoring area reaches the preset risk value. If the risk value is reached or exceeded, the use of mobile phones, television, emergency broadcasting, public area publicity screen and other media to timely issue public warning, at the same time to the responsible departments or units of Pre-warning, and the monitoring data and alarm information will be transmitted to the emergency evacuation system and broadcast information system. [12] The subway crowded stampede accident warning system is shown in Figure 2.

The crowd density monitoring system will receive the alarm information and the evacuation plan information imported by the emergency evacuation system, and publish the alarm information and evacuation plan information through voice broadcast and/or LED screen. [13]

Through the deployment of long-distance RFID readers, video monitoring equipment and human fall monitoring terminals, the actual situation in the subway station is monitored, recorded and analyzed in real time, and the risk of crowd stampede is quantified. [14] The computer is used to calculate the current situation, and a reasonable evacuation plan is obtained. The actual situation of the subway station, a public place, is scientifically and effectively controlled, and the negligence of the artificially led emergency plan is avoided. At the same time, it can also put forward targeted evacuation proposals to prevent subway stampede accidents, and effectively reduce the loss of people and property caused by emergencies, so as to realize the objective control of emergencies. [15] A stampede accident occurred in the subway. The subway stampede accident Pre-warning system is controlled in an intelligent way, which makes the handling of emergency events more timely and reliable.

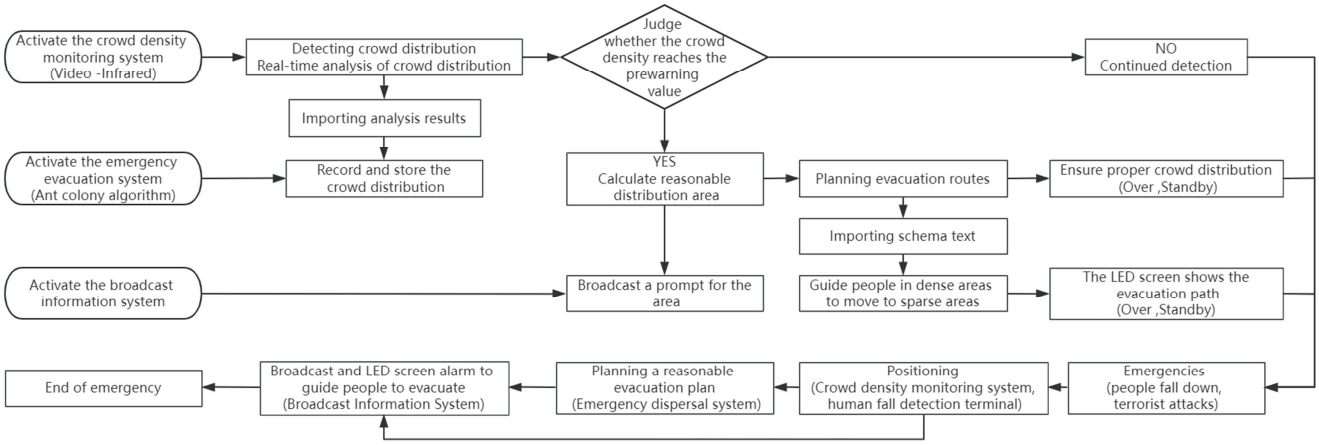

Figure 2. *Subway Stampede Accident Warning System.*

4. Conclusion

Through automatic monitoring and Pre-warning, the system records and analyzes the actual situation in the subway station in real time, and quantifies the risk value of crowd crowding and stampede. Through computer simulation, scientific and effective control measures and solutions are put forward, so as to realize the control of subway stampede accident risk. The application of the monitoring and Pre-warning system can effectively prevent subway stampede accidents, reduce casualties and property losses.

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Conflicts of Interest

The authors declare no conflicts of interest.

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