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Analyzing the Adoption and Impact of Emerging Technologies in Sports: Opportunities, Challenges, and Strategies

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ABSTRACT

This study analyzes the adoption and impact of emerging technologies in sports, focusing on their transformative role in enhancing athletic performance, event management, and spectator engagement. Using a mixed-methods approach, the research combines grounded theory and quantitative analysis to explore technology integration. Qualitative data, gathered through semi-structured interviews with sports technology experts, including managers and IT specialists, were analyzed using MAXQDA2020 to develop a paradigmatic model. Quantitative data from a survey of 181 athletes and sports managers, primarily in Iran, were analyzed with Smart PLS 4 to validate variable relationships. Findings revealed that technologies like wearable devices, motion sensors, and data analytics optimize training and reduce injury risks, while systems like Video Assistant Referee (VAR) and Hawk-Eye enhance officiating accuracy. Virtual reality (VR) and augmented reality (AR) create immersive spectator experiences, revolutionizing engagement. However, adoption faces challenges, especially in resource-constrained settings like Iran, where only 37% of sports federations use modern technologies. High costs, limited expertise, and cultural resistance, exacerbated by sanctions, hinder progress. Proposed strategies include specialized training to boost digital literacy, supportive policies for ethical and privacy frameworks, and funding for sports technology startups to ensure equitable access. These strategies aim to foster innovation and overcome barriers. The study highlights technology's potential to drive competitiveness, public health, and economic growth through job creation and increased revenue.

Introduction

Before the new millennium, the integration of technology into sports was rarely considered, but today, professional sports are inseparable from advanced technological systems that have reshaped athletic performance, event management, and spectator engagement. Sports technology, encompassing tools like wearable devices, motion sensors, data analytics, and artificial intelligence (Liu), has become a cornerstone of modern sports, enhancing performance, ensuring athlete safety, and enabling precise data analysis (Khadempir et al., 2023; Nuriddinov, 2023). Systems such as Video Assistant Referee (VAR), Hawk-Eye, and AI-driven analytics improve decision-making accuracy, while virtual reality (VR) and augmented reality (AR) create immersive experiences that deepen spectator involvement (Hsu et al., 2023). he global sports technology market, valued at $15.92 billion in 2023, is projected to reach $68.01 billion by 2031 with a compound annual growth rate (CAGR) of 19.90%, underscoring technology's role as a key indicator of global competitiveness (Orunbayev, 2023). This study aims to analyze the extent of adoption and

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application of emerging technologies in sports, exploring opportunities, challenges, and strategies for their effective integration, with a particular focus on contexts like Iran, where unique barriers shape adoption dynamics.

Technological advancements have revolutionized how athletes train and compete. Wearable devices, GPS systems, and RFID chips provide real-time data on speed, acceleration, heart rates, and movement patterns, enabling coaches to optimize training programs and reduce injury risks through precise physiological and biomechanical insights (Cooper et al., 2024; Qi et al., 2024). Officiating technologies like VAR and Hawk-Eye minimize human errors, fostering fairness and trust in competitions, while safety systems such as the Head and Neck Support (HANS) device in motor racing enhance athlete protection (Palazzetti et al., 2024). VR and AR not only simulate competitive environments for training but also transform spectator experiences by offering interactive, real-time engagement with sports events (Karimi et al., 2025). These innovations extend beyond technical improvements, influencing emotional and social dimensions for fans and contributing to the cultural evolution of sports (Qi et al., 2024). In Iran, for instance, the adoption of technologies has grown, with 37% of sports federations utilizing modern tools and 50% of professional athletes using wearables in 2021, up from 20% in 2016 (James & Petrone, 2016). Major football clubs like Persepolis and Esteghlal have invested in data analytics and video analysis systems, while 3% of domestic matches now employ VAR, improving officiating accuracy. Despite these advancements, adopting sports technologies faces significant barriers. High costs of equipment and maintenance, particularly for smaller teams and developing countries, limit access, while insufficient training and cultural resistance hinder effective implementation (Huang et al., 2024).

However, adoption faces barriers, including high costs, limited expertise, and cultural resistance, especially in resource-constrained settings like Iran, where sanctions, inadequate infrastructure, and insufficient investment exacerbate challenges (Farahani, 2002; Huang et al., 2024). In Iran, 37% of sports federations use modern technologies, and 50% of professional athletes employed wearables in 2021, up from 20% in 2016 (James & Petrone, 2016; Qi et al., 2024). In Iran, challenges are amplified by sanctions, inadequate technological infrastructure, limited investment, and a shortage of skilled personnel, which restrict the pace of adoption (Farahani, 2002). Current research often focuses on short-term impacts, such as performance gains, leaving gaps in understanding long-term effects, scalability, and strategies for overcoming adoption barriers, particularly in resource-constrained settings. This study addresses these gaps by examining the causal conditions driving technology adoption, contextual factors enabling or limiting it, and actionable strategies to facilitate integration. By developing a paradigmatic model, it aims to provide a framework for stakeholders to navigate challenges and leverage opportunities.

The significance of this research lies in its comprehensive analysis of technology's role in transforming sports, offering insights into enhancing athletic performance, event management, and spectator experiences. It is particularly relevant for developing countries like Iran, where strategic interventions can boost competitiveness, improve public health, and drive economic growth through job creation and increased revenue in the sports technology sector. The study's objectives include identifying key drivers and barriers to technology adoption, proposing solutions such as specialized training, supportive policies, and financial backing, and exploring the cultural and economic impacts of these technologies. By addressing both global trends and local challenges, this research seeks to guide sports organizations, policymakers, and technology providers in fostering sustainable, equitable technology integration in the global sports ecosystem.

Methodology

This study adopts an applied-developmental approach to investigate the adoption and impact of emerging technologies in sports, employing a mixed-methods design to combine qualitative depth with quantitative rigor. The qualitative phase utilized grounded theory, an inductive and exploratory method that derives theories from real-world data rather than preconceived hypotheses (Corbin & Strauss, 1990). Specifically, the systematic approach of Strauss and Corbin (1990) was applied, involving three coding stages—open, axial, and selective—to construct a paradigmatic model of technology adoption. Data were collected through semi-structured, in-depth interviews with 10 experts, including information

technology specialists, sports club managers, and representatives from knowledge-based sports technology companies. Participants were selected via purposive sampling to ensure expertise and explanatory depth, continuing until theoretical saturation was achieved after 10 interviews, ensuring comprehensive data coverage. Interviews were analyzed using MAXQDA2020 software to systematically code and categorize themes, with coding validity enhanced through a three-member focus group comprising a professor, a researcher, and an independent expert.

Table 1. Interview Participants' Profile.

ID	Education	Trends	Gender	Age
P1	Ph.D.	Motor behavior	Male	**30-40**
P2	M.S	Sport Management	Male	**20-30**
P3	M.S	Sport Management	Female	**20-30**
P4	Ph.D. Student	Sport Management	Female	**30-40**
P5	Ph.D.	Sport Management	Male	**30-40**
P6	Ph.D.	Sport Management	Male	**30-40**
P7	M.S	Motor behavior	Female	**20-30**
P8	M.S	Sport Management	Male	**20-30**
P9	Ph.D.	Sport Management	Male	**30-40**
P10	M.S	Sport Management	Male	**20-30**

In the quantitative phase, a researcher-developed questionnaire was designed based on the qualitative paradigmatic model to validate relationships among identified indicators, components, and dimensions. The questionnaire was distributed to 181 athletes and physical education managers in Iran, selected to represent diverse perspectives within the sports community. Responses were analyzed using Smart PLS 4 software, which assessed the questionnaire's validity and tested structural relationships within the model through partial least squares structural equation modeling (PLS-SEM). This mixed-methods approach ensured a robust exploration of the causes, contexts, challenges, and strategies related to technology adoption in sports, providing both theoretical insights and empirical validation aligned with the study's objectives.

Results

The qualitative phase employed grounded theory to analyze interview transcripts from 10 sports technology experts, using MAXQDA2020 software for systematic coding. An iterative process began with open coding, extracting 44 initial codes to identify concepts related to technology adoption in sports. Axial coding organized these into 15 core categories, linking causal conditions (e.g., technological advancements, need for performance improvement), contextual factors (e.g., infrastructure, sports culture), and intervening conditions (e.g., costs, resistance to change). Selective coding refined these into six general categories, forming a paradigmatic model that delineates relationships among conditions, strategies (e.g., training, funding), and consequences (e.g., enhanced performance, economic growth). This model, illustrated in Figure 1, provides a theoretical framework for understanding technology integration in sports, highlighting opportunities and challenges.

Table 2. Results of Open, Axial, and Selective Coding

Selective Coding	Axial Coding	Open Coding	Source
Causal conditions	Technological Advancements	Increased data processing power	***P1,P3,P5,P6,P7,P9***
		Development of wearable hardware	***P1,P4,P5,P6,P7,P8***
		data Easy access to the internet and big	***P3,P4,P7,P9***
	The need to improve athletic performance	Monitoring and Analyzing Athletes' Performance	***P1,P2,P3,P5,P6,P8,P9,P10***
		Improving Exercises Based on Scientific Data	***P2,P3,P6,P7,P8,P9,P11,P12***
		Reduced risk of injury	***P1,P2,P3,P5,P6,P8,P9,P10***
	Increasing Global Competitiveness	The need to update training methods	***P4,P5,P6,P7,P9***
		Using Technology to Attract Spectators	***P1,P2,P3,P5,P6,P10***
		Improving the user experience at sporting events	***P1,P2,P10***
Contextual conditions	Technology Infrastructure	speed internet-High	***P6,P9,P10***
		Access to new devices	***P6,P8,P9,P10***
		Financial support for new technologies	***P1,P2,P3,P5,P6,P8,P9,P10***
	Sports Culture	Embracing new technologies in sport	***P4,P5,P6,P7,P9***
		athletes and coaches Training and awareness of	***P1,P2,P10,P10***
		Encouraging the use of technology to improve performance	***P4,P5,P6,P7,P9***
	Rules & Regulations	Legal Frameworks for the Use of Technology in Sport	***P5,P6,P8,P9***
		Policies Supporting Sports Innovations	***P1,P2,P3,P5,P6,P8,P9***
		Data Privacy Regulations	***P2,P6,P7,P8,P10***
Intervening conditions	High Costs	Initial investment for the purchase of equipment	***P5,P6,P8,P9***
		Maintenance and update costs	***P5,P6,P7,P,8,P10***
		Lack of adequate financial support	***P1,P4,P6,P7,P9,P10***
	Lack of adequate expertise	Lack of specialized training in the field of technology	***P5,P6,P8,P9,P10***
		Lack of familiarity of educators with new technologies	***P1,P2,P3***
		The need for technical skills in the use of tools	***P2,P3,P4,P10***
	Resistance to change	Willingness to use traditional methods	***P1,P2,P8,P9,P10***
		Fear of change and lack of trust in technology	***P5,P6,P7,P,8,P10***
		Concerns about the impact of technology on human relationships in sport	***P5,P6,P7,P,8,P10***
Strategies	Training and Empowerment	courses for coaches and athletes Holding training	***P3,P4,P5,P6,P7,P10***
		Creating applications for technology learning	***P1,P4,P7,P9,P10***
		Promoting technological knowledge in universities and sports institutes	***P5,P6,P7,P,8,P10***
	Funding and support	financial facilities for the purchase of Providing modern equipment	***P2,P3,P4,P6,P8,P10***
		Supporting sports technology startups	***P2,P5,P6,P8,P10***
		Cooperating with private companies and the government to provide financial resources	***P5,P6,P7,P,8,P10***
	Formulation of Supportive Policies	Creating clear and specific rules for the use of technology	***P2,P5,P7,P9,P10***
		Developing ethical frameworks for the application of technology	***P1,P2,P3,P6,P9,P10***
		Providing privacy advice to athletes	***P5,P6,P7,P,8,P10***
Consequences	Improving athletic performance	Increasing the accuracy of evaluating athletes' performance	***P1,P3,P9,P10***
		Improving the quality of training and reducing injuries	***P1,P3,P10***
		Increasing the likelihood of success in the competition	***P5,P6,P7,P,8,P10***
	Cultural Development of Sport	Creating a culture of innovation in sports	***P5,P8,P10***
		Adoption of technology as an effective tool for improving performance	***P2,P3,P6,P9***
		Increasing social interactions in sports	***P2,P8,P9,P10***
	Economic	Increasing revenue through new technologies	***P3,P6,P8,P9,P10***

	growth in the sports industry	Creating new job opportunities in the sports technology industry	***P2,P5,P6***
		Attracting more investment in sports and technology	***P5,P6,P8,P9***

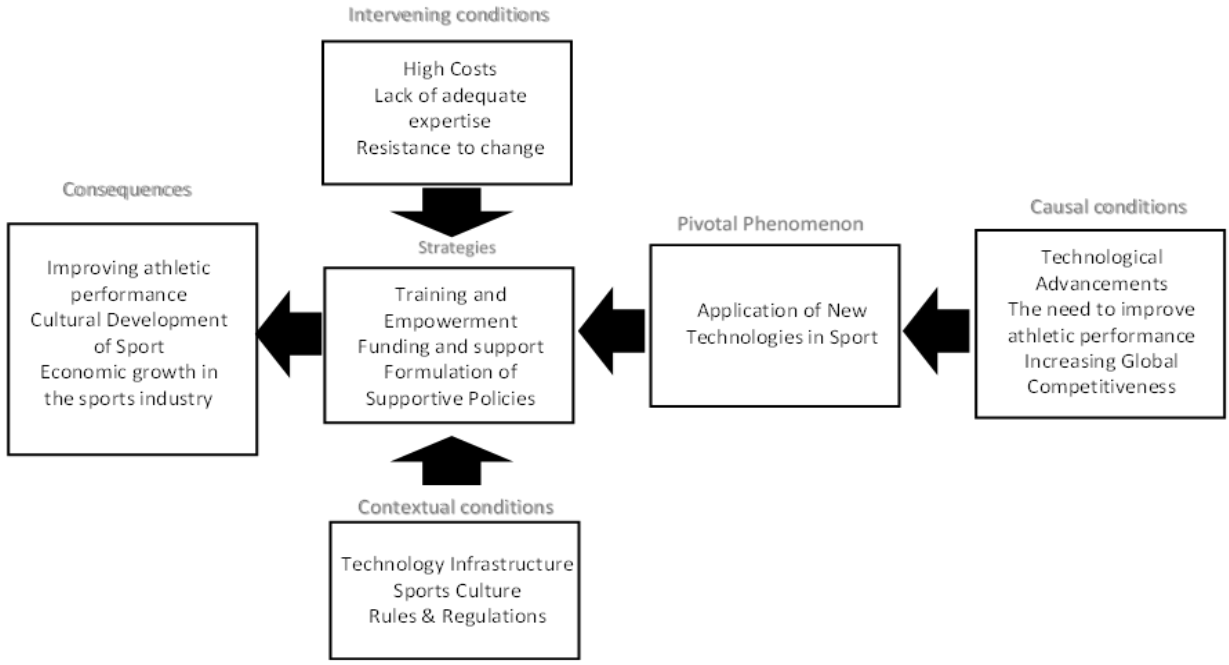

Figure 1. Paradigm Model for the Application of New Technologies in Sports.

As outlined previously, the quantitative analysis phase (variables communication test) built on the qualitative findings by developing a questionnaire to validate the proposed paradigmatic model of technology adoption in sports. This survey was distributed to 181 athletes and physical education managers in Iran, selected to reflect diverse perspectives within the sports community. The objective was to confirm relationships among model variables, such as causal conditions, strategies, and consequences. After collecting valid questionnaires, data were processed using Smart PLS 4 software, with the following analytical stages conducted:

a) Exterior Model Tests

The external model, which examines relationships between latent variables (e.g., technology infrastructure, performance improvement) and their observed indicators, was evaluated through Confirmatory Factor Analysis (CFA). This analysis ensured that latent variables were accurately measured by their indicators, as depicted in Figure 2 for standard coefficient estimates. Reliability was assessed first, using two key metrics: Cronbach's alpha and composite reliability.

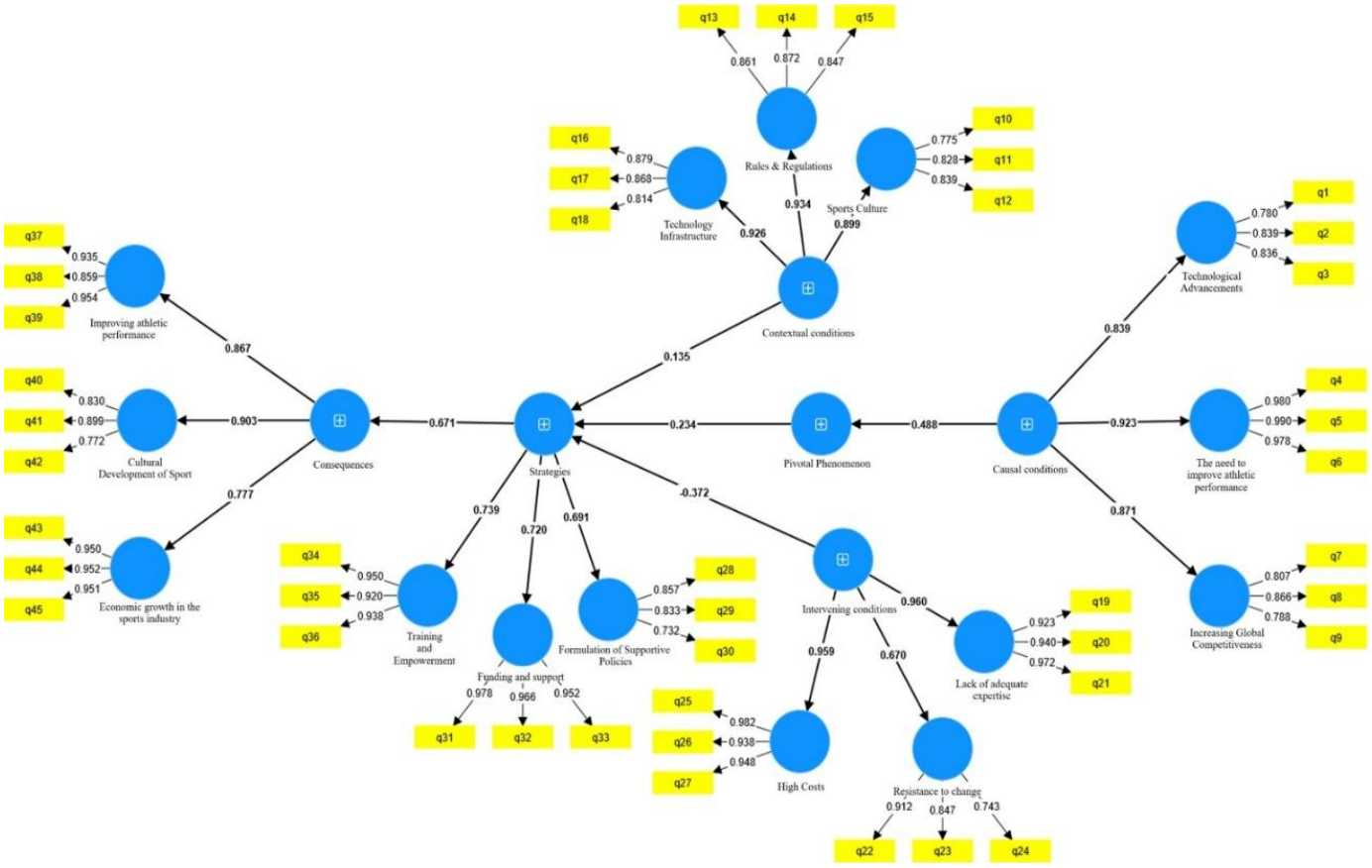

Figure 2. External model for estimating standard coefficients.

• Cronbach's alpha

Cronbach's alpha, a traditional measure of reliability, evaluates internal consistency in structural equation modeling. It provides a robust indicator of model stability. Results of Cronbach's alpha coefficients are presented in Table 3, confirming strong reliability across variables.

Table 3. Results of Cronbach's alpha coefficients.

Variables	Cronbach's alpha
Training and Empowerment	0.739
Increasing Global Competitiveness	0.757
athletic performance Improving	0.904
Funding and support	0.963
Formulation of Supportive Policies	0.929
Cultural Development of Sport	0.784
Economic growth in the sports industry	0.947
Technology Infrastructure	0.746
Lack of adequate expertise	0.782
Culture Sports	0.824
Rules & Regulations	0.815
Resistance to change	0.953
The need to improve athletic performance	0.982
High Costs	0.940
The application of new technologies in Sports (Pivotal Phenomenon)	0.763
Technological Advancements	0.754

- **Compositional Reliability**

While Cronbach's alpha serves as a traditional measure of variable reliability, structural equation modeling using the partial least squares (PLS-SEM) method, as implemented in Smart PLS 4 software, employs a more advanced criterion known as composite reliability. Unlike Cronbach's alpha, composite reliability assesses internal consistency based on the inter-correlations among observed indicators, providing a robust measure of reliability for latent variables such as technology infrastructure and performance improvement. This dual approach ensures comprehensive reliability assessment in the PLS-SEM framework, critical for validating the model of technology adoption in sports. The composite reliability coefficients, demonstrating strong consistency across variables, are presented in Table 4.

Table 4. Results of Combined Reliability Coefficients

Variables	Composite Reliability
Training and Empowerment	0.850
Increasing Global Competitiveness	0.861
Improving athletic performance	0.940
Funding and support	0.976
Formulation of Supportive Policies	0.955
Cultural Development of Sport	0.873
Economic growth in the sports industry	0.966
Technology Infrastructure	0.855
Lack of adequate expertise	0.875
Sports Culture	0.895
Regulations & Rules	0.890
Resistance to change	0.970
The need to improve athletic performance	0.988
High Costs	0.962
The application of new technologies in Sports (Pivotal Phenomenon)	0.863
Technological Advancements	0.859

B) Validity test of the reflective external model

To assess the validity of the reflective external model, Smart PLS 4 software employed four key methods, including convergent and divergent (diagnostic) validity tests, to ensure the model's constructs accurately represent the data on technology adoption in sports.

• Convergent Validity

The Average Variance Extracted (AVE) criterion, introduced by Fornell and Larcker (1981), measures convergent validity by calculating the mean variance extracted between each latent variable (e.g., technology infrastructure, performance improvement) and its indicators. A high AVE indicates strong correlations between a variable and its indices, confirming measurement accuracy. The study's AVE results, presented in Table 5, demonstrate robust convergent validity across variables, supporting the reliability of the model in capturing the relationships driving technology adoption in sports.

Table 5. Results of the Extractive Average Variance Index.

Variables	Convergent Validity
Training and Empowerment	0.655
Increasing Global Competitiveness	0.674
Improving athletic performance	0.841
Funding and support	0.932
Policies Formulation of Supportive	0.876

Cultural Development of Sport	0.698
Economic growth in the sports industry	0.905
Technology Infrastructure	0.663
Lack of adequate expertise	0.701
Sports Culture	0.740
Rules & Regulations	0.730
Resistance to change	0.914
improve athletic performance The need to	0.965
High Costs	0.893
The application of new technologies in Sports (Pivotal Phenomenon)	0.678
Technological Advancements	0.670

C) Internal Model Tests

The internal model tests were conducted to evaluate the research hypotheses, represented in a schema derived from the literature, to examine causal relationships among latent variables (e.g., technological advancements, strategies, performance improvement) following robust measurement. Using Smart PLS 4 software, internal model confirmation involved two key tests: the prediction accuracy test, measured by R-squared, which assesses the explanatory power of endogenous latent variables, and the prediction quality test, which evaluates the model's predictive relevance. Results, presented in Table 6, confirm strong predictive accuracy and quality, validating the model's ability to explain relationships driving technology adoption in sports.

Table 6. Test Results $R^2$and Common Index

Variables	R-square	CV COM
Training and Empowerment	0.477	0.319
Increasing Global Competitiveness	0.759	0.345
Improving athletic performance	0.751	0.639
Funding and support	0.518	0.801
Formulation of Supportive Policies	0.546	0.701
Cultural Development of Sport	0.815	0.390
Economic growth in the sports industry	0.604	0.282
Technology Infrastructure	0.808	0.753
Lack of adequate expertise	0.449	0.400
Sports Culture	0.872	0.461
Rules & Regulations	0.858	0.444
Resistance to change	0.920	0.769
athletic performance The need to improve	0.852	0.859
High Costs	0.923	0.734
Technological Advancements	0.704	0.339

D) The Relationship Between the Variables of the Proposed Model

In the overall research model depicted in Figure 2, both the measurement model—representing the relationships between observable indicators and their corresponding latent constructs—and the structural model—illustrating the relationships among latent variables—have been analyzed. The results of the path analysis, including the path coefficients and their statistical significance, are summarized in Table 7.

Table 7. Results of path coefficients and significance

	Path coefficient	T Statistic	Significance level	Approved Confidence Level
lasuaC → Pivotal Phenomenon	0.488	7.350	0.000	%99
Pivotal Phenomenon → Strategies	0.234	3.585	0.000	%99
snoitidnoC lautxetnoC → Strategies	0.135	1.730	0.084	%90
snoitidnoC gninevretnI → Strategies	-0.372	4.285	0.000	%99
Strategies → Consequences	0.671	13.800	0.000	%99

Discussion and Conclusion

This study provides an in-depth exploration of how emerging technologies are adopted and integrated into the field of sports. Through a grounded theory methodology, six core selective codes were identified—technological advancements, the need to improve athletic performance, technology infrastructure, sports culture, rules and regulations, and high costs—which collectively shape a paradigmatic model explaining the dynamics of technological innovation in sports settings. The model captures not only the structural and contextual elements influencing adoption but also the underlying motivations, constraints, and resultant transformations.

Technological advancements such as wearable sensors, motion capture systems, artificial intelligence (Liu), and big data analytics are at the forefront of this transformation. These tools allow for the real-time monitoring of physiological and biomechanical indicators, offering precise insights into athletes' health, performance, and recovery. This is consistent with the findings of Qi et al. (2024), who argue that such technologies are essential for optimizing performance and preventing injury through predictive analytics. These advancements are not merely tools; they are reshaping how athletes train, how coaches make decisions, and how organizations strategize for competitive advantage (Qi et al., 2024). The need to enhance athletic performance and global competitiveness further motivates adoption, as teams seek data-driven strategies to gain a competitive edge. The need to improve athletic performance remains one of the strongest motivators behind the uptake of new technologies. In an increasingly globalized and commercialized sports ecosystem, the margin for competitive edge is narrow, and even incremental performance improvements can determine outcomes. As Hsu et al. (2023) suggest, data-driven decision-making is becoming an indispensable element of modern athletic training and game strategy. Beyond individual performance, teams and federations are leveraging technology to monitor collective dynamics, optimize scheduling, and minimize physical overload across a season (Hsu et al., 2023).

However, technological infrastructure plays a critical role in enabling or limiting these benefits. Access to stable high-speed internet, smart devices, and secure data management systems is essential for successful integration. Yet, infrastructure disparities between developed and developing countries, as well as between elite and grassroots sports programs, remain stark. Huang et al. (2024) emphasize that while high-income countries are rapidly moving toward digital transformation in sports, many lower-income contexts are constrained by infrastructural bottlenecks (Huang et al., 2024). In parallel, sports culture significantly influences the pace and effectiveness of technology adoption. In some contexts, deeply rooted traditions and resistance to change pose psychological and institutional barriers. Coaches, athletes, and decision-makers may harbor skepticism about replacing intuition and experience with algorithms and data dashboards. Concerns about depersonalization, reduced spontaneity, and the loss of "human touch" in coaching are frequently cited (Seçkin et al., 2023). Moreover, traditional coaching philosophies that value subjective judgment over empirical evidence can delay adoption. This cultural inertia must be addressed through sensitization, stakeholder engagement, and the demonstration of tangible benefits.

Rules and regulations further complicate the adoption process. Regulatory ambiguity about data ownership, athlete consent, the validity of technology-assisted decisions, and the ethical use of AI in talent identification can hinder progress. A lack of standardized frameworks across sports disciplines leads to inconsistent implementation and potential legal and ethical disputes. While organizations like the International Olympic Committee have begun discussing such issues, many

national federations lack the policy capacity to govern the use of new technologies effectively. Clear guidelines are essential to ensure fairness, transparency, and trust. Among the most persistent intervening conditions are high financial costs and the shortage of technical expertise. Advanced technologies require substantial investment—not just in devices and software, but also in maintenance, upgrades, cybersecurity, and skilled personnel. Liu (2024) reports that financial constraints are a leading cause of delayed implementation, particularly in resource-limited countries. Furthermore, even where funding is available, the lack of trained professionals capable of operating, analyzing, and interpreting data limits the utility of these tools. Without dedicated training programs, even the best technologies risk underutilization or misuse (Liu, 2024).

To address these barriers, the study proposes three interrelated strategies: training and empowerment, financial and institutional support, and supportive policies and ethical frameworks. First, customized training programs targeting coaches, athletes, and sports managers can foster digital literacy and facilitate smoother transitions to technology-enhanced practices. Karimi et al. (2025) emphasize the value of hands-on workshops and certifications in increasing user competence and confidence. Second, financial incentives—such as grants, tax subsidies, or public-private partnerships—can alleviate the initial cost burden and encourage innovation in sports-tech startups. Lastly, ethical policies that prioritize data privacy, informed consent, and transparency are essential for fostering long-term trust and compliance (Karimi et al., 2025). The results of a study conducted in Malaysia indicate that policymakers and stakeholders in the startup ecosystem should focus on increasing financial support and revising related policies to significantly improve the growth and sustainability of startups. Additionally, reevaluating the functions and structure of incubators and accelerators can enhance the quality of their services and increase the effectiveness of non-financial support. These findings hold considerable relevance and applicability in line with global efforts to strengthen innovation and entrepreneurship ecosystems (AZHAR et al., 2024). The consequences of effective technology adoption are multifaceted. On the individual level, athletes experience improved training outcomes, injury prevention, and personalized coaching plans. On the organizational level, sports clubs and federations gain operational efficiencies, enhanced scouting capabilities, and data-backed decision-making processes. On the societal level, the adoption of sports technologies contributes to broader health promotion, digital innovation, and economic development (Frevel et al., 2022).

When compared to prior literature, this study presents a novel contribution by integrating grounded theory with a multi-layered understanding of sociocultural, economic, and technological variables. Unlike studies such as Liu (2024) (Liu, 2024), which concentrate on business model innovation, or Cooper et al. (2024), which focus narrowly on biomechanical engineering, this research presents a more holistic framework that considers both barriers and solutions in real-world contexts (Cooper et al., 2024). Furthermore, the incorporation of mixed methods addresses the gap identified by Qi et al. (2024), who call for more nuanced analyses of long-term adoption and impact. By grounding theory in field data while also drawing from international literature, this study bridges micro-level practices with macro-level policy recommendations (Qi et al., 2024).

In practical terms, these insights offer clear guidance for a range of stakeholders. Sports organizations must prioritize the development of internal capacities, from hiring data analysts to upskilling coaches in digital competencies. Government agencies and policymakers should invest in infrastructure, particularly in underserved areas, and establish regulatory frameworks that address ethical concerns. Private sector innovators and investors have an opportunity to design scalable, affordable technologies tailored to the needs of developing countries. Finally, educational institutions can contribute by integrating sports technology into academic curricula, creating a pipeline of skilled professionals ready to lead future advancements.

Conclusion

In conclusion, the integration of emerging technologies in sports is not a linear or purely technical process. It is a dynamic interplay of advancement, resistance, adaptation, and transformation. Understanding this complexity is essential for designing interventions that are not only technologically sound but also socially and culturally sustainable. By recognizing the

interdependence of infrastructure, culture, policy, and strategy, this study provides a roadmap for stakeholders seeking to navigate the evolving landscape of digital transformation in sports.

Ethical Considerations

Compliance with ethical guidelines: Ethical points have been observed.

Authors' contribution: All authors have contributed to the design and implementation of this study.

Conflict of interest: There is no conflict of interest.

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