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Article

Risk prevention and control of personal injury accidents in stadium activities

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Abstract: As stadium activities become increasingly popular, the frequency of accidents involving personal injuries has gradually increased, posing a serious threat to the safety of society and participants. To effectively prevent and control these accidents, this study systematically analyzes the common types and causes of personal injury accidents in stadium activities and employs various risk assessment models to scientifically evaluate these risks. The results show that inadequate facilities, insufficient management measures, and weak safety awareness among participants are the main risk factors leading to accidents. Additionally, the study explores the probability and severity of various types of accidents in different stadium activities and proposes corresponding risk prevention and control measures. It is recommended to enhance the construction and maintenance of stadium facilities, improve the safety management capabilities of personnel, strengthen safety education and training, and develop and implement scientific emergency plans to effectively reduce accident rates and improve the overall safety level of stadium activities. This study aims to provide valuable reference points for relevant management departments, thereby better ensuring the safety and health of sports participants and promoting the sustainable development of the sports industry.

Keywords: stadium activities; personal injury accidents; risk assessment; facility construction; safety management

1. Introduction

1.1. Research background

With the rapid development of modern society, stadium activities have increasingly become an essential part of people's lives. Whether it is large-scale sports events, entertainment performances, or community sports exercises, the frequency and scale of stadium activities are continuously growing. However, while enjoying the pleasure and health benefits brought by sports activities, the occurrence of personal injury accidents often troubles event organizers and participants. Because stadium activities usually involve large crowds, once an accident occurs, it often leads to severe consequences, not only posing a threat to the physical health of participants but also potentially arousing widespread public concern and anxiety.

In the context of frequent personal injury accidents, strengthening the identification and management of potential risks in stadium activities becomes particularly important. This issue concerns not only individual life safety and health but also public safety and the sustainable development of the sports industry. The investments by governments and organizations in the sports industry reflect this point. For example, the total revenue of the sports industry in the United States reaches hundreds of billions of dollars, with the NFL and NBA generating over $5 billion and $2 billion annually [1], respectively. In the United Kingdom, the Premier League

generates more than £3 billion annually, while in China, investments in sports infrastructure continue to increase, such as the total investment of approximately 20 billion CNY for the 2022 Beijing Winter Olympics.

However, the consequent personal injury accidents from sports activities cannot be ignored. In the United States, approximately 500,000 people are injured annually due to sports activities, and in the UK, about 200,000 people are injured each year due to football activities [2]. In China, about 100,000 teenagers are injured annually from sports activities. Facing such high injury rates, it is urgent to strengthen the safety management of stadium activities and propose effective risk prevention and control measures. Through systematic research and scientifically effective preventive measures, the accident rate can be significantly reduced, thereby improving the safety management level of stadium activities and providing the public with a safe and healthy sports environment.

1.2. Research objectives

1) The purpose of this study is to systematically explore the risk factors of personal injury accidents in stadium activities and propose corresponding preventive measures to effectively reduce the incidence of accidents, thereby ensuring the life safety and health of participants [3]. By analyzing the current status of safety management in stadium activities both domestically and internationally, identifying, and evaluating the common personal injury risk factors in stadium activities, and using scientific risk assessment models to conduct quantitative and qualitative analysis of these risks, this study aims to propose practical preventive measures. The goal of this study is not only to provide theoretical guidance but also to offer practical suggestions for stadium managers and relevant departments, enhancing the overall safety management level of stadium activities.
2) The study has significant theoretical and practical implications. Firstly, through systematic analysis of the risk factors of personal injury accidents in stadium activities, this study can enrich and improve existing risk management theories, promoting the development of research on stadium safety management. Secondly, by using scientific risk assessment models for quantitative and qualitative analysis of risks in stadium activities, the study provides data support and theoretical basis for risk management.
3) From a practical perspective, the preventive measures proposed in this study will be directly applied to the safety management of stadium activities, enhancing the response capability and decision-making level of managers. By improving facility construction, strengthening safety education, improving management systems, and developing emergency plans, the study aims to effectively reduce accident rates and ensure the life safety and health of participants [4]. Furthermore, the findings of this study can serve as a reference for the formulation and implementation of relevant policies, promoting the healthy and sustainable development of the sports industry and increasing public confidence and participation in stadium activities.

2. Research background

2.1. Current state of research

In the field of stadium activity safety management, scholars worldwide have conducted extensive research. Chinese scholars primarily focus on the construction of safety management systems, the application of modern safety technologies, and safety risk assessments in stadiums. Efforts include formulating safety regulations, training safety personnel, and improving emergency response plans to enhance overall safety management levels. However, despite some achievements, the research content remains relatively singular, mainly focusing on technical aspects, lacking comprehensive research and practical applications. Additionally, there is a notable deficiency in interdisciplinary studies.

In contrast, research in other countries is more diverse. For example, scholars in the United States and the United Kingdom have conducted in-depth studies on international safety standards and norms, such as the safety guidelines of the International Association of Amusement Parks and Attractions (IAAPA). They also examine the safety management models of stadiums in different countries and regions, comparing their strengths and weaknesses. These countries place great emphasis on building a safety culture by raising the safety awareness of spectators and staff, thereby enhancing overall safety management levels [5]. However, these studies face limitations as well, such as the failure of many theoretical research findings to translate effectively into practical applications and a lack of empirical research support.

Overall, both in China and internationally, there are certain shortcomings and limitations in the research on stadium activity safety management. The research tends to be singular, lacking empirical and interdisciplinary studies, and there is a need to improve the integration of theory and practice. Future research should focus on combining theory and practice, using multidisciplinary research methods to enhance the safety management level of stadium activities and ensure the life safety and health of participants.

2.2. Current safety management in stadium activities

Safety management in stadium activities is a critical aspect of ensuring the life safety and health of participants. To effectively prevent and control personal injury accidents, various safety management measures are typically implemented in stadium activities and continuously optimized and improved in practice. Firstly, the construction and maintenance of safety facilities are crucial. This involves ensuring that the infrastructure of the stadium, such as stands, passages, and emergency exits, meet safety standards, with regular inspections and maintenance to promptly repair any damage [6]. Clear safety signs and indicators should be placed in key locations to help participants quickly locate emergency exits and rescue equipment. Secondly, personnel management and training are essential. Stadium staff and volunteers should undergo systematic safety training to acquire basic safety knowledge and emergency response skills. Regular emergency drills should be conducted to enhance the staff's ability to respond and collaborate during emergencies. Audience management and control are also important. Through reasonable personnel diversion and control

measures, the congregation of spectators in specific areas can be avoided, reducing the likelihood of stampede accidents. Security checks at entry points should prevent dangerous items from being brought into the stadium. Additionally, equipping with emergency plans and rescue equipment is crucial. Detailed emergency plans should be formulated, clearly defining the handling procedures and responsibilities for various emergencies to ensure a rapid response in urgent situations. Adequate emergency rescue equipment, such as fire extinguishers, first aid kits, and Automated External Defibrillators (AEDs), should be available and maintained in good condition [7]. Lastly, safety supervision and evaluation involve regular comprehensive safety inspections of the stadium to identify and eliminate potential safety hazards. Scientific risk assessment methods should be used to evaluate the safety status of stadium activities, providing suggestions and measures for improvement. These safety management measures are widely applied in various stadium activities and are continuously optimized through practical experience, improving overall safety levels. Effective safety management can significantly reduce the accident rate, providing participants with a safe and enjoyable activity environment.

2.3. Relevant theories and models

Theories on Causes of Sports Accidents primarily explain the reasons behind accidents in sports activities, generally encompassing human factors, technical factors, and environmental factors. The human factors theory emphasizes that unsafe behaviors and decision-making errors by participants are the main causes of accidents. The technical factors theory focuses on the impact of equipment failures and technical defects on accidents. The environmental factors theory addresses the influence of weather, field conditions, and external disturbances on accidents. These theories help us understand and analyze the potential causes of accidents in sports venues, thereby improving the prevention and control of such incidents.

Stadium Risk Management Theories emphasize identifying, assessing, and controlling risks within stadiums to ensure the smooth conduct of activities and the safety of participants. The prevention theory focuses on identifying and eliminating potential risks to prevent accidents. The emergency management theory responds swiftly to incidents after they occur to minimize losses. The risk dispersal theory aims to reduce the impact of a single incident on the overall operation of the stadium by diversifying risks, such as introducing insurance mechanisms and distributing personnel movement [8]. The risk trade-off theory balances risks and benefits to decide whether to implement specific risk management measures, such as balancing economic costs and safety investments. The application of these theories helps systematically enhance the safety management level of stadiums.

Common Risk Assessment Models for Stadiums include the Risk Matrix Model, Analytic Hierarchy Process (AHP), Fault Tree Analysis (FTA), Event Tree Analysis (ETA), and Bayesian Network. These models are used to quantify and analyze risks within stadiums by evaluating the likelihood and impact of risks and categorizing them into different levels to help managers prioritize high-risk factors. The Risk Matrix Model assesses the likelihood and impact of risks, categorizing them into high, medium, and low levels. The Analytic Hierarchy Process analyzes the importance of

different risk factors using a hierarchical structure to determine priorities. Fault Tree Analysis builds fault tree models to analyze possible causes and pathways of incidents. Event Tree Analysis predicts the consequences of different event pathways using event tree models. Bayesian Network uses probability-based graphical models to represent conditional dependencies among variables, assessing risks under uncertain environments. The comprehensive application of these assessment models can effectively prevent and control accidents, ensuring the safe operation of stadiums.

3. Research methods

This study selects multiple representative stadiums as the research objects, covering various types of sports activities, including large-scale sports events, daily training, and community sports activities. The selected stadiums not only include large comprehensive stadiums in cities, such as Olympic venues and the home grounds of professional sports clubs, but also small and medium-sized stadiums in schools and communities. This diverse selection ensures the wide applicability and representation of the research results.

3.1. Data collection and analysis methods

1) Questionnaire Survey: Design detailed questionnaires targeting stadium managers, coaches, athletes, and spectators to collect their opinions and suggestions on stadium safety management.
2) Field Inspection: Conduct field inspections of the selected stadiums to record the condition of facilities, safety measures, and management processes, and interview on-site management personnel.
3) Accident Report Analysis: Collect and analyze various personal injury accident reports from the selected stadiums over the past few years to explore the causes of accidents and response measures.
4) Application of Risk Assessment Models: Use risk assessment models such as FTA and AHP to conduct quantitative and qualitative analyses of the collected data, evaluating potential risks in stadium activities.

3.2. Selection of risk assessment models

To ensure the accuracy and scientific validity of the research results, this study will employ the following risk assessment models:

FTA is a systematic analysis method that identifies and analyzes potential faults and their causes within a system using a logical tree diagram. In stadium risk management, FTA can help analyze the potential causes of specific accidents, such as fires or stampedes (**Figure 1**). By constructing a fault tree model, it identifies key risk factors and analyzes the paths that may lead to accidents. Its advantage lies in its ability to visually display the possible causes of accidents, aiding managers in taking targeted preventive measures. However, FTA primarily relies on expert experience, making quantitative analysis of complex systems challenging [9].

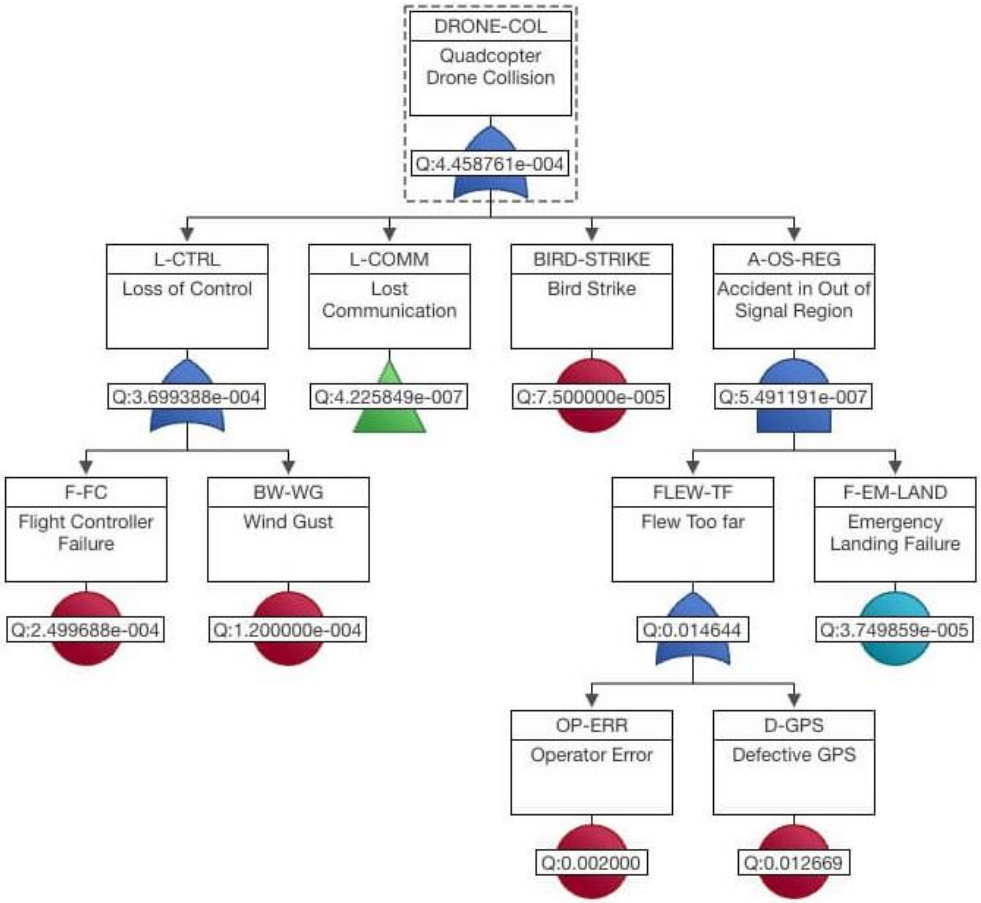

Figure 1. A sample of FTA tree.

Source: https://relyence.com/products/fault-tree/risk-analysis/.

AHP is a multi-criteria decision-making method that decomposes complex decision problems into several sub-problems through a hierarchical structure, and determines the weight of each factor through comparative judgments. In stadium risk management, AHP can be used to evaluate and compare the importance of different risk factors. For example, managers can use the AHP model to analyze the relative importance of facility failures, crowd density, and environmental factors, prioritizing the most critical risks [10]. The advantage of AHP is its systematic analysis of complex problems and provision of objective decision-making bases (**Figure 2**). However, AHP requires extensive data and expert judgments and may encounter difficulties when dealing with inconsistent judgments.

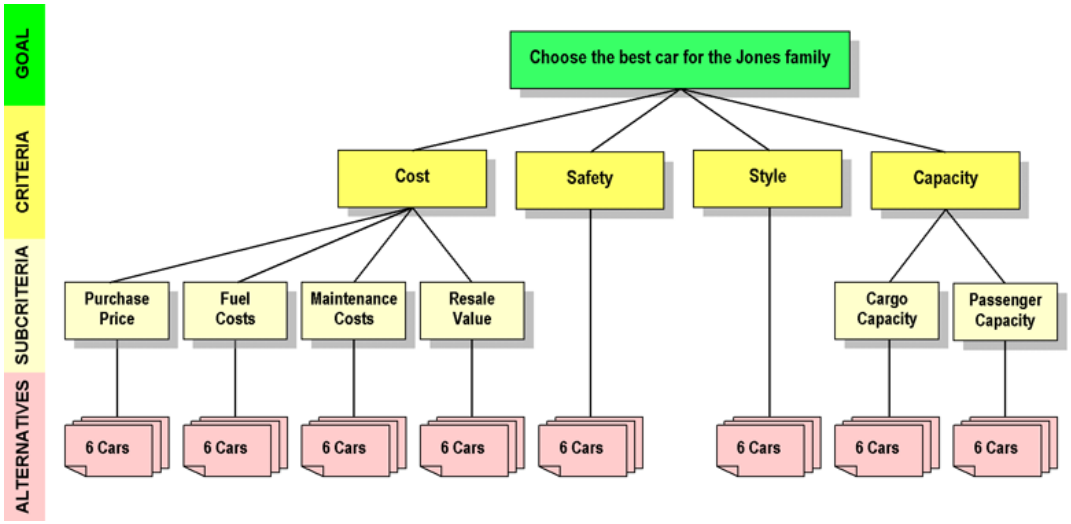

Figure 2. AHP model.
Source: https://citizendium.org/wiki/Analytic_Hierarchy_Process.

Bayesian Network is a probabilistic graphical model used to represent conditional dependencies among variables. It calculates the conditional probabilities of each variable using Bayes' theorem. In stadium risk management, Bayesian Networks can be used to assess and predict risks in complex environments. For example, by constructing a Bayesian Network model, it can analyze the impact of spectator behavior, weather conditions, and equipment status on the probability of accidents, and dynamically update risk assessment results [11]. The advantage of Bayesian Networks is their ability to handle uncertainty issues and provide flexible risk assessment and decision support. However, constructing and maintaining a Bayesian Network model requires extensive prior knowledge and data, and involves high computational complexity.

Through the comprehensive application of these methods and models, this study aims to systematically and comprehensively evaluate and analyze the risks of personal injury accidents in stadium activities and propose corresponding preventive measures.

4. Analysis of causes of personal injury accidents in stadium activities

4.1. Classification and characteristics of accidents

Theories explaining the causes of sports accidents cover human factors, technical factors, and environmental factors. The human factors theory points out that unsafe behaviors and decision-making errors by participants are the primary reasons for accidents. The technical factors theory focuses on how equipment failures and technical defects contribute to accidents [12]. Meanwhile, the environmental factors theory considers the influence of weather, field conditions, and external disturbances on accidents. These theories help us understand the potential causes of accidents in sports venues, thereby aiding in the prevention and control of such incidents.

Stadium Risk Management Theories aim at identifying, assessing, and controlling risks within stadiums to ensure smooth activities and the safety of participants. The prevention theory seeks to identify and eliminate potential risks to

avert accidents. The emergency management theory is about responding swiftly to incidents to minimize losses. The risk dispersal theory reduces the impact of a single incident on the overall operation by diversifying risks, such as through insurance mechanisms and distributing personnel movement. The risk trade-off theory balances risks and benefits to decide on specific risk management measures, like weighing economic costs against safety investments. Applying these theories systematically enhances the safety management of stadiums.

Common Risk Assessment Models for Stadiums include the Risk Matrix Model, Analytic Hierarchy Process (AHP), Fault Tree Analysis (FTA), Event Tree Analysis (ETA), and Bayesian Network [13]. These models quantify and analyze risks within stadiums by assessing the likelihood and impact of risks and categorizing them to help managers prioritize high-risk factors. The Risk Matrix Model evaluates risks' likelihood and impact, categorizing them into high, medium, and low levels. The Analytic Hierarchy Process determines the importance of different risk factors using a hierarchical structure to set priorities. Fault Tree Analysis builds models to analyze possible causes and pathways of incidents. Event Tree Analysis predicts outcomes of different event pathways. Bayesian Network uses probability-based graphical models to represent conditional dependencies among variables, assessing risks under uncertain environments. The comprehensive use of these models helps prevent and control accidents, ensuring the safe operation of stadiums.

In stadium activities, personal injury accidents vary widely and can be categorized into falls, collisions, crushes, equipment-related injuries, and environmental factor accidents. Falls often occur on slippery, uneven surfaces or in areas with many obstacles, leading to fractures, abrasions, or concussions. Collision accidents are common in high-contact sports like football or basketball, causing fractures, dislocations, or soft tissue injuries. Crush accidents happen in crowded settings, such as during the entry or exit phases of large events, leading to suffocation, fractures, or internal injuries. Equipment-related injuries arise from malfunction or improper use of fitness equipment, resulting in muscle strains, joint or ligament tears, or contusions [14]. Environmental factor accidents, triggered by natural phenomena like high temperatures, heavy rain, or lightning, cause heatstroke, dehydration, or lightning strikes.

To enhance the safety of stadium activities, data on personal injury accidents should be collected from diverse stadium activities across different geographic locations and facility types. Utilizing objective data collection methods, such as real-time monitoring systems, injury reports, and sensor-based data, would reduce bias in risk assessments. Collaborating with experts in sociology, psychology, and human factors engineering can provide valuable insights into safety behaviors and risk perceptions. Studying crowd dynamics and group behavior will help better understand and mitigate risks. For smaller or less-funded stadiums, developing low-cost, scalable solutions like simpler crowd control measures, manual safety checklists, and localized training programs is essential. Providing guidelines for non-technical interventions, such as manual crowd monitoring or printed safety guides, is crucial for regions with limited access to advanced technologies.

Finally, a framework for monitoring and adapting to changes in risk factors over time should be developed. Predictive models that consider technological

advancements, environmental shifts, and evolving sports practices will enhance the study's applicability to future scenarios. These measures will collectively contribute to safer and more effective management of stadium activities.

5. Typical case analysis

There are numerous typical cases of personal injury accidents occurring in stadium activities. The following are several cases with detailed analyses, aimed at deeply understanding the process and causes of accidents to draw valuable lessons:

5.1. San Salvador crowd crush

The stampede occurred after a match when fans hurried to leave the stadium, leading to overcrowding at the exits and a severe stampede that injured many. The analysis reveals several causes: firstly, the exit design was inadequate, with narrow passages unable to accommodate the rapid evacuation of a large crowd. Secondly, the event organizers had insufficient planning for crowd dispersal and failed to anticipate the potential surge of spectators. Additionally, security personnel on-site were unable to effectively manage the crowd and failed to guide spectators to leave in an orderly manner. This incident exposed multiple issues in stadium design and management, highlighting the importance of facility construction and emergency management.

5.2. 2019 US marathon heatstroke incident

Hot weather caused multiple participants to suffer from heatstroke among marathon in Boston, requiring urgent medical treatment. The main causes included poor scheduling of the event in high-temperature conditions without fully considering the health risks to participants. Additionally, the organizers failed to provide adequate hydration and cooling measures, such as sufficient water stations and misting systems along the course [15]. Some participants also lacked experience and awareness of the risks associated with competing in high temperatures and did not take timely self-protective measures. This incident underscored the organizers' inadequate response capabilities under extreme weather conditions, necessitating improved monitoring of high temperatures and the development of emergency plans.

5.3. 2022 FINA drowning incident

During the swimming competition at Budapest, artistic swimmer Anita Alvarez lost consciousness due to exhaustion and sank, requiring urgent rescue. The analysis indicated that the participant did not fully recover from high-intensity training and was in poor physical condition. Additionally, the pre-competition evaluation of the participant's health status was insufficient, failing to identify potential health risks. Furthermore, the rescue measures were not promptly executed, delaying the optimal rescue time. This incident highlighted the importance of physical recovery and health assessments before high-level competitions, as well as the need for organizers to enhance on-site first aid capabilities and emergency response speeds.

5.4. Beijing winter Olympics luge track training crash

A participant in the luge training experienced equipment failure while skiing at high speed, resulting in a severe fall and leg injuries. The primary cause was the quality of the luge equipment, which may have had manufacturing defects or insufficient testing. Additionally, pre-competition inspections were inadequate, failing to identify

and resolve potential equipment faults [16]. The participant's lack of understanding of the equipment's condition and failure to conduct thorough checks and adjustments before the competition also contributed to the incident. This event emphasized the importance of equipment quality and maintenance, requiring organizers to strengthen inspections and management of competition equipment to ensure the safety and reliability of the gear used by participants.

Through in-depth analysis of these typical accident cases, it becomes evident that the occurrence of accidents is usually the result of multiple factors interacting together. These factors include inadequate facility design, insufficient emergency preparedness, improper event organization, and inadequate preparation by participants. Therefore, enhancing the safety management level of stadium activities requires a comprehensive consideration of various factors and the formulation of scientifically effective risk prevention measures.

6. Risk assessment and analysis

Risk Identification: Through detailed research and analysis of actual accident cases, the main risk factors in stadium activities can be identified. These include facility risks, management risks, participant risks, and environmental risks. Facility risks primarily involve slippery or uneven surfaces, obstacles, and the aging, improper maintenance, or quality issues of sports equipment, which can lead to falls and equipment malfunctions. Management risks include the lack of safety plans, improper personnel management, and uncontrollable audience management, where ineffective management and emergency measures increase the likelihood of accidents. Participant risks stem mainly from improper behavior, lack of safety awareness, and poor physical condition, where unsafe behaviors and a lack of self-protection awareness increase accident risks [17]. Environmental risks are related to weather factors (such as high temperatures, heavy rain, strong winds) and the surrounding environment (such as complex surroundings and external disturbances), where adverse conditions can lead to accidental injuries. By identifying and analyzing these primary risk factors, targeted risk management measures can be formulated and implemented to effectively prevent and control personal injury accidents in stadium activities.

6.1. Existing risk classification methods and their results

In the risk assessment of stadium activities, commonly used risk classification methods include the Risk Matrix Model, Analytic Hierarchy Process (AHP), and Risk Scoring Model. These methods evaluate and categorize risks from different dimensions to determine the severity and urgency of various risk factors.

1) Risk Matrix Model
   - Method Description: The Risk Matrix Model evaluates the likelihood and impact of risk events, categorizing them into different levels (high, medium, low). This model constructs a two-dimensional matrix with the horizontal axis representing the likelihood of the risk event occurring and the vertical axis representing the impact of the risk event, thus visually classifying the risks [4, 7].

- Classification Results: In practical applications, risks such as inadequate facilities (e.g., slippery floors) are rated as high likelihood and high impact, thus classified as high risk. Management deficiencies (e.g., lack of emergency plans) are rated as medium likelihood and high impact, classified as medium-high risk. Environmental factors (e.g., weather changes) are rated as low likelihood and medium impact, thus classified as medium-low risk. This classification method helps managers prioritize high-risk factors.

2) AHP
   - Method Description: AHP is a multi-criteria decision-making method that decomposes complex decision problems into several sub-problems through a hierarchical structure and determines the weight of each factor through comparative judgments. Specific steps include establishing a hierarchical structure model, constructing a judgment matrix, calculating weights, and performing consistency checks.
   - Classification Results: Through AHP analysis, the relative importance of facility risks, management risks, participant risks, and environmental risks can be determined. For example, facility risks might be given a weight of 0.4, management risks 0.3, participant risks 0.2, and environmental risks 0.1. This classification result helps managers prioritize higher importance risk factors, especially when resources are limited.
3) Risk Scoring Model
   - Method Description: The Risk Scoring Model quantitatively evaluates each risk factor by establishing scoring criteria, resulting in a comprehensive score and classification. This method typically involves expert scoring and statistical analysis to ensure the objectivity and scientific accuracy of the scores [18].
   - Classification Results: In practical applications, the score for inadequate facilities (e.g., slippery floors) might be 80 (high risk), poor management (e.g., lack of emergency plans) might score 70 (medium-high risk), improper participant behavior might score 60 (medium risk), and environmental factors might score 50 (medium-low risk). This scoring method provides a quantitative basis for risk management, facilitating comparisons and decision-making.
   - Through the comprehensive application of these methods, it is possible to systematically and scientifically classify and analyze various risks in stadium activities, clarifying the severity and urgency of each risk factor. This assists stadium managers in prioritizing high-risk factors and implementing effective prevention measures, thereby enhancing overall safety management levels.

6.2. Risk prevention and control measures

Preventive Measures: To reduce the occurrence of risks in stadium activities and ensure participant safety, the following specific preventive measures can be implemented: Firstly, improve facilities by regularly inspecting and maintaining the stadium floor to ensure it is smooth, dry, and free of obstacles. Clear safety signs and

indicators should be placed in key positions to ensure emergency exits and escape routes are obvious. Additionally, regular inspections and maintenance of sports equipment and devices should be strengthened to ensure their normal operation, with timely replacement of old or damaged equipment. Secondly, enhancing management involves developing and refining detailed safety management systems and emergency response plans. This includes clarifying the procedures and responsibilities for handling various emergencies and regularly providing systematic safety training to security personnel and staff to equip them with emergency handling skills. This training enhances their ability to respond to unexpected incidents. During large events, it is essential to strategically manage crowd distribution and control measures to avoid excessive crowding and reduce the risk of congestion and stampedes [19]. Increasing participants' safety awareness is also critical. This can be achieved through various means such as safety posters, electronic screens, and broadcasts, promoting safety knowledge to spectators and participants. Pre-event safety education should emphasize adhering to stadium regulations and the importance of self-protection, with clear behavioral guidelines for participants to follow, thereby avoiding unsafe behaviors. Finally, environmental monitoring is crucial. Keeping a close watch on weather forecasts and adjusting sports activities accordingly can help avoid outdoor events during adverse weather conditions. Improving the surrounding environment of the stadium to minimize external disturbances is also important. By comprehensively adopting these preventive measures, the occurrence of risks in stadium activities can be effectively reduced, ensuring the life safety and health of participants.

Monitoring and Emergency Plans:

Establishing an effective risk monitoring system and emergency plans is crucial for ensuring the safety of stadium activities. Firstly, stadiums should be equipped with advanced monitoring equipment such as high-definition cameras and infrared detectors to continuously monitor the safety conditions inside and outside the venue, and a monitoring center should be established to promptly identify and report potential risks [9]. Additionally, a multi-level emergency plan should be established, covering common emergencies such as fires, stampedes, and adverse weather conditions. These plans should clearly define the handling procedures, responsibilities, and emergency response times for various events and regularly organize emergency drills to improve the emergency response capabilities of staff. A well-developed monitoring and emergency plan system enables rapid response and handling when accidents occur, minimizing the loss and impact caused by accidents.

Policy Recommendations and System Construction:

Given the current state of safety management in stadium activities, the following policy recommendations and system construction plans are proposed: Firstly, strict safety management regulations for stadiums should be formulated and promulgated, clearly defining the safety standards and management requirements for various stadiums. Secondly, stadiums should be encouraged to upgrade and renovate safety facilities, providing the necessary funding and technical support to ensure that facilities meet the latest safety standards. Additionally, a comprehensive safety management system should be established, including daily inspections, regular maintenance, safety training, and emergency drills, to ensure that all safety measures are implemented effectively [20]. Furthermore, a dedicated safety supervision agency

should be established to oversee and guide the safety management work of stadiums, conduct regular safety inspections and evaluations, and promptly rectify any identified issues. Through these policy recommendations and system construction, the safety management level of stadium activities can be improved, ensuring the life safety and health of participants.

7. Conclusion

This paper systematically analyzed the risk factors associated with personal injury accidents in stadium activities and proposed effective risk management strategies. Through the analysis of typical cases, the main causes of accidents were identified and summarized, including inadequate facilities, poor management, improper participant behavior, and environmental factors. In the risk assessment, models such as Fault Tree Analysis (FTA), Analytic Hierarchy Process (AHP), and Bayesian Network were applied to systematically evaluate the severity and urgency of various risks. Based on these evaluations, preventive measures such as improving facilities, strengthening management, enhancing participants' safety awareness, and monitoring the environment were proposed. Specific countermeasures included the establishment of effective monitoring systems and emergency plans. This research provides important theoretical and practical references for the safety management of stadium activities.

However, a major limitation of this study is data collection. Due to the limited scope of research objects, some data may not fully reflect the actual situation of stadium activities. Furthermore, the study's time span is limited, failing to fully consider the dynamic changes in long-term risk factors. The quantitative analysis of certain complex systems during the research process was challenging, relying on subjective judgments from experts, which may affect the accuracy of the assessment results.

Future research in the safety management of stadium activities can develop in the following directions: Firstly, expanding the scope and sample size of data collection, integrating big data and artificial intelligence technologies to achieve more comprehensive and accurate risk assessments. Secondly, conducting in-depth studies on the dynamic changes in stadium environments and facilities to explore long-term risk management strategies. Thirdly, increasing emphasis on interdisciplinary research, utilizing knowledge from sociology, psychology, engineering, and other disciplines to enhance the comprehensiveness and practicality of the research. Lastly, further improving and optimizing emergency plans and safety management systems, strengthening empirical research and case analysis to enhance the operability and practical application value of the research findings.

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