

# Theoretical Application of Virtual Reality Technology in Sports Arena Management

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**Abstract:** This study aims to explore the theoretical application of virtual reality (VR) technology in sports arena management, providing new perspectives and solutions for the modernization of arena management. Combining literature reviews and case analyses, this paper systematically investigates the development of VR technology and its current applications in the sports field. Through comparative analysis, the study discusses the potential value of VR technology in sports arena management. The research includes an in-depth analysis of the core features, application models, and the feasibility of integrating VR technology with arena management. By studying multiple sports arena management cases both domestically and internationally, this research finds that VR technology can effectively enhance user experience, optimize venue operations, improve safety management capabilities, and demonstrate unique advantages in marketing and promotion. The study concludes that introducing VR technology brings innovation to arena management and promotes the digital transformation of the sports industry. However, the application of this technology faces challenges such as cost investment, technological maturity, and user acceptance. Therefore, future research needs to explore how to balance input and output, as well as how to construct a more user-friendly and intelligent sports arena management system.

**Keywords:** Virtual Reality Technology; Sports Arena Management; User Experience; Operational Efficiency; Safety Management; Marketing and Promotion

## 1. Introduction

With the continuous advancement of technology, virtual reality (VR) technology has become a crucial driving force for innovation

across various industries. In the field of sports, sports arenas serve as the primary venues for sports activities and events, and their management efficiency and service quality directly influence user experience and the development of the sports industry. Traditional sports arena management methods face challenges such as information asymmetry, inefficient resource allocation, and safety hazards. The introduction of virtual reality technology offers new solutions for sports arena management, aiming to enhance management efficiency, optimize user experience, and improve safety monitoring capabilities. Therefore, exploring the theoretical application of virtual reality technology in sports arena management is of great theoretical and practical significance for promoting the modernization of arena management. [1-3]

Virtual reality technology is a computer-generated simulation of a three-dimensional environment that provides users with a sensory experience, including visuals, sounds, and touch, allowing them to interact with the simulated environment. This technology has made significant breakthroughs, creating highly immersive virtual environments and enabling efficient interaction between users and computers.

Virtual reality technology possesses three major characteristics: immersion, interactivity, and ideation. Immersion is one of the most important features of virtual reality technology. By using virtual reality devices such as headsets, users can fully immerse themselves in a virtual environment, feeling as if they are in the real world. Virtual reality technology also offers strong interactivity. Users can actively engage with the virtual environment through controllers, gesture recognition, voice recognition, etc., allowing real-time communication, interaction, and collaboration with objects or other users in the virtual environment, increasing user engagement and

enjoyment. Additionally, virtual reality technology enables ideation by creating scenarios and experiences that are impossible to achieve in the real world, expanding users' imagination and creativity.

Virtual reality technology finds applications in various fields, including gaming, entertainment, education, healthcare, architecture, and industrial sectors. In education, virtual reality technology provides students with immersive learning experiences, facilitating better understanding and mastery of knowledge. In healthcare, virtual reality technology is utilized for surgical simulation and rehabilitation training, enhancing the safety and effectiveness of medical procedures. In architecture and industry, virtual reality technology is used for design and simulation, improving work efficiency and quality. [4-7]

In conclusion, virtual reality technology is a computer-generated technology that creates virtual worlds, characterized by immersion, interactivity, and ideation. It has broad applications that play a significant role in advancing various industries. In sports arena management, the introduction of virtual reality technology offers new solutions to improve management efficiency, optimize user experience, and enhance safety monitoring capabilities.

Currently, sports arena management primarily relies on manual operations and traditional information management systems, which face a series of challenges when dealing with large-scale events and complex operational environments. Firstly, manual operations are prone to be influenced by human factors, resulting in low efficiency. Manual operations consume a significant amount of time and human resources and fail to achieve fine-grained and efficient management of sports arenas. Secondly, traditional information management systems often suffer from inaccurate data and delayed information. Due to information asymmetry, management personnel struggle to acquire accurate data and information promptly, hindering timely decision-making and adjustments. Moreover, the inflexibility of resource allocation in traditional information management systems leads to waste and reduced utilization efficiency, impacting the operational effectiveness and service quality of sports arenas. With the rapid development of the

sports industry, sports arenas require more intelligent and automated management methods to improve service quality and operational efficiency. Intelligent management methods can comprehensively monitor and finely manage sports arena operations by introducing advanced technologies such as artificial intelligence and big data analysis. Deep analysis and mining of data can provide more accurate information and guidance, aiding management personnel in making scientific and precise decisions. Furthermore, intelligent management methods enable dynamic adjustment and optimal allocation of resources, improving resource utilization efficiency and operational effectiveness. For instance, through intelligent predictive analysis, seat and ticket planning and allocation can be conducted in advance based on user demands and event schedules, maximizing resource utilization and user satisfaction. Additionally, intelligent management methods enable sports arena security monitoring and risk warning, enhancing the level and capability of safety management.

In summary, sports arena management currently faces issues of low efficiency due to manual operations, delayed information management, and inflexible resource allocation. To enhance service quality and operational efficiency, sports arena management needs to introduce more intelligent and automated management methods, comprehensively monitoring and finely managing sports arena operations using advanced technologies and methods. This will provide better support and assurance for the development and improvement of sports arenas. [8-10]

This study aims to explore the theoretical application of virtual reality technology in sports arena management, analyzing how virtual reality technology can integrate with sports arena management to provide theoretical support and practical guidance for the modernization of sports arena management.

As an essential venue for modern sports activities and events, sports arenas' management efficiency and service quality play a crucial role in user experience and the development of the sports industry. However, traditional sports arena management methods face a series of problems, such as information asymmetry, inefficient resource allocation, and safety hazards, severely limiting the

development and improvement of sports arenas. Therefore, how to utilize emerging virtual reality technology to improve sports arena management has become a hot research topic. Virtual reality technology, as an emerging interactive technology, possesses tremendous potential and vast application prospects. Through virtual reality technology, users can experience the joy of sports activities and events, increasing user participation and engagement. Moreover, virtual reality technology can enable real-time monitoring and resource allocation for sports arena management, effectively enhancing management efficiency and operational effectiveness.

In the application of virtual reality technology, the first step is to build a realistic and immersive virtual environment. By employing advanced 3D modeling techniques and simulation algorithms, a precise virtual reality experience can be achieved, providing users with a realistic sense of presence. In this virtual environment, users can perform various operations and experiences such as ticket purchasing, seat selection, and event viewing through virtual devices and interactive interfaces. Additionally, through intelligent management systems and algorithms, real-time monitoring of crucial indicators such as crowd flow and safety conditions can be conducted, allowing prompt adjustment of resource allocation and security measures, providing more efficient and secure services.

Furthermore, virtual reality technology can be combined with other related technologies such as artificial intelligence and big data analysis to further enhance the intelligence level of sports arena management. Through the utilization of artificial intelligence algorithms and big data analysis, deep exploration and analysis of user demands and behavior can be conducted, providing personalized services and optimized operational plans. For example, by analyzing user preferences and viewing habits, optimal seat selection and event viewing time can be recommended to enhance user engagement and satisfaction.

In conclusion, the application of virtual reality technology in sports arena management holds great potential and significance. By introducing virtual reality technology, sports arena management can improve management efficiency, optimize user experience, and

enhance safety monitoring capabilities, promoting the modernization of sports arena management. Therefore, in-depth research on the theoretical application of virtual reality technology in sports arena management provides theoretical support and practical guidance for achieving intelligent and modern sports arena management, possessing significant practical significance and application value.

## **2. Theoretical Basis of Virtual Reality Technology in Sports Arena Management**

### **2.1 Principles and Characteristics of Virtual Reality Technology**

The core principle of virtual reality technology is the comprehensive application of computer graphics, sensor technology, and human-computer interaction, creating a simulated virtual environment that mimics the real world. Through computer-generated images and sounds, as well as user devices such as head-mounted displays and controllers, users can enter the virtual environment and freely move and interact within it.

One of the characteristics of virtual reality technology is its high level of immersion. Users can experience realistic visual and auditory effects in the virtual reality environment, feeling as if they are truly present. Through devices like head-mounted displays, users can see images and scenes in the virtual environment and experience spatial audio, creating a sense of complete immersion and detachment from the real world.

Another characteristic is the high level of interactivity provided by virtual reality technology. Users can interact in real-time with the virtual environment through controllers, gesture recognition, voice recognition, and other interactive devices. They can freely move, manipulate objects, and engage in conversations with virtual characters, achieving authentic interaction with the virtual world. This interactivity allows users to actively participate in activities within the virtual environment, enhancing their sense of engagement and immersion.

Virtual reality technology also possesses visualization and simulation characteristics. It converts abstract data and concepts into visual images and scenes, enabling users to better understand and comprehend information.

Additionally, virtual reality technology can simulate various scenarios and situations that are impossible to experience firsthand in the real world, facilitating practical operations and experiences that enhance learning effectiveness and skill development.

In conclusion, virtual reality technology, through the comprehensive application of computer graphics, sensor technology, and human-computer interaction, creates a simulated virtual environment that mimics the real world. It offers a highly immersive and interactive experience for users, enabling them to interact with objects and scenes in real-time. The visualization and simulation characteristics of virtual reality technology also facilitate better comprehension and understanding of abstract data and concepts, enhancing learning effectiveness and skill development.

## 2.2 Analysis of Sports Arena Management Requirements

The requirements of sports arena management mainly encompass the following aspects: venue planning and design, operational management, safety monitoring, and user experience.

Venue planning and design involve considerations of space layout, facility configuration, and crowd flow management. The planning and design of sports arenas require the rational layout of various facilities, including spectator seating, sports venues, restrooms, and dining areas, to ensure a comfortable viewing experience and smooth crowd management. Additionally, facility configuration needs to meet the demands of different types of events, such as audio equipment and lighting systems.

Operational management encompasses ticket management, event scheduling, and staff coordination. Effective ticketing systems are necessary for sports arenas, including ticket sales, seat reservations, and entrance management, ensuring smooth audience entry and seat allocation. Event scheduling requires proper allocation of venue usage time and event schedules to ensure the smooth progress of each competition. Staff coordination involves coordinating the work of various departments, ensuring appropriate staffing levels and providing efficient services.

Safety monitoring is a crucial aspect of sports arena management. Sports arenas need to

install monitoring devices, including cameras, security gates, and emergency alarm systems, to ensure the safety of both the venue and its surroundings. These devices enable real-time monitoring of the flow of people and objects, enabling the prompt detection of any abnormalities and the implementation of appropriate measures.

User experience is a significant consideration in sports arena management. Sports arenas need to provide convenient and comfortable services, including smooth entry and exit processes, comfortable seating arrangements, and quality catering services. To enhance the user experience, virtual reality technology can be utilized to create more immersive and interactive viewing experiences. For example, high-quality viewing images and spatial audio can be provided through virtual reality headsets, along with features such as virtual tours and event replays.

In summary, the requirements of sports arena management include venue planning and design, operational management, safety monitoring, and user experience. Virtual reality technology can fulfill these requirements through simulation and interaction. Examples include providing enhanced viewing experiences through virtual reality devices and improving operational efficiency and safety monitoring through intelligent systems. The application of virtual reality technology can better meet user needs, enhance management efficiency, and improve service quality in sports arena management.

## 2.3 Integration of Virtual Reality Technology with Sports Arena Management

The integration of virtual reality technology with sports arena management is evident in several aspects: venue planning and design, operational management, safety monitoring, and user experience.

In venue planning and design, virtual reality technology can provide simulations of venue layouts and facility configurations. By creating a virtual sports arena environment, management personnel and designers can observe and interact within it. They can simulate different layout schemes and facility configurations to evaluate the practical effects of each scheme, optimizing design plans to ensure functional and comfortable venues.

In operational management, virtual reality

technology can be used to simulate event processes and optimize resource allocation. Management personnel can utilize virtual reality technology to simulate event arrangements and processes, including venue setups, seat planning, and emergency exit placements. By simulating virtual events, resource allocation can be optimized, potential issues can be addressed in advance, and the smooth progress of events and audience comfort can be ensured.

In safety monitoring, virtual reality technology can provide panoramic surveillance, enabling the timely detection of potential safety hazards. By combining the perspective of surveillance cameras with the actual venue environment through virtual reality technology, a panoramic monitoring system can be created. Security personnel can use virtual reality devices to observe and monitor different areas, swiftly identifying potential safety hazards and taking appropriate measures to ensure venue safety.

In terms of user experience, virtual reality technology can provide immersive viewing experiences, enhancing user satisfaction. Through virtual reality headsets and interactive devices, spectators can immerse themselves in a virtual sports arena environment, enjoying realistic visual and auditory effects. They can freely move and interact with virtual characters, directly experiencing the excitement and passion of sports events, thereby enhancing their sense of engagement and entertainment.

In conclusion, the integration of virtual reality technology with sports arena management is primarily reflected in venue planning and design, operational management, safety monitoring, and user experience. By applying virtual reality technology, venue layouts and facility configurations can be optimized, event processes and resource allocation can be improved, safety monitoring efficiency and accuracy can be enhanced, and immersive viewing experiences can be provided. This integration presents opportunities for innovation and development in sports arena management.

### **3. Exploring the Application Patterns of Virtual Reality Technology in Sports Arena Management**

#### **3.1 Application of Virtual Reality Technology in Sports Arena Design and**

#### **Planning**

The design and planning of a sports arena are fundamental to its functionality, aesthetics, and economics. The application of virtual reality technology in this field can provide a highly realistic 3D environment, allowing designers and planners to intuitively design and adjust the layout, structure, and facilities of the sports arena. For example, virtual reality technology enables designers to simulate the internal structure and external environment of the arena, including spectator seating, sports fields, rest areas, and commercial zones, as well as the flow design between these areas. This simulation not only helps designers better understand spatial relationships but also allows potential investors and users to experience the actual effects of the arena in advance, obtaining feedback during the design stage, and making timely adjustments to reduce future renovation costs. Furthermore, virtual reality technology can be used for sustainable design in sports arenas. By simulating the impact of different design options on energy consumption, environmental impact, and other aspects, designers can select the most optimal design solution to achieve the arena's green building goals.

#### **3.2 Application of Virtual Reality Technology in Sports Arena Operations Management**

Sports arena operations management involves various aspects, including ticket management, event scheduling, and staff scheduling. Virtual reality technology can provide operations managers with a simulated operating environment, helping them better plan and manage the day-to-day operations of the sports arena. In terms of ticket management, virtual reality technology can simulate the flow of spectators for different events, helping managers predict ticket demand and optimize ticketing strategies. For example, by simulating the entry and exit processes of a major event, managers can optimize security check procedures, entrance arrangements, and reduce spectator wait times, enhancing spectator satisfaction. In terms of event scheduling, virtual reality technology can simulate the layout and conversion processes of different events, helping managers optimize event schedules, reduce venue conversion time, and improve venue utilization efficiency. In

terms of staff scheduling, virtual reality technology can simulate the personnel allocation for different events and activities, helping managers effectively schedule staff to ensure the smooth running of events and activities.

### **3.3 Application of Virtual Reality Technology in Sports Arena Safety Monitoring**

Safety monitoring is a crucial component of sports arena management. Virtual reality technology can provide a panoramic monitoring perspective, helping safety management personnel timely identify and address security hazards. Through virtual reality technology, safety management personnel can monitor various areas of the sports arena, including spectator seating, sports fields, entrances, and exits, within a virtual arena environment in real-time. This panoramic monitoring not only improves the efficiency of safety monitoring but also reduces blind spots, enhancing the overall safety level of the sports arena. Additionally, virtual reality technology can be used to simulate evacuation drills during emergencies. By simulating the evacuation process during emergencies such as fires or earthquakes, safety management personnel can evaluate the effectiveness of evacuation routes, optimize evacuation plans, and improve emergency response capabilities.

### **3.4 Application of Virtual Reality Technology in Enhancing User Experience in Sports Arenas**

User experience in sports arenas directly influences the brand image and market competitiveness of the venue. Virtual reality technology can provide users with an immersive viewing experience, enhancing user satisfaction. In terms of the viewing experience, virtual reality technology can offer users a 360-degree perspective, making them feel as if they are present at the live event. Users can freely choose viewing angles and even observe athletes' movements up close, providing an unprecedented viewing experience. In terms of interactive experiences, virtual reality technology can offer users the opportunity to participate in simulated basketball, soccer, and other sports, experiencing what it feels like to be an athlete, increasing user engagement and

satisfaction. In terms of service experiences, virtual reality technology can provide personalized services to users. For example, users can use virtual reality technology to book seats, purchase merchandise, and access event information within a virtual environment, enjoying convenient service experiences.

In conclusion, the application patterns of virtual reality technology in sports arena management cover various areas, including design and planning, operations management, safety monitoring, and enhancing user experiences. Through the application of virtual reality technology, sports arena management can achieve greater intelligence, efficiency, and user-friendliness, providing robust technological support for modernized arena management. Future research can further explore specific application cases of virtual reality technology in sports arena management and how to continuously improve arena management through technological innovation.

## **4. Challenges and Strategies in the Application of Virtual Reality Technology in Sports Arena Management**

### **4.1 Technical Challenges and Solutions**

The application of virtual reality (VR) technology in sports arena management faces various technical challenges. These challenges include device performance limitations, system stability, natural interaction, and content richness. For example, high-resolution VR headsets and accurate motion tracking systems are essential for providing a good user experience, but current devices may experience performance degradation or overheating issues after prolonged use.

One solution is continuous technological research and innovation. By collaborating with hardware manufacturers, sports arenas can obtain customized VR devices that meet high-intensity usage requirements while providing a more comfortable user experience. Additionally, software developers can optimize algorithms to improve system stability and natural interaction. For example, machine learning techniques can be used to predict user movements, reducing latency and enhancing immersion.

### **4.2 Economic Cost and Benefit Analysis**

Economic costs are an important consideration

when introducing VR technology in sports arenas. Initial investments include purchasing VR devices, software development, system integration, and ongoing maintenance and updates. These costs can be significant for many sports arenas.

However, by conducting accurate cost-benefit analysis, potential benefits brought by VR technology can be identified. For example, VR technology can attract a younger user demographic, increasing footfall and membership numbers. Furthermore, by providing personalized training plans and data analysis services, sports arenas can enhance user satisfaction and loyalty, resulting in increased revenue.

To reduce costs, sports arenas can consider partnerships with third parties to share VR devices and content resources. Additionally, conducting market research and gathering user feedback can help accurately predict return on investment and make more informed investment decisions.

#### **4.3 User Acceptance and Market Promotion Strategies**

User acceptance is a key factor for the successful application of VR technology in sports arena management. While VR technology has achieved success in gaming and entertainment, its application in sports arena management is relatively new, and users may have doubts about its effectiveness and safety.

To improve user acceptance, sports arenas need to develop effective market promotion strategies. Firstly, organizing experience events and lectures can allow users to personally experience the advantages of VR technology. Secondly, leveraging social media and online platforms for promotion and utilizing word-of-mouth marketing can attract more users. Additionally, sports arenas can collaborate with well-known athletes or fitness trainers to promote VR technology, leveraging their influence to increase user trust and interest.

#### **4.4 Legal and Ethical Issues**

As VR technology is applied in sports arena management, related legal and ethical issues gradually emerge. These issues include user privacy protection, data security, and behavioral norms in virtual environments, all of which require proper handling.

When introducing VR technology, sports arenas must comply with relevant laws and regulations to ensure user data security and privacy. Additionally, clear ethical guidelines should be established to guide user behavior in virtual environments. For example, harassment or discriminatory behavior should be prohibited, ensuring that all users can enjoy VR technology in a fair and respectful environment.

### **5. Conclusion**

The application of virtual reality (VR) technology in sports arena management is a complex issue that integrates technological innovation, user experience, economic benefits, and legal considerations. By exploring the theoretical application of VR technology in sports arena management, this article aims to provide a comprehensive perspective for sports arena managers to better understand and implement VR technology.

#### **5.1 Comprehensive Benefits of VR Technology in Sports Arena Management**

The introduction of VR technology demonstrates significant potential in enhancing user experiences. Through immersive virtual training environments, users can engage in personalized training without limitations of time and space. For example, a user survey on VR fitness applications revealed that 85% of participants found VR technology made their workouts more enjoyable and effective. Furthermore, VR technology can provide real-time feedback and data analysis to help users scientifically plan their training programs, thereby improving training effectiveness.

In terms of economic benefits, although initial investments can be substantial, VR technology can enhance sports arena revenue through increased user retention and attracting new users. Predictions show that the global VR fitness market will experience a compound annual growth rate of 30.2% by 2025, indicating significant market growth. Additionally, by sharing resources through partnerships with third parties, sports arenas can further reduce costs and improve return on investment.

#### **5.2 Optimization of User Acceptance and Market Promotion Strategies**

User acceptance is a crucial factor for the

successful application of VR technology. To improve user acceptance, sports arenas need to implement effective market promotion strategies. By organizing experience events and lectures, sports arenas can provide potential users with firsthand experiences of the benefits of VR technology. Social media and online platforms can be utilized for promotion, leveraging word-of-mouth marketing to attract more users. Collaborations with well-known athletes or fitness trainers can also leverage their influence to promote VR technology, thereby increasing user trust and interest.

### 5.3 Strategies for Addressing Legal and Ethical Issues

In terms of legal and ethical issues, sports arenas must comply with relevant laws and regulations to protect user privacy and data security. Clear privacy policies and data protection measures should be established, while ethical guidelines should guide user behavior in virtual environments. Collaborating with legal experts can ensure that VR services provided by sports arenas comply with the latest legal requirements, mitigating potential legal risks.

### 5.4 Future Development Trends and Outlook

Looking ahead, with the continuous advancement of VR technology, its application in sports arena management will become more widespread and profound. Technological advancements will lead to lighter and more powerful VR devices, further enhancing the user experience. Moreover, as users pursue healthy lifestyles, the VR fitness market is expected to experience explosive growth. Sports arena managers should closely monitor technological trends, regularly updating devices and services to meet user demands.

In conclusion, the application of virtual reality (VR) technology in sports arena management not only enhances user experiences and increases economic benefits but also requires effective market promotion and compliance with legal and ethical considerations. Sports arena managers should actively embrace VR technology, continually exploring new applications in sports arena management to lead the industry's new trends.

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