Safety Risk Analysis and Countermeasures for Performance Activities

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Abstract: The risks associated with performance activities not only affect the performance's outcome but can also lead to casualties, property damage, and serious public opinion issues. Based on this, this paper analyzes the main risk factors in performance activities, including personnel factors, environmental factors, equipment and facilities, management factors, and inherent activity factors. To address these safety risks, the paper proposes strategies such as improving safety management systems and emergency plan formulation, enhancing training and management of performers and staff, introducing advanced digital technologies and equipment, and strengthening third-party inspections of equipment. The aim is to reduce risks in performance activities and improve the scientific and safety aspects of performance management, thereby ensuring safety and empowering the high-quality development of the cultural industry.
***Keywords*:** Performance activities, Risk assessment, Safety management

1. Introduction

In recent years, with the continuous improvement of people's cultural living standards, various performance activities have emerged, with increasingly diverse forms and higher levels of professionalism. In performance activities, safety risks related to personnel, environment, equipment and facilities, management, and other factors often arise, such as production safety risks, operational risks, and social ideological risks. As performance projects increase nationwide, various risks have emerged in domestic performance activities. For example, in Xiamen Circus City, an actor fell from a height during an acrobatic performance, resulting in one death; at the Martyrs' Stadium in Kinshasa, a stampede occurred during a concert, causing at least nine fatalities. How to effectively identify and respond to these risks has become key to improving the safety management level of performance activities. This paper systematically analyzes the main safety risk factors in performance activities and proposes corresponding countermeasures, aiming to reduce the risks involved in performance activities and enhance the scientific and safety management of performances, thereby ensuring safety and empowering the high-quality development of the cultural industry.

2. Risk Factor Analysis

2.1 Personnel Factors

2.1.1 Personnel Density

The number of participants is an important parameter for assessing the scale of a performance activity. As the scale of performances and related activities continues to grow, the crowd density within these events increases. High-density crowds heighten the safety risks of the event and make effective management difficult, which can disrupt the normal progress of the event and lead to accidents. For instance, on the evening of October 29, 2022, a large-scale stampede occurred during a Halloween party in Itaewon, Seoul, South Korea, resulting in 159 deaths and over 150 injuries. This was the ninth-largest stampede accident of the 21st century.

2.1.2 Crowd Composition

(1) Age and Gender Composition.

The age and gender composition of the crowd also affects the safe operation of performance activities. Elderly individuals, women, children, and disabled people are more vulnerable and prone to injury. In public spaces, the higher the proportion of these vulnerable groups, the greater the risk of crowding and stampede accidents. In performance activities, the audience demographic varies according to the type of performance. For example, opera performances typically attract older audiences, children's theater has more children in attendance, and musicals tend to attract more female viewers.

(2) Group Composition.

The audience, performers, and staff are the primary groups involved in performance activities. Each group has different psychological states and participates in different aspects of the performance, often in distinct environments, meaning the risks they face can differ. The audience is a key participant in the event but is often unfamiliar with the environment. More-

over, their limited ability to escape or provide assistance during an emergency increases the risk of crowding and stampede accidents. The risk is even higher when the audience includes vulnerable groups such as the elderly or children. Performers face risks mainly due to unfamiliarity with the new environment, insufficient rehearsal protection, and inadequate stage equipment safety. Staff members' primary risks involve operational errors with equipment or the inherent unreliability of the equipment itself, which could cause harm[1].

(3) Personnel Status.

Personnel status refers to the psychological and emotional states of the crowd, such as excitement, anxiety, or panic. The main factors influencing personnel status include political factors, the nature of the activity, and safety awareness.Political factors: Malicious individuals may take advantage of the dense and highly mobile crowds at performance activities, exploiting safety oversight vulnerabilities to create terror events, leading to a loss of control among the crowd and causing mass casualties.Nature of the event: The nature of the performance activity influences the emotional fluctuations of the crowd. As the event reaches its climax and emotions rise to extreme levels, the crowd becomes more prone to emotional imbalance, which can lead to dangerous accidents.Safety awareness: An individual's safety knowledge is influenced by their age and profession, and these factors contribute to their safety awareness and ability to respond to risks. Thus, the crowd's structure and emotional status can reflect their level of safety awareness and risk management capability.

2.2 Environmental Factors

2.2.1 Natural Environment

During the preparation and execution of performance activities, the natural environmental risk factors include catastrophic weather events and geological disasters, such as typhoons, heavy rain, floods, tsunamis, earthquakes, and mudslides. These risk factors can lead to casualties and property damage. It is important to note that these natural environmental risks are often constrained by the level of on-site management, which can also trigger secondary accidents such as fires and crowd stampedes.

2.2.2 Surrounding Environment

Industrial Hazards: Industrial hazards are a critical factor when assessing the safety of the surrounding environment of performance venues. When selecting the location for a performance, it is important to ensure the venue is situated far from major industrial facilities and maintains a safe distance from them to avoid the risk of explosions, fires, or gas leaks from industrial facilities.Traffic Environment: Performance activities are usually accompanied by the gathering and dispersal of large crowds within a short time frame. The surrounding traffic environment of the event venue plays a crucial role in managing the flow and evacuation of people, and is closely related to the level of service provided by local roads and traffic systems.Emergency Shelters: During performance activities, large crowds of people and vehicles typically gather. In the event of a public emergency, suitable emergency shelters should be identified to redirect the crowd and vehicles to safer evacuation points.

2.2.3 Social Environment

The smooth execution of performance activities is an important component of urban cultural life, and it also serves to showcase the city's image to the public. When assessing the risks of performance activities, it is essential to consider indices that reflect the economic and social level of the hosting area. Local factors such as employment rates, crime rates, and income stability can serve as useful indicators for evaluating the potential risks associated with the performance.

2.3 Facility and Equipment Factors

2.3.1 Professional Equipment Safety and Reliability

In performance activities, stage equipment includes systems such as stage machinery, lighting, audio-visual systems, and special effects. The safety and reliability of stage equipment directly impact the safety of both the audience and performers. In recent years, with the integration of culture and tourism, and the rapid development of the performance industry, the use of stage equipment has become more widespread, and the risks faced by various types of performances have increased. The primary risks associated with stage facilities and equipment include structural safety, electrical fires, and operational safety hazards[2].

2.3.2 Infrastructure Safety and Reliability

(1) Buildings and Structures.

Buildings and structures serve as the main carriers for performance activities. The safety and reliability of these structures directly affect the smooth execution of the event. This is particularly important for temporary stages and grandstands, which have the following characteristics: increasingly innovative designs, short construction periods, tight timelines, high difficulty, and complex functions, all of which present significant safety risks.

(2) Power Systems.

Power systems include electricity transmission, transformation and distribution systems, electrical facilities, and back-up power generation systems. The main hazards threatening the safety of power systems include electrical line interruptions, electrical fires, and electric shock incidents.

(3) Communication Systems.

When hosting large-scale performance events, the massive movement of people can cause a sudden surge in mobile phone users and increased traffic in critical areas. If the network's capacity is insufficient, it may fail to ensure normal communication and network security between the event site and the outside world.

(4) Integrated Underground Pipelines.

The underground integrated pipeline network is an essential part of the infrastructure, including power, communication, water supply and drainage, and gas pipelines. The primary hazards and risks related to these systems include fires, explosions, pipeline ruptures, leaks, line interruptions, and collapses.

(5) Security Facilities.

Security facilities such as perimeter fencing, fire protection equipment, electrical safety monitoring systems, safety lighting, smoke exhaust systems, ventilation systems, and lightning protection devices provide essential safety guarantees for the event venue environment.

3. Strategies for Addressing Safety Risks in Performance Activities

3.1 Improve Safety Management System and Strengthen Risk Management Throughout the Entire Performance Process

A comprehensive safety management system is the cornerstone of performance activity safety. It is essential for performance activities to establish and refine a safety management system, clearly defining the safety responsibilities and duties of each level of personnel. By specifying the responsibility chain, the system ensures that safety management covers every stage of the performance process. The primary responsible organization for the event should conduct a detailed risk assessment prior to the activity, identifying potential safety hazards and developing corresponding preventive and control measures[3].For example, before the performance, attention should be paid to weather forecasts. If adverse weather is expected, preparations should be made in advance, such as setting up rain shelters or reinforcing stage facilities. In addition to strengthening preventive measures before the event, an emergency response team should be established, with clearly defined roles and responsibilities for each member. The team must be able to make quick decisions during emergencies and coordinate resources from all parties involved.In the event of an emergency, it is essential to activate the event's emergency management system. More importantly, government command agencies must mobilize their forces to form a coordinated response. Relevant departments should follow the emergency plan issued by the command agency, determine the level of the emergency, assign responsibilities, and work together in a unified effort to carry out emergency response actions and minimize damage and impact.

3.2 Improve the Emergency Plan Formulation System and Enhance Accident Emergency Response Capability

Formulating a comprehensive emergency plan and regularly conducting drills are key measures for improving accident emergency response capability. Through emergency drills that simulate actual performance accident scenarios, the effectiveness and operability of the plans can be tested. Detailed emergency plans should cover various types of emergencies that may occur during performance activities, such as equipment failures, crowd stampedes, or performance interruptions. The plan should outline clear emergency response procedures, including accident reporting, on-site rescue, crowd evacuation, and medical treatment, ensuring that each step is assigned to specific personnel, and the processes are smooth and efficient. In routine work, regular risk assessments of performance activities should be conducted and normalized. Additionally, it is necessary to establish and improve the emergency system for performance activities, enhancing the ability to respond to unexpected events. This ensures that resources can be quickly integrated after an emergency occurs, crowds can be swiftly evacuated, and the situation can be controlled and managed in a timely and effective manner.

3.3 Strengthen the Training and Management of Performers and Staff to Improve Comprehensive Quality

Personnel are a critical factor in performance activity risks. Raising the safety awareness and improving the comprehensive quality of relevant performance personnel are essential to ensuring the safety of performance activities. In daily work,

performers and staff should receive basic safety awareness training and education on safe operating procedures. This training should include safety regulations, operating procedures, and protective knowledge. Through these training programs, the personnel involved in performance activities can stay updated on the latest safety standards, acquire necessary safety skills, and better mitigate risks during actual operations.For high-risk performance actions, performers should undergo sufficient rehearsal and be equipped with the necessary protective gear. Due to the unique nature of performance activities, the safety management work involves multiple parties. All responsible parties should maintain regular communication and coordination throughout the entire event process to strengthen collaboration and clarify the cooperative relationships between them. This ensures the smooth operation of safety management tasks, increases sensitivity to potential crises, and further improves the overall safety of performance activities.

3.4 Introduce Advanced Digital Technology and Equipment to Dynamically Monitor Potential Risks in Performance Activities

With the development of technology, digital technology continues to advance in the cultural industry, and its role in performance activity management has become increasingly prominent. By utilizing information and security technologies, it is possible to effectively provide early warning and monitoring for risks such as crowd safety capacity, venue conditions, unauthorized personnel, fire hazards, and dangerous chemicals during performance activities [4]. Therefore, when conditions permit, relevant parties in the activity should actively introduce advanced digital technology and equipment to establish dynamic monitoring systems that can better identify and manage potential risks in performance activities.

(1) Using Drones and 3D Modeling: By utilizing drones, 3D modeling, and similar technologies, the performance site environment can be comprehensively and continuously monitored in real time, allowing for the early detection of potential environmental risks such as geological or meteorological hazards. These technologies can provide precise data to help performance management teams make scientific decisions and responses promptly.

(2) Performance managers can use smart sensors, the Internet of Things (IoT), and infrared scanning technology to monitor the operating conditions of stage mechanical equipment, ensuring the equipment operates at optimal status and reducing the likelihood of safety accidents caused by equipment malfunctions. Additionally, big data analysis and artificial intelligence can be used to predict potential risks during the performance, allowing for early preventive measures to be taken.

(3) A digital platform for performance management can be developed to integrate various monitoring data, enabling information sharing and real-time updates. This significantly enhances the efficiency of on-site safety management. Through these technological methods and devices, performance managers can achieve round-the-clock, comprehensive dynamic monitoring of the performance site, greatly improving the ability to manage safety risks.

3.5 Strengthen Third-Party Inspection and Testing of Stage Equipment, and Ensure Proper Equipment Maintenance Management

The inspection, testing, and maintenance of stage equipment are crucial components in ensuring the safety of performance activities. Professional third-party inspection agencies (with CMA certification), which are independent of the commissioning party and have no financial ties with the construction party, can provide impartial, complete, and fair inspection reports. These agencies conduct their work in compliance with national laws, regulations, and relevant standards or specifications. They can effectively assess the quality, reliability, and safety of stage equipment, comprehensively evaluating aspects such as design calculations, equipment selection, manufacturing processes, layout, installation, commissioning, and safe operation. This process ensures that stage equipment meets relevant safety and performance requirements, which is essential for preventing risks related to stage equipment during performances.

Furthermore, the maintenance and management of equipment and facilities cannot be overlooked. The performance management team should establish a detailed equipment management system, regularly inspecting and servicing the equipment, and promptly replacing aging or damaged parts to avoid safety incidents caused by equipment malfunctions. For critical equipment—such as fire curtains, motorized hoists (scenery rigs), lighting poles, main curtain machines, single-point hoists, and sound reflectors—dedicated personnel should be responsible for daily maintenance to ensure the equipment is in good working condition throughout the performance. During the event, professional technicians should be on-site to monitor the operation of equipment in real-time, allowing for the immediate identification and resolution of any issues.

4. Conclusion

Performance activities involve complex and diverse risks, covering factors related to personnel, environment, equipment and facilities, management, and the activities themselves. Effective risk assessment and control are critical to ensuring the smooth execution of performances. To manage these risks effectively, the advancement of technology and updated

management concepts provide opportunities to improve safety and risk control during performance activities. This can be achieved by enhancing the safety management system, establishing emergency response plans, strengthening the training and management of performers and staff, and actively integrating advanced digital technologies. Additionally, third-party inspection and testing should be strengthened to dynamically monitor and reduce potential risks related to equipment during performances.

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