

Abstract

Purpose : This research aims to identify the factors influencing the smartization of sports equipment in national football stadiums.

Methods : The present study is applied in nature and conducted qualitatively using a descriptive phenomenological approach. The data analysis employed the Colaizzi method. The study population included 23 experts in related fields. Data collection was conducted through semi-structured interviews, and the MAXQDA software version 20 was used for data analysis and categorization. To ensure validity and reliability, criteria such as credibility, transferability, dependability, and confirmability were employed.

Results : The results indicate that smartization of football stadiums can significantly improve fan experience, resource management, and operational efficiency. Modern technologies such as the Internet of Things (IoT), artificial intelligence, and smart management systems contribute to optimizing equipment performance and enhancing stadium security. However, continuous support and maintenance of smart systems, especially in technical areas, data security, and energy management, are crucial. Additionally, high initial costs and the need for long-term investment pose challenges that require careful planning and sufficient resources.

Conclusion: The study concludes that smartization of football stadiums can enhance fan experience, improve efficiency, and reduce costs. However, sustained support and maintenance of smart systems, along with appropriate investment, are essential for optimal system performance. Successfully implementing these processes requires addressing technical challenges, ensuring data security, and managing resources effectively.

Keywords: Identifying - Smartization - Football Stadiums

Problem Statement

Despite significant and remarkable advancements in the smartization of football stadiums in developed countries, Iran remains at an early stage of this transformation, with many of the potential benefits of smart technologies yet to be fully realized in its football stadiums. Insufficient infrastructure, lack of necessary investments, absence of coherent policies and strategic frameworks, and limited technical knowledge and skills among managers and staff are among the primary barriers hindering the development of smart technologies in Iranian football stadiums (Reis et al., 2022; Mohammadi, 2020). These obstacles have prevented stadiums from achieving optimal levels in energy efficiency, crowd management, security, and service quality, falling short of international standards.

Several recent studies have examined smart technologies in stadiums, offering valuable insights that can guide the development of this domain in Iran. For instance, Zarei et al. (2021) highlighted the critical role of the Internet of Things (IoT) and cloud computing in modernizing Iranian football stadiums, demonstrating that these technologies can substantially improve operational efficiency and security. Mohammadi (2020) emphasized the importance of intelligent surveillance systems in enhancing stadium safety and better crowd control. Additionally, Gros (2020) focused on smart energy management in

stadiums, proposing strategies to reduce their environmental footprint. In the domain of fan engagement and revenue enhancement, Yu and Lee (2021) revealed that digital technologies can increase audience participation and improve the financial performance of clubs. At the international level, Reis et al. (2022) addressed managerial challenges in implementing smart technologies in Latin American stadiums, offering valuable lessons for developing countries, including Iran.

Nevertheless, a significant gap remains in understanding the comprehensive and localized factors influencing the smartization of football stadiums in Iran. Beyond technological and managerial aspects, cultural, economic, and political dimensions can significantly impact the adoption and development of these technologies, yet these areas have not been fully explored in prior studies. Moreover, stakeholder attitudes and readiness—including those of managers, staff, athletes, and spectators—are critical success factors for the smartization process but have received limited attention in domestic research.

Furthermore, legal and regulatory issues related to data privacy and information security, especially in the context of IoT and artificial intelligence deployment within smart stadiums, present additional challenges. The absence of clear laws and standards in this area may raise concerns among users and hinder the full adoption of smart technologies.

Overall, the lack of a thorough and multidimensional identification of the facilitating factors and obstacles to smartization in Iranian football stadiums has posed significant challenges to effective planning and policymaking in this field. Therefore, this study aims to conduct an in-depth and scientific investigation of technological, organizational, cultural, economic, and legal factors affecting stadium smartization, alongside an analysis of stakeholder attitudes and readiness, to develop a comprehensive framework for advancing smart technologies in the Iranian sports sector.

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Football holds a pivotal cultural and social position in Iran, underscoring the critical need for advanced infrastructure development within the country's sports sector. Stadiums, as iconic symbols of sports development, require modernization through the integration of smart technologies to enhance their operational efficiency and meet the increasing demands of stakeholders. The smartization of stadiums presents a promising avenue to improve service quality, bolster security measures, reduce operational costs, and promote environmental sustainability (Marr, 2019). In the context of rapid technological advancements and escalating international competition in sports, neglecting this imperative could adversely affect Iran's global sporting stature.

Moreover, this study provides a scientifically grounded and practical framework for sports managers and policymakers to identify opportunities and challenges related to smartization. Given the scarcity of localized research on this topic, the findings are expected to serve as a foundation for future investigations and inform policy development, thereby contributing to the sustainable growth of sports infrastructure in Iran.

Research Methodology

This study aims to conceptually explore the dimensions of smartification in sports organizations using a qualitative approach grounded in the Grounded Theory methodology. Grounded Theory enables researchers to develop new theoretical frameworks based on empirical data and real experiences of participants. Given the complexity and emerging nature of smartification in this field, a qualitative method is best suited to gain a deep and comprehensive understanding of the phenomenon. The research population consisted of managers, experts, and researchers active in sports management and smart technologies within sports organizations across the country. Purposeful sampling was employed to select individuals with relevant knowledge and experience in smartification. Additionally, snowball sampling was used to expand the sample by having participants introduce other qualified experts. Sampling continued until theoretical saturation was reached, with a final sample size of 23 participants. Data were gathered through semi-structured, in-depth interviews. The interview questions were developed based on a literature review and focused on participants' experiences, challenges, and opportunities related to smartification in sports organizations. Each interview lasted approximately 45 to 60 minutes and was audio-recorded with participants' informed consent, then fully transcribed.

Data analysis was conducted concurrently with data collection using MAXQDA software. The process followed the stages of open coding, axial coding, and selective coding as outlined in Grounded Theory

methodology. This facilitated the extraction of concepts, their categorization, and the development of a conceptual model of smartification in sports organizations.

To enhance the validity and reliability of the findings, techniques such as member checking, peer review, and thorough documentation of the research process were employed. Ethical considerations, including maintaining participant confidentiality and obtaining informed consent, were strictly observed throughout the study

Results

The analysis of the participants' data led to identifying the factors influencing the smartization of sports equipment in football stadiums in Iran. These include 65 sub-themes grouped into six main themes: technology and innovation, accessibility and usability, security and data protection, costs and investment, fan experience, and support and maintenance. Table 1 presents the main and sub-themes of the study.

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Table 1 - Identification of Factors Influencing the Smartization of Sports Equipment in Football Stadiums

Main Theme	Sub-Themes
Technology and Innovation	- Smart systems for monitoring equipment status - Game analysis cameras - Player tracking systems - Fan crowd and traffic management - Data retrieval and problem prediction - Enhancing spectator experience with AR - Virtual reality training for players - Digital and mobile ticketing - Electronic payments and digital wallets - Interactive applications for game viewing
Accessibility and Usability	- Search and navigation systems in stadiums - Automated facilities for registration and entry - Real-time technical support - Simultaneous management of multiple users - Accessibility of systems and equipment - Fast and contactless payment facilities - Smart emergency call systems - Online services and problem prediction - Quick and easy exit routes from the stadium - Environmental status awareness systems
Security and Data Protection	- Protection of fans' personal information - Security of online payment systems - Identification and authentication systems - Security of player-related data

Main Theme	Sub-Themes
	- Prevention of cyberattacks - Protection of sensitive team and coach information - Access control to systems - Data backup and recovery - Security in wireless communication networks - Staff training in security - Real-time security analysis and monitoring - Protection of user data in applications - Prevention of traffic control system breaches - Transparency and security reporting
Costs and Investments	- Initial costs of implementing smart systems - Maintenance and support costs - Investment in IT infrastructure - Costs for staff training and empowerment - Investment in research and development - Cybersecurity-related costs - Financing models (foreign investment) - Communication and advertising expenses - Cost management and resource optimization - Energy costs and efficiency - Costs related to smart customer services - Role of sponsors and advertisements in project financing
Fan Experience	- Easy access to game information - Guidance systems in the stadium - Interactive match viewing experience - Special services for individuals with specific needs - Loyalty and reward systems for fans - Connecting fans with teams and players - Safety and comfort in the stadium environment - Mobile facilities and dedicated applications - Social spaces and gathering areas
Support and Maintenance	- Preventive and periodic maintenance - Training and empowering support teams - Updating and upgrading software and hardware - Continuous monitoring of system performance - Maintenance of security systems - Management of energy resources and consumption - Addressing issues related to mobile software and applications - Data management and storage - Identification and application of new technologies for maintenance

Discussion

This study has conceptually explored the dimensions of smartification in sports organizations, with a particular focus on the critical role of support and maintenance systems in smart stadiums. By integrating technological, organizational, managerial, and social dimensions, the research highlights how smartification can transform sports organizations, particularly through the lens of smart stadium operations. The following discussion presents the key findings, elaborates on their significance, compares them with prior research, and provides actionable recommendations for both practice and future research.

Finding 1: Importance of Preventive and Periodic Maintenance

Description: Preventive and periodic maintenance of smart systems in sports stadiums is essential to ensure uninterrupted operations and prevent equipment failures. Smart stadiums rely on complex infrastructures, including IoT sensors, AI-driven analytics, and integrated management systems, which require regular maintenance to sustain optimal performance (Deloitte, 2022). This includes routine checks on hardware (e.g., sensors and wearables) and software (e.g., analytics platforms) to mitigate risks of malfunctions during high-demand events.

Comparison and Analysis: This finding aligns with Gómez-González et al. (2020), who emphasized that consistent maintenance of smart infrastructure in sports facilities is critical for longevity and efficiency. Unlike prior studies that focus on reactive maintenance (e.g., addressing failures post-occurrence), this research underscores the proactive nature of preventive maintenance, which reduces downtime and enhances system reliability. The analysis reveals that neglecting maintenance can lead to significant operational disruptions, as highlighted by Han et al. (2022), who noted that equipment failures in smart systems can compromise athlete performance monitoring and fan experience. The integration of predictive maintenance, supported by AI and machine learning, further enhances efficiency by identifying potential issues before they escalate (Li et al., 2023).

Recommendations: Sports organizations should establish structured preventive maintenance schedules, incorporating AI-based predictive tools to anticipate and address system vulnerabilities. Training programs for technical staff should focus on predictive maintenance techniques and rapid issue resolution. Future research should investigate the cost-benefit analysis of preventive versus reactive maintenance in smart stadiums, particularly in resource-constrained settings.

Finding 2: Necessity of Continuous Technical Support

Description: Continuous technical support, including 24/7 response teams, is indispensable for managing unexpected disruptions in smart stadiums. These systems collect vast amounts of data daily (e.g., fan information, game statistics, and equipment status), requiring immediate technical intervention to address issues such as cyberattacks or system failures (Popa et al., 2024). Real-time monitoring tools, enhanced by AI, enable rapid detection and resolution of problems, ensuring seamless operations.

Comparison and Analysis: This finding corroborates Chen et al. (2019), who highlighted the critical role of responsive technical teams in maintaining spectator satisfaction and safety in smart venues. While prior studies emphasize general IT support, this research specifically underscores the need for AI-driven

diagnostic tools to minimize downtime in smart stadiums. The analysis indicates that the lack of continuous support can lead to significant reputational and financial losses, as noted by Zhang et al. (2023), who discussed the impact of system failures on fan experience. The integration of automated monitoring systems, as suggested by Deloitte (2025), enhances responsiveness by alerting technical teams instantly.

Recommendations: Stadium managers should establish dedicated 24/7 technical support teams equipped with AI-based diagnostic tools to address disruptions promptly. Partnerships with technology providers can ensure access to advanced monitoring systems. Future research should explore the effectiveness of automated versus human-led support systems in smart stadiums, focusing on response times and stakeholder satisfaction.

Finding 3: Critical Role of System Updates and Upgrades

Description: Regular updates and upgrades of smart systems are vital to keep pace with rapid technological advancements and maintain system functionality and security. Outdated systems in smart stadiums can compromise efficiency, expose vulnerabilities to cyberattacks, and hinder compatibility with emerging technologies (Li & Wang, 2021).

Comparison and Analysis: This finding aligns with Li and Wang (2021), who noted that obsolete systems in sports facilities pose significant security risks and reduce operational efficiency. Unlike prior research, which often focuses on initial technology adoption, this study emphasizes the ongoing need for system upgrades to ensure compatibility and relevance. For instance, Popa et al. (2024) highlighted blockchain's role in secure ticketing but did not address the need for continuous updates to maintain system integrity. The analysis suggests that regular upgrades, combined with compatibility testing, are essential to prevent system obsolescence and enhance long-term performance.

Recommendations: Sports organizations should implement regular software and hardware upgrade protocols, including compatibility testing with new technologies. Collaboration with technology vendors can facilitate timely updates. Future research should examine the impact of system obsolescence on smart stadium operations and develop frameworks for cost-effective upgrade strategies.

Finding 4: Energy Management as a Key Component of Smartification

Description: Effective energy resource management, supported by smart systems, is crucial for reducing operational costs and promoting sustainability in smart stadiums. Technologies such as smart grids and renewable energy integration (e.g., solar panels) optimize energy consumption and align with global sustainability goals (SpringerOpen, 2023). **Comparison and Analysis:** This finding builds on SpringerOpen (2023), which discussed the role of cloud computing in optimizing resource use in sports facilities, but extends the focus to energy-specific smart systems. Unlike Deloitte (2022), which broadly addresses IoT applications, this study highlights the specific impact of energy management on cost reduction and environmental sustainability. The analysis reveals that energy-efficient smart systems not only lower costs but also enhance the reputation of sports organizations as environmentally responsible entities, a factor increasingly valued by fans and stakeholders (Ratten, 2020).

Recommendations: Sports organizations should adopt smart energy management systems, integrating renewable energy sources like solar power to reduce costs and environmental impact. Pilot projects testing energy-efficient technologies in smaller venues can inform broader implementation.

.Finding 5: Data Backup as a Pillar of System Reliability

Description: Robust data backup systems are critical for safeguarding the vast amounts of data generated by smart stadiums, including fan information, game statistics, and equipment status. Regular backups protect against data loss due to malfunctions or cyberattacks, ensuring continuity and fan satisfaction (Appinventiv, 2024).

Comparison and Analysis: This finding aligns with Appinventiv (2024), which emphasized the importance of data management in IoT-driven sports applications. However, while prior studies focus on data collection and analysis, this research highlights the critical role of backup systems in preventing irreparable losses. The analysis suggests that inadequate backup protocols, as noted by Popa et al. (2024) in the context of blockchain security, can undermine stakeholder trust and operational continuity. Robust backup systems are thus a foundational element of smartification.

Recommendations: Sports organizations should implement automated, cloud-based backup systems with regular testing to ensure data integrity. Partnerships with cybersecurity firms can enhance protection against cyberattacks. Future research should investigate the optimal frequency and methods for data backups in smart stadiums to balance cost and reliability.

Conclusion

This study has provided a comprehensive conceptual exploration of the dimensions of smartification in sports organizations, with a particular emphasis on its transformative potential in smart stadiums. By delineating the technological, organizational, managerial, social, and data-related dimensions, the research offers a holistic framework that integrates these elements to address the multifaceted challenges faced by sports organizations, including optimizing athlete performance, enhancing fan engagement, improving resource management, and ensuring operational sustainability. The findings underscore the critical role of smartification in revolutionizing the sports industry, while also highlighting the barriers that must be overcome to realize its full potential.

The study has identified several key insights that contribute to both theoretical and practical advancements in the field. First, the technological dimension, encompassing tools such as artificial intelligence (AI), the Internet of Things (IoT), big data analytics, and blockchain, serves as the backbone of smartification, enabling real-time monitoring, data-driven decision-making, and enhanced stakeholder experiences (Deloitte, 2022; Zhang et al., 2023). For instance, IoT-enabled wearables and smart stadium infrastructure have been shown to improve athlete performance and fan satisfaction, aligning with findings from Han et al. (2022). However, unlike prior studies that focus on isolated technologies, this research emphasizes the need for integrated systems to maximize impact, addressing a gap noted by Ratten (2020).

Second, the organizational dimension highlights the importance of fostering a culture of innovation and adaptability to support smartification. As noted by Li et al. (2023), organizational readiness is a critical driver of successful technology adoption, yet resistance to change remains a significant barrier, particularly in smaller sports organizations. This study extends prior research by proposing that cultural

transformation, supported by training and leadership development, is essential for effective smartification, a perspective less explored in works like Gómez-González et al. (2020).

Third, the managerial dimension underscores the necessity of data-driven decision-making to optimize resource allocation and strategic planning. This aligns with Zhang et al. (2023), who demonstrated the impact of AI-driven analytics on sports strategies, but this study further emphasizes the need for managerial competencies to interpret and act on data insights. The integration of continuous technical support and system updates, as highlighted by Li and Wang (2021), ensures that these data-driven systems remain functional and secure, addressing vulnerabilities such as cyberattacks.

Fourth, the social dimension focuses on enhancing stakeholder engagement, particularly with fans and local communities, through innovations like smart stadiums and personalized digital platforms (Deloitte, 2025). This builds on Ratten (2020), who identified digital platforms as key to fan engagement, but extends the discussion to include broader social impacts, such as inclusivity and community involvement, which are critical for sustainable sports ecosystems.

Finally, the study emphasizes the critical role of data backup systems in safeguarding the vast amounts of data generated by smart stadiums, including fan information, game statistics, and equipment status (Appinventiv, 2024). This finding complements Popa et al. (2024), who discussed data security in blockchain applications, but highlights the specific importance of regular backups to prevent irreparable losses due to malfunctions or cyberattacks, ensuring operational continuity and stakeholder trust.

The proposed conceptual framework integrates these dimensions to provide a roadmap for sports managers to design and implement smartification strategies that optimize performance, reduce costs, and enhance stakeholder value. By addressing barriers such as financial constraints, lack of skilled personnel, cultural resistance, and data privacy concerns (Li et al., 2023; Chen et al., 2019), the framework offers practical guidance for overcoming these challenges. For instance, the adoption of AI-based predictive maintenance and cloud-based backup systems can enhance system reliability, while energy-efficient smart systems promote sustainability and cost savings (SpringerOpen, 2023).

This study contributes to the theoretical advancement of smartification in sports by providing a comprehensive framework that bridges gaps in prior research, which often focused on individual technologies or dimensions in isolation (Gómez-González et al., 2020; Ratten, 2020). Practically, it offers actionable insights for sports organizations to leverage smart technologies for competitive advantage and stakeholder satisfaction. The emphasis on preventive maintenance, continuous technical support, system upgrades, energy management, and data backup ensures that smart stadiums can operate at peak performance, even during high-demand events, delivering exceptional experiences for fans and athletes alike.

Moving forward, this research lays the groundwork for future studies to explore the long-term impacts of smartification on the sports industry. Specific areas for investigation include the scalability of smart technologies in resource-constrained organizations, the social impact of smartification on marginalized communities, and the cost-benefit analysis of preventive versus reactive maintenance strategies. Additionally, future research should examine the integration of emerging technologies, such as 5G and augmented reality, to further enhance smart stadium operations. By providing a robust foundation for both theoretical and practical advancements, this study positions smartification as a cornerstone of

innovation in sports organizations, fostering sustainability, competitiveness, and enhanced stakeholder experiences in the global sports ecosystem.

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