Article

Not peer-reviewed version

Unlocking Blockchain's Potential in Sports: A Multisport Comparative Study of Adoption, Performance, and Innovation

Rocsana Bucea-Manea-Țoniș *, Mihaila Constanța , Andrei Antonescu

Posted Date: 28 April 2025

doi: 10.20944/preprints202412.1619.v3

Keywords: blockchain Apps; sports technology; SEM; cluster analysis; team performance; Romania

 doi:10.20944/preprints202412.1619.v3

Article

Unlocking Blockchain's Potential in Sports: A Multisport Comparative Study of Adoption, Performance, and Innovation

Rocsana Bucea-Manea-Țoniș *, Mihaila Constanța and Andrei Antonescu

National University of Physical Education and Sports, Bucharest, Romania

* Correspondence: rocsense39@yahoo.com

Abstract: Blockchain technology is transforming the sports industry by enhancing data security, smart contracts, ticketing transparency, and fan engagement. Despite its potential, adoption remains limited, particularly in team sports. This study examines the impact of blockchain applications on team sports performance, focusing on football and basketball in Romania. A survey of sports professionals was conducted, followed by Structural Equation Modeling (SEM) with SmartPLS and cluster analysis in SPSS 22.0 to assess blockchain's perceived benefits and applicability. The findings reveal that blockchain adoption significantly influences athlete performance at both national and European levels. Football demonstrates higher adoption rates in smart ticketing and fan engagement, while basketball leads in financial support mechanisms and performance analytics. A Multivariate Analysis of Variance (MANOVA) confirmed statistically significant differences between the two sports in blockchain utilization. Benchmarking against finance, healthcare, and supply chain industries further highlights best practices for overcoming adoption barriers. This study validates the role of blockchain in fostering transparency, efficiency, and competitive growth in sports, while also identifying key challenges, such as scalability, regulatory constraints, and stakeholder resistance. The research provides data-driven insights for policymakers, sports organizations, and technology developers, offering strategic recommendations for blockchain implementation in sports governance and athlete management.

Keywords: blockchain; sports technology; team performance; smart contracts; fan engagement; SEM; MANOVA; comparative analysis

1. Introduction

By 2030, the disruptive technology known as blockchain is predicted to boost the world economy by 1.76 trillion USD. This decentralized, transactional database technology is well-known for its traceability and transparency, propelling advancements across various industries, including supply chain and crowdfunding. Numerous facets of blockchain, including its advantages, difficulties, and possibilities, have been the subject of recent studies. However, a thorough examination of the effects of recent developments on society and their enormous potential across industries has not yet been conducted (Shukla, 2024).

Blockchain technology, widely recognized for its decentralized, transparent, and secure nature, is anticipated to contribute $1.76 trillion to the global economy by 2030 (Shukla et al., 2024). Initially developed for financial applications, blockchain has demonstrated its potential across diverse sectors, including supply chain management, healthcare, and entertainment. Despite its transformative potential, comprehensive analyses of blockchain's societal implications and sector-specific advancements remain limited (Agbozo & Hayawi, 2024). This study seeks to bridge that gap within the sports industry, a rapidly evolving domain increasingly characterized by technology-driven commercialization.

 doi:10.20944/preprints202412.1619.v3

The sports industry has adopted cutting-edge technologies, such as the Internet of Things (IoT), artificial intelligence, and advanced sensor systems, to improve athletic performance and fan experiences. Innovations like performance-tracking sensors, video-assisted refereeing, and goal-line technology have revolutionized game officiating and athlete training (Li & Huang, 2024; Chen et al., 2024). However, persistent challenges—such as limited transparency, data security vulnerabilities, and centralized governance structures—hinder the full optimization of these technologies (Bartholic et al., 2022, Mehra et al., 2025). Blockchain's inherent attributes—decentralization, immutability, and privacy—offer compelling solutions by enhancing accountability, enabling secure data management, and fostering equitable governance (Berkani et al., 2024).

Emerging applications of blockchain in sports include performance tracking, anti-doping measures, and fan tokenization. (Kanat et al., 2024). Blockchain ticketing, trialed during the 2018 Asian Games, demonstrated secure and tamper-proof mechanisms to counter ticket fraud while improving fan engagement (Schlimm et al., 2024). Additionally, blockchain-based fan engagement platforms, such as Socios.com, empower fans through ownership of digital tokens while generating new revenue streams for clubs (Manoli et. al, 2024). Despite these promising applications, adoption remains in its nascent stages due to limited empirical evidence and stakeholder understanding (Agbozo & Hayawi, 2024).

Building upon existing studies (Tedesco, 2022; Li & Zhu, 2023), we designed a survey to evaluate blockchain applications in Romanian team sports. The data collected helped to design a Structural Equation Modeling (SEM) with Smart PLS. By offering new insights into blockchain's role in performance enhancement and stakeholder engagement, this study aims to guide policymakers, sports organizations, and technology developers toward the effective implementation of blockchain systems.

Considering the issues discussed above the research questions are:

Q1. Does blockchain adoption in sports brings benefits?

Q1a. What are the primary advantages of integrating blockchain technology into the sports industry as perceived by sports professionals?

Q1b. To what extent do blockchain applications (e.g., data management, ticketing, fan engagement) address transparency and security challenges in sports?

Q2. Does blockchain adoption in sports impact on athletes' performance?

Q2a. How does the implementation of blockchain technology influence athletes' performance at the national and European levels?

Q2b. What are the relationships between the benefits of blockchain adoption and its applications on measurable performance outcomes in team sports?

Q3. Which are the professional perspectives on blockchain implementation in sports?

Q3a. How do perceptions of blockchain's advantages and its applicability vary among different professional roles, such as coaches, players, and sports managers?

Q3b Are there any significant differences in the adoption and effectiveness of blockchain technologies between team sports (e.g., football and basketball)?

2. Applicability of Blockchain in Sports

By offering a safe, unchangeable ledger for transactions, increasing transparency, and guaranteeing regulatory compliance, blockchain technology is completely changing sports management. Smart contracts can reduce fraud, enforce adherence to preset standards, and automate financial transactions. Sports event management benefits greatly from a dual-layer architecture strategy that divides the public and private blockchain levels to safeguard private data while preserving an open, decentralized system for ticketing and fan interaction (Cappiello & Carullo, 2021).

Sports event administration is automated via smart contracts, which decreases human control while boosting productivity and confidence. For instance, during the World Cup, FIFA used

 doi:10.20944/preprints202412.1619.v3

blockchain-based smart contracts for access control and ticketing, guaranteeing automatic ticket authentication and resale, lowering fraud, and guaranteeing safe transactions (Fukuzawa et al. 2024). Blockchain-enabled contracts have been used to automate prize distribution among players, sponsors, and organizers in professional tennis events, removing inconsistencies and delays. (Ghosh, 2024, Calderone &Costa, 2024).

Through Decentralized Autonomous Organizations (DAOs), blockchain technology enables inclusive and transparent governance. This allows event administrators, athletes, sponsors, and fans to actively engage in decision-making through voting processes based on tokens. Organizations can use the DCF (Dynamic Capabilities Framework) and FMG (Four Modes of Governance) frameworks to spot new trends, put smart contracts and DAOs into place, and constantly adjust governance structures for best results and legal compliance (Bartholic et al., 2022, Manoli et. al, 2024).

By reducing typical industry problems like ticket scalping, fake goods, and illegal access, blockchain's technical architecture immediately supports risk management and fraud prevention. By guaranteeing automatic fund transfer in accordance with predetermined agreements and removing conflicts and inefficiencies, self-executing smart contracts also lessen financial fraud (Fukuzawa et al. 2024).

Secure credential verification procedures are ensured by athletes, coaches, and participants being verified through blockchain-based decentralized identity management. Verifiable credentials and decentralized IDs complement DCF's focus on reorganizing digital resources. (Regner et al., 2022; Sung et al., 2023).

A paradigm change promoting creativity, effectiveness, and inclusivity is represented by the incorporation of blockchain technology into sports event administration. Sports organizations can optimize event experiences and increase stakeholder participation by implementing flexible, transparent, and secure governance models using the DCF, CGT (Collaborative Governance Theory), and FMG frameworks (Goldsby and Hanisch, 2022, Ante et al., 2024).

By improving value creation, management operations, and stakeholder involvement, blockchain technology is revolutionizing sports event management. By offering digital collectibles for buy, sell, and trade on blockchain platforms, sports organizations' use of tokens and NFTs (Non-Fungible Tokens) has revolutionized fan interaction. By encouraging fan involvement and support, these tokens help clubs become more financially and strategically strong. NBA Top Shot uses digital collectibles and NFT-based ticketing to guard against fraud and guarantee authenticity. The sports blockchain market is expected to reach $1.4 billion, with an anticipated 8.5% annual growth rate until 2030 (Potts et al., 2023; Tripathi et al., 2023).

Blockchain has been criticized, nevertheless, for perhaps commodifying fandom and associating it with traits similar to gambling. Notwithstanding these reservations, the advent of NFTs and fan tokens has given sports organizations new sources of income and allowed them to play a bigger part in the market. Decentralized Autonomous Organizations (DAOs), which feature a networked model of governance and finance, are made possible by the application of blockchain technology in sports transformation procedures and processes (Wilson et al., 2022).

The ongoing development of blockchain applications, especially through DAOs, smart contracts, and NFTs, demonstrates the technology's revolutionary potential in creating a more decentralized and effective sports administration ecosystem in spite of these obstacles. To maximize blockchain's influence on the sector and improve governance frameworks, more investigation and real-world case studies will be essential (Schlimm et al., 2024; Fukuzawa et al. 2024).

Blockchain technology has the potential to revolutionize various facets of sports by addressing fundamental issues of transparency, efficiency, and trust. This section explores its practical applications across key areas, supported by relevant studies and technological advancements.

2.1. Athlete Data Management

 doi:10.20944/preprints202412.1619.v3

Metrics that assess an athlete's condition, performance, and health are critical for competitive success and long-term well-being. However, traditional centralized data systems often suffer from vulnerabilities such as manipulation and lack of transparency. Blockchain provides a decentralized, secure, and tamper-proof method to manage athlete performance data, ensuring integrity and privacy (Kanat et al., 2024). Initiatives like Microsoft's "BraveLog" and startups such as Peerspoint and Playmaker Chain have demonstrated blockchain's viability in safely tracking performance metrics and creating comprehensive sports resumes (Chen et al., 2024; Berkani et al., 2024). Similarly, blockchain-based systems like B-PEIS enhance real-time management and storage of athletes' fitness data, promoting accuracy and security (Chen, X., 2024).

Blockchain technology also supports performance prediction. For instance, secure platforms (Healthereum) incorporating predictive algorithms and neural networks can evaluate patterns and trends, contributing to effective performance enhancement and injury prevention strategies (Cheng et al., 2024; Li & Huang, 2024).

2.2. Sports Event Management

Managing large-scale sports events is a complex task that demands high levels of efficiency and fraud prevention. Blockchain enhances transparency by enabling digital issuance and validation of tickets using non-fungible tokens (NFTs) and smart contracts (Schlimm et al., 2024). For example, a blockchain-powered ticketing system eliminates counterfeit tickets by tracking ownership and resale transactions securely (Regner et al., 2022). NBA teams like the Sacramento Kings and UEFA already experimented.

During the 2018 Asian Games, blockchain technology was integrated with RFID mechanisms to prevent ticket fraud and streamline secondary sales (Torrance et. al. 2023). Beyond fraud prevention, blockchain reduces ticket speculation and dynamic pricing challenges, benefiting both organizers and attendees. FutbolCoin facilitate contracts and transactions between sports clubs, players, and agents using smart contract. UEFA, the European football governing body, implemented blockchain ticketing in 2018 and 2021 to prevent fraud and scalping during major tournaments. The system distributed 1 million tickets via a blockchain-based mobile app for the 2018 Europa League Final and mobile-only ticketing at the EURO 2020 tournament. The impact was reduced ticket fraud, scalping, and improved fan experience. The study supports the findings that blockchain enhances ticketing security and transparency, and validates the importance of Smart Tickets, a key variable in the study (UEFA Press Release, 2021).

2.3. Anti-Doping Compliance

The persistent issue of doping in sports has eroded trust among stakeholders. Blockchain's tamper-proof record-keeping ensures traceability in drug storage, testing processes, and compliance monitoring. Solutions such as a redesigned Anti-Doping Administration & Management System (ADAMS), using blockchain to enhance data integrity and privacy, showcase its utility in this domain (Regner et al., 2022; Bartholic et al., 2022).

Furthermore, innovative blockchain designs allow anonymized storage and verification of athlete biological data, supporting a robust anti-doping ecosystem while safeguarding privacy. Thus, blockchain offer an Athlete Passport to store and verify athletes' biological data.

2.4. Sports Collectibles and Merchandise

The market for sports memorabilia suffers from counterfeiting and questionable authenticity. Blockchain addresses these issues through transparent and immutable records of ownership. Platforms like NBA Top Shot leverage NFTs to create unique digital collectibles that fans can trade securely. Companies such as Pro Exp Media and Stryking.io partner with sports entities to launch digital collectibles, enhancing fan interaction while ensuring transparency (Lopez-Gonzalez, et al., 2024; Berkani et al., 2024). Nike CryptoKicks verify the authenticity of sneakers.

 doi:10.20944/preprints202412.1619.v3

2.5. Fan Engagement

Blockchain-based fan tokens empower supporters to actively participate in their favorite teams' decision-making and loyalty programs. Socios.com exemplifies this trend by offering tokenized platforms where fans earn cryptocurrency-based rewards for their engagement (Manoli et. al, 2024). Tokens provide voting rights, VIP access, and exclusive experiences, enhancing fan loyalty and creating new revenue streams for sports organizations (Schlimm et al., 2024). The integration of Proof of Attendance Protocol (POAP) NFTs further enriches fan experiences by providing verifiable records of event participation, redeemable for merchandise and future event tickets (Ante et al., 2024).

FC Barcelona and Juventus use Sociaos.com, and NBA Top Shot by Dapper Labs offers blockchain-based collectible highlights (digital cards) that fans can buy, sell, and trade.

2.6. Sponsorship and Crowdfunding

Blockchain facilitates innovative funding models for athletes and clubs through tokenization and smart contracts. Platforms like SportyCo and Globaltalent.com enable supporters to invest in players' future earnings while ensuring transparency and fairness (Principe et al., 2024). For example, tokenized sponsorships streamline contract management and minimize intermediary fees, benefiting both sponsors and recipients (Berkani et al., 2024).

2.7. Esports and Sports Betting

In Esports, blockchain enables secure, transparent transactions through cryptocurrencies and NFTs. Decentralized competition platforms supported by smart contracts mitigate fraud and enhance user trust (Billings, 2024; Shao & Cheng, 2024). In the domain of sports betting, blockchain ensures fairness by automating payouts and securely verifying outcomes via oracles. Augur and Gnosis offer decentralized betting market.

2.8. Copyright Protection in Sports Media

Blockchain offers innovative solutions to address copyright issues in sports broadcasting. Its transparency ensures that content ownership is immutable, reducing unauthorized use and infringement (Sherif et. al, 2025). Additionally, it facilitates cost-effective licensing and royalty distribution, benefiting content creators and broadcasters (Yadav, 2022; Berkani et al., 2024).

Thus, we may affirm that the applicability of blockchain technology in sports spans across critical domains, offering transformative solutions to long-standing challenges. By addressing data security, enhancing engagement, and streamlining operations, blockchain represents a paradigm shift in how the sports industry operates. With further research and stakeholder collaboration, blockchain's potential can be harnessed to maximize its benefits for athletes, fans, and organizations alike.

3. Methodology

3.1. The Purpose of the Research and the Instruments Used

This study aims to explore the advantages of blockchain technology and assess how blockchain applications influence athletes' performance. To achieve this, we developed an online survey designed to collect responses from sports professionals. The questionnaire was structured into three distinct sections, each targeting a specific theme:

a. **Blockchain Benefits**: Highlighting the perceived advantages of integrating blockchain technology into the sports domain.
b. **Blockchain Apps**: Exploring how respondents have implemented blockchain applications in their professional roles.
c. **Performance**: Collecting data on the participants' sports performance levels and achievements.

 doi:10.20944/preprints202412.1619.v3

Each section consisted of multiple questions available on-line at https://forms.gle/NreiyKtQseVcKN5TA. These components were converted into constructs and subjected to regression analysis using SmartPLS software to assess their interrelationships.

3.2. Design and Research Phase

The survey was conducted via Google Forms, with respondents completing the forms under the researcher's guidance. Participants included athletes and academics from the National University of Physical Education and Sports in Bucharest, as well as representatives from the Romanian National Sports Federations. To ensure compliance with ethical and legal standards, the study adhered to GDPR regulations. All respondents provided informed consent for the anonymous processing of their data and opinions.

Following a rigorous data-cleaning process, 293 valid responses were retained, comprising 213 from football and 80 from basketball participants. Ambiguous and incomplete responses were excluded to maintain the integrity of the analysis.

The questionnaire was informed by prior studies (Li, 2023; Tedesco, 2022) and the primary author's firsthand experience coaching athletes who incorporated blockchain technology as part of their professional practices. Respondents rated their answers on a Likert scale, ranging from -2 (totally disagree) to 2 (totally agree).

The methodological framework ensured the systematic organization and evaluation of the data. Partial least squares (PLS) structural equation modeling was employed for data analysis. This technique allows for simultaneous examination of interactions between latent, formative, and reflective variables, even in studies with smaller sample sizes. The model incorporated two latent reflective constructs: Blockchain Apps and Blockchain Benefits. The variables and their corresponding description items are presented below:

Blockchain benefits in sports - Blockchain-based sponsorship uses the internet to publish and broadcast information about sports teams and athletes, enabling online payment. Tokenization is used to fund amateur and lesser-known athletes, recouping investment from team earnings. Smart tickets are tracked using blockchain technology, and decentralization prevents ticket resale. Data security is enhanced by allowing secure sharing of personal information. Antidoping is managed through blockchain technology. Fans can invest in talented young athletes, recouping their investment through tokens and smart contracts. Fans can also track and reward fun activities using a unique algorithm.

Blockchain Apps -The app offers various features such as crypto sponsorships, tokenizing athletes, smart tickets, decentralized ticket distribution, secure performer data recording and sharing, decentralized participation and payments, fan revenue sharing, and rewarding fan interaction. It also provides a platform for decentralized participation and payments in fantasy sports.

Performance Level -The player's national team caps, European level performance, national team caps, goals, and World Selections caps are all important factors to consider when evaluating their performance.

We performed a Path analysis using the three constructs ***Blockchain benefits in sports***, ***Blockchain Apps, Performance Level*** detailed above with the SmartPLS program to evaluate the interrelationships among the variables in the context of our hypotheses. The analysis highlights the connections underpinning our three core hypotheses. Two formative constructs—Performance—and two reflective constructs—Blockchain Apps and Blockchain Benefits—form the foundation of our investigation. The statistical significance of our sample was validated for the target population, ensuring the robustness of the findings.

The two primary constructs, **Blockchain Apps** and **Blockchain Benefits**, were rated on a five-point Likert scale. Meanwhile, the open-ended Performance variables were measured numerically, capturing participation, achievements, and goals in team sports.

 doi:10.20944/preprints202412.1619.v3

Building on this foundation, our study examines the perceived advantages of blockchain technology and its impact on athletes' performance, with a specific focus on the Romanian sports ecosystem. This research aims to address three central hypotheses:

- **H1**: The implementation of blockchain applications in sports fosters trust among coaches and athletes regarding blockchain's benefits.
- **H2**: Blockchain applications positively influence athletes' performance at national and European levels.
- **H3**: Perceptions of blockchain's advantages differ significantly based on professional roles within sports.
- **H4**: Blockchain adoption in sports differs significantly between football and basketball due to structural, economic, and technological factors

3. Results

3.1. Descriptive statistics

Our sample demonstrates a well-balanced age distribution, encompassing individuals aged 19 to 55. Specifically, 35.15% of respondents are 14-18 years old, 29.69% are 19-25 years old, 17.75% are 26-35 years old, 15.36% are 36-45 years old, and 2.05% are older than 46 years. Gender distribution reflects the nature of team sports, with 78.55% male participants and 21.50% female. Additionally, a majority reside in urban areas (77.46%), and respondents predominantly have advanced educational qualifications: faculty degrees (50.23%), master's degrees (35.21%), and PhDs (4.23%).

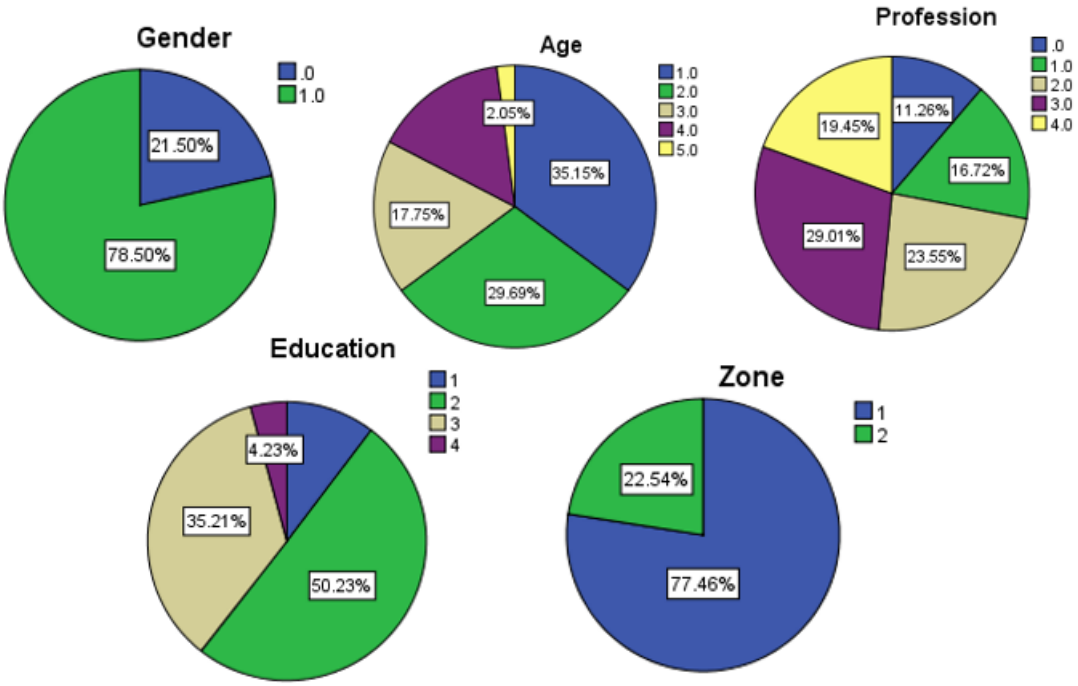

Figure 1. Descriptive statistics.

3.2. Comparative Variance Analysis of Basketball versus Football

Figure 2 illustrates key variable comparisons between basketball and football participants.

Preprints.org (www.preprints.org) | NOT PEER-REVIEWED | Posted: 28 April 2025 doi:10.20944/preprints202412.1619.v3

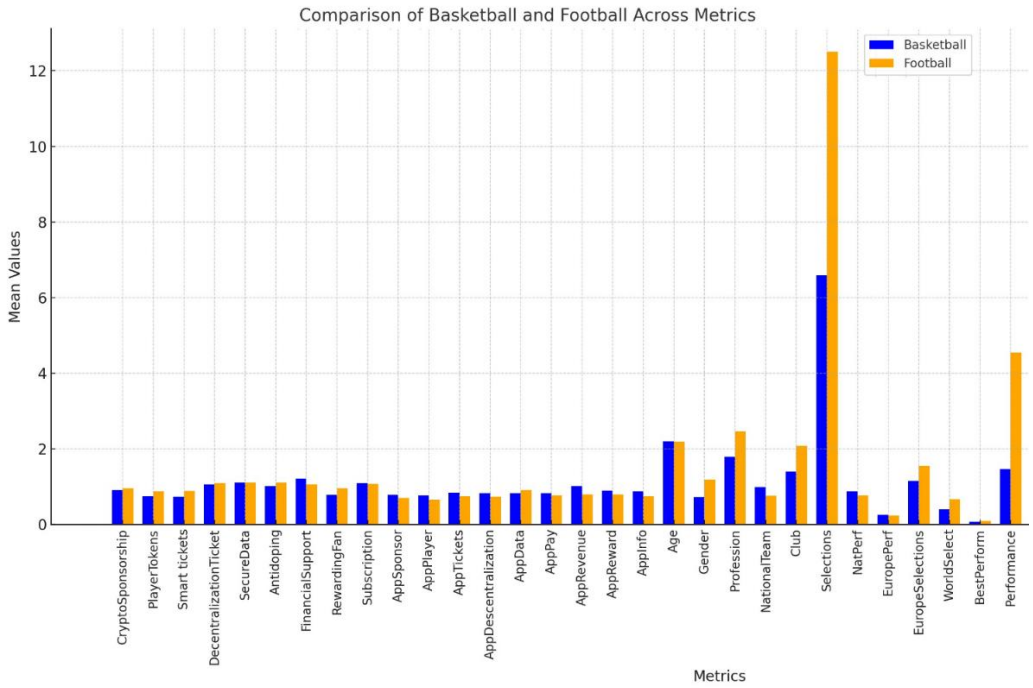

Figure 2. Comparison of Basketball and Football on all variables analyzed.

Football exhibits higher values in categories like **Crypto Sponsorship** (0.958 vs. 0.951), **Player Tokens** (0.87 vs. 0.75), **Smart Tickets** (0.89 vs. 0.73), **Rewarding Fans** (0.95 vs. 0.78), and **Blockchain Advantage** (1.03 vs. 0.96). Conversely, basketball leads in **Financial Support** (1.21 vs. 1.06), **AI in Sport** (1.42 vs. 1.35), and **Blockchain Apps** (0.853 vs. 0.775). The differences in **Antidoping** and **Secure Data** were negligible. A one-way ANOVA (Table 1) revealed no significant differences in blockchain-related opinions across sport types, gender, or profession, as indicated by p-values consistently exceeding 0.05.

Table 1. One-way ANOVA by sport, gender, and profession.

One-Way ANOVA	By sport		By gender		By profession	
(Welch's)	**F**	**p**	**F**	**p**	**F**	**p**
CryptoSponsorship	0.126	0.723	0.822	0.446	1.038	0.39
PlayerTokens	0.867	0.354	0.979	0.384	1.194	0.317
Smart tickets	1.2111	0.274	0.624	0.541	1.431	0.228
DecentralizationTicket	0.0614	0.805	0.938	0.399	0.868	0.485
SecureData	1.87E-06	0.999	1.088	0.346	1.671	0.161
Antidoping	0.4816	0.489	0.764	0.472	1.431	0.228
FinancialSupport	1.6093	0.207	0.146	0.865	1.091	0.364
RewardingFan	1.5903	0.21	0.618	0.544	0.535	0.71
Subscription	0.0205	0.886	0.202	0.818	0.618	0.651
AppSponsor	0.4666	0.496	1.277	0.289	1.401	0.238
AppPlayer	0.8626	0.355	0.951	0.394	1.296	0.275
AppTickets	0.5009	0.48	0.999	0.376	1.632	0.17
AppDescentralization	0.4468	0.505	0.208	0.813	0.901	0.465
AppData	0.3986	0.529	0.932	0.401	0.634	0.639
AppPay	0.1783	0.674	1.505	0.233	1.797	0.134
AppRevenue	3.544	0.062	4.249	0.02	1.476	0.214
AppReward	0.6126	0.435	1.186	0.315	2.096	0.085

 doi:10.20944/preprints202412.1619.v3

AppInfo	0.9118	0.342	0.981	0.383	0.682	0.606

3.3. Model Fit and Path Coefficients

Using SmartPLS, we evaluated the reliability and validity of the constructs. The Cronbach's Alpha coefficients confirm strong internal consistency. Path coefficients and corresponding loadings provide additional validation of the hypotheses (Figure 3):

- **H1**: **Blockchain Benefits** significantly influence the adoption of **Blockchain Apps**. A Path coefficient of 0.591 indicates a strong influence, supporting the first hypothesis.
- **H2**: **Blockchain Apps** positively impact athletes' performance at national and European levels, demonstrated by a moderate Path coefficient of 0.410.

Fornell-Larcker discriminant validity requirements were satisfied, with diagonal matrix values exceeding off-diagonal entries (Table 2). Additionally, the standardized root means square residual (SRMR) of 0.032, below the threshold of 0.05, indicates excellent model fit (Diamantopoulos, 2006).

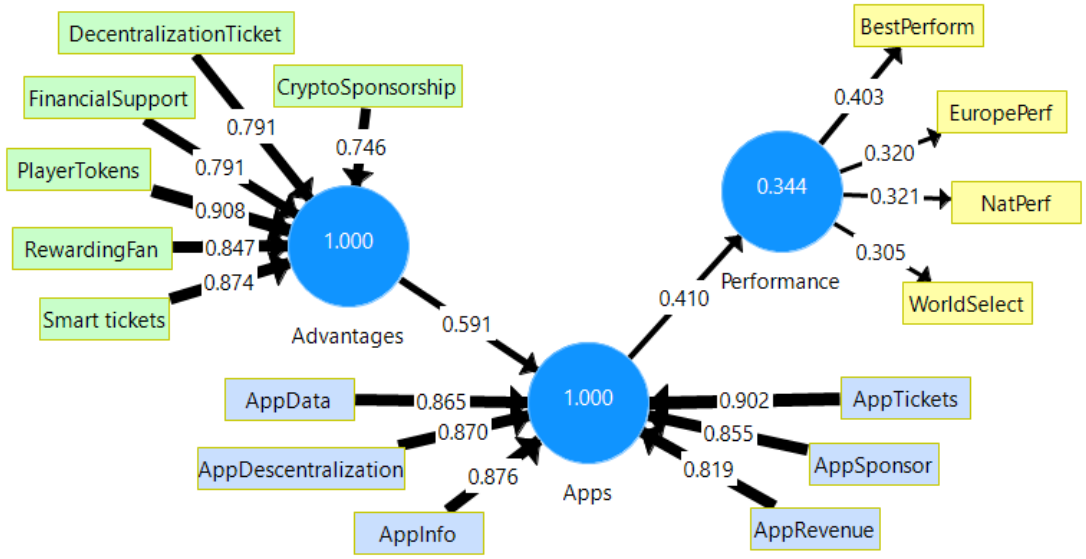

Figure 3. Cronbach's Alpha analysis and Path coefficients. Source: SmartPLS analysis (reprinted from a free version of SmartPLS software, version 3.3.9, created on 30 June 2024) (Hair et.al, 2019).

Table 2. Discriminant validity - Fornell-Larcker.

Variables	Block. Benefits	Block Apps	Performance
Blockchain Benefits			
Blockchain Apps	0.591		
Performance	0.264	0.410	0.339

An exceptional match can be explained by the SRMR (0.032), which has a value of less than 0.05 (Diamantopoulos, 2006). The parameters d ULS and d G, which stand for the squared Euclid distance and the geodesic distance, respectively, are utilized to calculate the discrepancy depending on the eigenvalue value (Van Laar, 2002). The estimates for SRMR, d ULS, and Chi-Square (Saturated =137.647 and Estimated=137.718) are greater than the saturated model, which stands in for the threshold when the estimated and saturated values of the models are compared (Table 3). The NFI (0.953) score indicates a consistent model because it is quite near threshold 1.

Table 3. Model fit.

	Saturated Model	Estimated Model
SRMR	0.032	032

 doi:10.20944/preprints202412.1619.v3

d_ULS	0.140	0.141
d_G	0.093	0.094
Chi-Square	137.647	137.718
NFI	0.953	0.953

The degree to which the exceptionally strong correlations between the variables that predicted elevated the variance of the generated coefficients of regression is determined by the variance inflation factor or VIF. There does not exist collinearity among the variables when the VIF is lower than the conventional threshold of 5 (Ringle, 2015). In our case all variable has lower values than 4, meaning that the multicollinearity is not manifest between our variables (Table 4).

Table 4. VIF values for each varaibles.

Variable	VIF	Variable	VIF
AppData	3.06	DecentralizationTicket	2.80
AppDescentralization	3.84	EuropePerf	1.15
AppInfo	3.67	FinancialSupport	2.32
AppRevenue	3.14	NatPerf	1.03
AppSponsor	2.27	PlayerTokens	2.65
AppTickets	3.80	RewardingFan	2.69
BestPerform	1.12	Smart tickets	2.85
CryptoSponsorship	2.14	WorldSelect	1.00

The standard errors for the PLS-SEM results are produced using the predictions from the bootstrapping subsamples. When assessing the significance of PLS-SEM data, SmartPLS software computes t-values, confidence intervals, and standard errors (Ringle, 2015). To evaluate the significance of the PLS-SEM results, T-values, p-values, and confidence intervals were produced using the previously mentioned data (Sarstedt, 2022). Model coherence is shown by T-values larger than 1.96 (Sarstedt, 2022), and reduced p-values (less than 0.01) because the first regression Blockchain Benefits -> Blockchain Apps has μ=0.59, DS=0.043. Tstat=13.869 and p=0.00. The H1 and H2 that were previously mentioned have been met. Because of the extremely low standard deviations and p-values, we can confirm the high accuracy of our model.

3.4. Cluster Analysis

K-Means clustering (SPSS) was used to analyze perceptions of blockchain advantages and applications. Three distinct clusters emerged:

1. **Cluster 1 (39.24%)**: Athletes and trainers leaning towards agreement with blockchain benefits (center = 1.17) but neutral regarding blockchain apps (center = 0.44).
2. **Cluster 2 (28.66%)**: Respondents neutral on both blockchain benefits (center = 0.13) and apps (center = 0.19).
3. **Cluster 3 (32.08%)**: Strong agreement with blockchain benefits (center = 1.59) and blockchain apps (center = 1.75).

On a Likert scale (-2: totally disagree, 0: neutral, 2: totally agree), most participants in Clusters 1 and 3 expressed favorable attitudes toward blockchain benefits. Notably, Cluster 2 reflected neutrality yet continued use of blockchain tools. Statistical significance was established via ANOVA, with high F-values (Blockchain Benefits: 273.892, Blockchain Apps: 429.864) and p-values below 0.05 (Table 5).

Table 5. ANOVA for Cluster analysis.

	Cluster	Error	F	Sig.

 doi:10.20944/preprints202412.1619.v3

	Mean Square	df	Mean Square	df		
BlockchainAdv	50.222	2	.183	290	273.892	.000
BlockchainApps	65.359	2	.152	290	429.864	.000

These findings substantiate **H3**, confirming that perceptions of blockchain's advantages and applications vary across professional roles. This supports the broader implications of blockchain adoption in team sports for advancing technology integration and performance optimization.

The Multivariate Analysis of Variance (MANOVA) based on CryptoSponsorship, PlayerTokens, Smart tickets, DecentralizationTicket, SecureData, Antidoping, FinancialSupport, RewardingFan, Subscription results indicate that sport type (Football vs. Basketball) has a statistically significant effect on blockchain adoption across multiple variables. The key statistical findings are: Wilks' Lambda: 0.342, $F = 60.61$, $p < 0.0001$, meaning that sport type significantly influences blockchain adoption. The Pillai's Trace is 0.658, $p < 0.0001$ and indicates a large effect size of sport type on blockchain adoption variables. Hotelling's Trace and Roy's Largest Root (1.928 and $p < 0.0001$) supports our hypothesis. The results confirm significant differences in how blockchain is perceived and implemented in football vs. basketball. Based on previous data trends football shows higher adoption in: Smart Tickets (UEFA ticketing experiments), Fan Tokens (Socios.com adoption by major clubs), Decentralized Ticketing (FIFA blockchain trials). Basketball leads in: Financial Support (Crypto sponsorships like FTX). NFT Collectibles (NBA Top Shot driving blockchain engagement). Athlete Performance Analytics (NBA integrating blockchain for player tracking). These data confirm our H4.

4. Discussions

Blockchain technology holds transformative potential for addressing entrenched challenges in the sports industry, including transparency, security, and efficiency. Thus, the researched questions have been answered as in accordance with international researches published as we may see below.

4.1. Key Findings and Implications

Ticketing systems can be created using blockchain-based platforms, allowing fans to purchase tickets directly from organizers, eliminating the risk of counterfeit tickets and ensuring fair pricing. Additionally, blockchain can enable the resale of tickets on a secure secondary market, allowing fans to buy and sell tickets without intermediaries (Berkani, 2024, Regner, 2022). Figure 3 shows that the loading factors for SmartTicket (LF=0.874) and DescentralizationTiket (LF=0.791) are both quite high (over the 0.6 threshold), indicating that respondents believe they offer significant benefits brought about by blockchain.

Authenticity and provenance of sports memorabilia can also be verified through blockchain-based smart contracts, recording ownership history on a blockchain to ensure authenticity and prevent tampering. Fan engagement platforms can reward fans with digital tokens for attending games, purchasing merchandise, or engaging with content on social media (Mehra et al., 2025, Bartholic et al., 2022, Berkani, 2024). The loading factors for RewardingFan (LF=0.847) and PlayerTokens (LF=0.908) are also quite high (over the 0.6 threshold), indicating that respondents believe these to be significant benefits provided by blockchain (Figure 3).

Smart contracts automate and secure athlete contracts and payments, streamlining contract negotiations and automating payments. Sports betting platforms can be transparent and decentralized, eliminating intermediaries and ensuring fair outcomes (Berkani, 2024, Regner, 2022, Lopez-Gonzalez et al., 2022). In Figure 3 one may observe that the loading factor for FinancialSupport (LF=0.791) and CryptoSponsorship (LF=0.746) have very high values (higher than 0.6 threshold), meaning that in the respondents' opinion they represent important advantages brough by blockchain.

 doi:10.20944/preprints202412.1619.v3

Blockchain technology can improve performance in sports by securely tracking player performance data, preventing tampering or manipulation, and providing medical staff with comprehensive records of a player's medical history. Wearable devices equipped with blockchain technology can continuously monitor player health metrics during training and matches, providing early warning signs of potential injuries (Sai Radha, 2023, Li, 2023, Li & Huang, 2024, Cheng et. Al., 2024, Li, Quan&Song, 2024). Figure 3 shows that AppDescentralization (LF=0.870) and AppData (LF=0.876) have very high loading factors (over the 0.6 threshold), indicating that respondents believe blockchain apps are crucial for athletic performance.

Scouting and talent identification can be achieved through transparent and decentralized platforms, where player performance data and reports are securely recorded and shared among clubs, agents, and scouts. Fan engagement platforms can provide fans with new ways to interact with their favorite sports clubs, such as issuing digital tokens representing ownership or voting rights (Principe, 2024, Lopez-Gonzalez et al., 2024, Khaund, 2020, Berkani, 2024). As can be seen in Figure 3, the loading factors for AppInfo (LF=0.876) and AppSponsor (LF=0.855) are both quite high (over the 0.6 threshold), indicating that respondents believe blockchain apps are crucial for athletic performance.

Lastly, secure and transparent ticketing systems can be created, preventing ticket fraud and scalping, enabling dynamic pricing based on demand, and transferring or reselling tickets securely and transparently (Berkani, 2024, Mehra et al., 2025, Bartholic et al., 2022). Figure 3 shows that the loading factors for AppTickets (LF=0.902) and AppRevenue (LF=0.819) are both quite high (over the 0.6 threshold), indicating that respondents believe blockchain apps are crucial to sports success.

The results of this study underscore the significant role of blockchain applications in fostering trust, improving performance, and streamlining operations within the Romanian sports ecosystem. This discussion contextualizes the findings within the broader framework of technological innovation and its implications for sports professionals, athletes, and policymakers.

First, the study validates the hypothesis that blockchain applications significantly enhance confidence in the perceived benefits of the technology among sports professionals. The adoption of blockchain apps, as evidenced by the strong path coefficient (0.591), is positively influenced by the recognition of its advantages, such as secure data management, anti-doping compliance, and transparent ticketing (Figure 3). Ticketing systems, as highlighted, utilize blockchain-based platforms to eliminate counterfeit tickets, ensure fair pricing, and enable secure resale markets. This result corresponds to the high loading factor for "Smart Tickets" (0.89 in football and 0.73 in basketball) in Table 1, demonstrating its pivotal role in fostering adoption. These findings align with previous research that highlights blockchain's ability to address critical vulnerabilities in centralized systems (e.g., Berkani et al., 2024; Kanat et al., 2024).

Second, blockchain applications were shown to have a moderate but positive impact on athletes' performance at both national and European levels (path coefficient: 0.410). The integration of decentralized technologies facilitates better data-driven decision-making, performance tracking, and injury prevention—key factors that contribute to improved outcomes. All loading factors for different Blockchain Apps have high loadings (above 0.819 across contexts), reflects the role of blockchain in managing sensitive player data, preventing injury, and supporting staff with comprehensive records. These findings extend existing knowledge by empirically demonstrating blockchain's role in enhancing measurable athletic performance metrics (Figure 3).

Third, the cluster analysis revealed variations in perceptions of blockchain benefits across professional roles. While athletes and coaches expressed stronger agreement with blockchain's advantages, sports managers and administrators exhibited more neutral attitudes. This divergence highlights the need for tailored strategies to improve stakeholder understanding and adoption of blockchain technology. Effective communication of blockchain's value proposition can bridge this gap and encourage wider acceptance (Figure 4).

 doi:10.20944/preprints202412.1619.v3

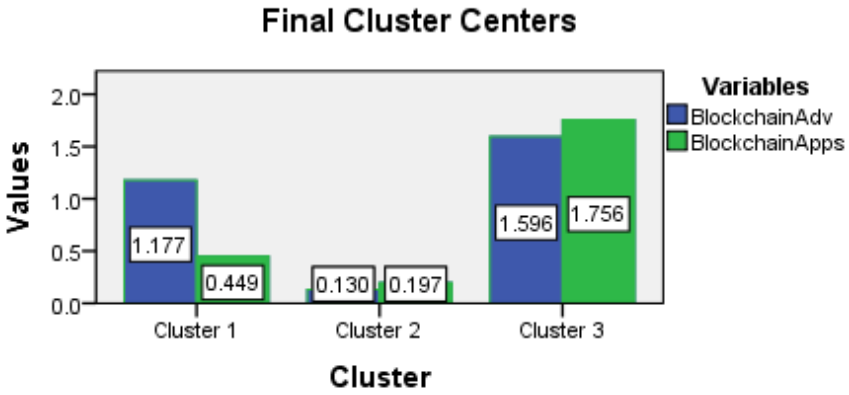

Figure 4. Cluster final centers by profession.

4.2. Practical Implication of Blockchain in Sport

Blockchain technology has numerous practical applications in sports, including ticketing, fan engagement, sponsorship, athlete management, anti-doping, merchandising, betting, and health tracking. It can combat ticket fraud and scalping by providing a secure and transparent way to issue, transfer, and verify tickets using non-fungible tokens (NFTs). Blockchain can also enable new forms of fan engagement through digital collectibles, fan tokens, and reward systems, increasing fan loyalty and creating new revenue streams. It can also provide transparent and efficient tracking of sponsorship deals and advertising metrics, ensuring both parties receive verifiable data on campaign performance. Blockchain platforms like FutbolCoin facilitate contracts and transactions between sports clubs, players, and agents using smart contracts. It can also improve transparency and trust in anti-doping processes by securely recording test results and ensuring immutability. It can also provide a decentralized and tamper-proof platform for placing and settling bets. This research proved that overall, the use of blockchain Apps in sports brings a lot of benefits reflected in increased performance of the athletes. This performance is associated with an increased return on investment (ROI) having a positive impact on the sportive clubs and countries economy.

Table 6. Comparative Analysis Football vs Basketball.

Blockchain Application	Football (Soccer)	Basketball	Key Differences
Smart Tickets	UEFA used blockchain for EURO 2020 ticketing	Limited adoption	Football faces higher ticket fraud risks, necessitating blockchain solutions
Fan Engagement	Fan tokens (FC Barcelona, PSG)	NBA Top Shot (NFTs)	Football engages fans through ownership; basketball leverages collectibles
Player Performance Data	Less adoption, mostly in elite clubs	NBA experimenting with blockchain-based tracking	NBA teams more focused on individual analytics
Sponsorship Management	Crypto sponsorships (e.g., eToro, Crypto.com)	Smart contracts used for sponsor deals (e.g., FTX)	Basketball relies more on digital asset sponsorships

Why Football Adopts Blockchain Faster Than Basketball?

 doi:10.20944/preprints202412.1619.v3

Football has larger, global audiences and as a consequence has higher demand for secure ticketing & fan engagement. UEFA & FIFA experimenting with blockchain early which enhances the industry-wide adoption. Basketball focuses more on NFT collectibles & analytics rather than direct blockchain governance.

Benchmarking Against Other Sectors: Blockchain adoption in sports is still in its early stages, but other industries have already achieved maturity in key blockchain applications. Comparing sports to finance, healthcare, and supply chains allows insights into best practices for overcoming adoption barriers. A industry comparisons might be observed in Table 7.

Table 7. Blockchain Benchmarking Against Other Sectors.

Blockchain Use Case	Sports	Finance	Healthcare	Supply Chain
Smart Contracts	Used for player contracts & sponsorships	Used for cross-border transactions (Ripple, Ethereum)	Used for insurance & patient consent management	Used for automating vendor contracts & shipments
Data Security & Privacy	Protects athlete performance & health data	Secures financial transactions & identities (e.g., KYC compliance)	Used for electronic medical records (EMRs)	Tracks product origins & reduces fraud (Walmart, IBM Food Trust)
NFTs & Digital Ownership	Used for fan engagement & sports collectibles	Used for digital art & music royalties	Potential for patient data ownership via NFTs	Used for tokenized tracking of high-value goods
Decentralized Governance	Used in fan voting & club decision-making (DAOs)	Used in Decentralized Finance (DeFi)	Not widely adopted yet	Blockchain-based supply chain consortia (e.g., TradeLens by Maersk)

The finance industry pioneered blockchain use through DeFi (Decentralized Finance), enabling secure cross-border transactions with smart contracts (e.g., Ripple, Ethereum). In Sports blockchain-powered player contracts & salary payments can eliminate intermediaries in international transfers (Table 7). Healthcare Blockchain secures Electronic Medical Records (EMRs), reducing fraud & unauthorized data access. In sports blockchain can protect athlete health records from tampering, similar to its use in anti-doping programs (Table 7). Supply Chain: Walmart & IBM track food safety using blockchain, ensuring transparency in the supply chain. In sports: Blockchain can be used to track athlete sponsorship deals, ensuring contract transparency (Table 7).

5. Limitations and Future Directions

Despite the promising results, this study has certain limitations. The sample is limited to Romanian team sports, which may restrict the generalizability of the findings to other contexts or individual sports. Moreover, while the study employed validated tools such as Structural Equation Modeling (SEM) and cluster analysis, qualitative insights from in-depth interviews or case studies could provide a richer understanding of blockchain's real-world applications.

Future research should explore the scalability of blockchain applications across diverse sports disciplines and geographic regions. Additionally, longitudinal studies could examine the sustained impact of blockchain adoption on athletic performance over time. Investigating the ethical and regulatory implications of blockchain in sports, particularly concerning data privacy and intellectual property, would also be valuable.

 doi:10.20944/preprints202412.1619.v3

By addressing these gaps, future studies can contribute to a more comprehensive understanding of how blockchain technology can revolutionize the sports industry.

6. Conclusion

This study provides compelling evidence of the transformative potential of blockchain technology in the sports industry, with a specific focus on Romanian team sports. The findings demonstrate that blockchain applications not only enhance confidence in their benefits among sports professionals but also positively influence athletes' performance at national and European levels. These outcomes are particularly significant given the early-stage adoption of blockchain in the sports domain.

Blockchain's capabilities—from secure data management to transparent ticketing and anti-doping compliance—address long-standing challenges and pave the way for innovation. Furthermore, blockchain-based fan engagement platforms and tokenization strategies offer new revenue streams and deepen fan loyalty, underscoring the broader economic and social implications of this technology.

However, realizing blockchain's full potential requires overcoming adoption barriers, including stakeholder skepticism and regulatory hurdles. Policymakers, sports organizations, and technology developers must collaborate to create enabling environments that support blockchain integration. Educational initiatives and pilot programs can further demonstrate blockchain's value, fostering trust and accelerating its adoption.

Sports have some lessons to learn from other sectors: Finance shows how smart contracts can automate sponsorship deals & athlete payments. Healthcare provides a model for securing athlete medical records using decentralized ledgers. Supply chain transparency solutions can reduce fraud in merchandise authentication & contracts. Finance & healthcare have clearer regulatory structures for blockchain than sports. Sports federations need to learn from supply chain models to handle large-scale blockchain adoption.

In conclusion, while this study highlights blockchain's promise, its widespread implementation in sports remains a work in progress. As the technology evolves, future research and practice should focus on maximizing its benefits for athletes, fans, and organizations alike. By doing so, blockchain can serve as a catalyst for transparency, efficiency, and competitive growth in the global sports industry.

Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Reference

1. Agbozo, E., & Hayawi, W. M. (2024). A Bibliometric Overview of Blockchain Technology in Sports. Facta Universitatis - Series Electronics and Energetics, 37(1), 157-168. https://doi.org/10.2298/FUEE2401157A
2. Ante, L., Saggu, A., Schellinger, B., & Wazinski, F.-P. (2024). Voting participation and engagement in blockchain-based fan tokens. Electronic Markets, 34(26). https://doi.org/10.1007/s12525-024-00709-z
3. Ayres Principe, V., P. S. M. da Silva, G. C., Gomes de Souza Vale, R., & de Alkmim Moreira Nunes, R. (2024). Blockchain and sports industry: a systematic literature review of Fan Tokens and their implications. Retos, 60, 823-840. https://doi.org/10.47197/retos.v60.107125
4. Bartholic, M. Laszka, A. Yamamoto G. and Burger, E. W. A Taxonomy of Blockchain Oracles: The Truth Depends on the Question, 2022 IEEE International Conference on Blockchain and Cryptocurrency (ICBC), Shanghai, China, 2022, pp. 1-15, doi: 10.1109/ICBC54727.2022.9805555.
5. Berkani, A., Moumen, H., Benharzallah, S., Yahiaoui, S., & Bounceur, A. (2024). Blockchain Use Cases in the Sports Industry: A Systematic Review. International Journal of Networked and Distributed Computing, 12(1), 17â€40. https://doi.org/10.1007/s44227-024-00022-3

 doi:10.20944/preprints202412.1619.v3

6. Billings, A.C. (2024), From gamification to personalization: sports media, Web 3.0 and the desire for the ultimate fan experience, International Journal of Sports Marketing and Sponsorship, Vol. ahead-of-print No. ahead-of-print. https://doi.org/10.1108/IJSMS-06-2023-0121
7. Calderone D. C. and Costa, G. Blockchain Integration in FIFA Clearing House: Enhancing Security and Operational Efficiency, 2024 IEEE International Workshop on Sport, Technology and Research (STAR), Lecco, Italy, 2024, pp. 26-31, doi: 10.1109/STAR62027.2024.10635976.
8. Cappiello, B., & Carullo, G. (Eds.). (2021). Blockchain, law and governance. Springer International Publishing. https://doi.org/10.1007/978-3-030-52722-8
9. Chen, X. (2024). Blockchain-based athlete health archives data sharing from the perspective of public health. Revista Internacional de Medicina y Ciencias de la Actividad Fisica y del Deporte, 24(95), 336-352.
10. Chen, Y., Chen, C. C. Tang L. C. and Chieng, W. H. Enhancing Running Exercise with IoT, Blockchain, and Heart Rate Adaptive Running Music, in IEEE Access, vol. 12, pp. 14168-14181, 2024, doi: 10.1109/ACCESS.2024.3355792
11. Cheng, M. Y., Yu, C. L., An, X., Wang, L., Tsai, C. L., Qi, F., & Wang, K. P. (2024). Evaluating EEG neurofeedback in sport psychology: a systematic review of RCT studies for insights into mechanisms and performance improvement. *Frontiers in psychology*, *15*, 1331997. https://doi.org/10.3389/fpsyg.2024.1331997
12. FIFA announces partnership with blockchain innovator Algorand. (n.d.) https://www.fifa.com/about-fifa/president/media-releases/fifa-announces-partnership-with-blockchain-innovator-algorand/. Accessed on 1 May 2024
13. Fukuzawa, M.B., McConnell, B.M., Kay, M.G., Thoney-Barletta, K.A. and Warsing, D.P. (2024), Implementing trades of the National Football League Draft on blockchain smart contracts, International Journal of Sports Marketing and Sponsorship, Vol. 25 No. 2, pp. 330-359. https://doi.org/10.1108/IJSMS-09-2023-0185
14. Ghosh, S. (2024). Public vs private blockchains for decentralization layers. In The age of decentralization. Productivity Press.
15. Goldsby, C., & Hanisch, M. (2022). The boon and bane of blockchain: Getting the governance right. California Management Review, 64(2), 141-168. https://doi.org/10.1177/00081256221080747
16. Kanat, E., Oget, E., & Kaya, F. (2024, March). The determinants of prices of fan tokens as a new sports finance tool. Ege Academic Review. https://doi.org/10.21121/eab.1309596
17. Li, A., Huang, W. A comprehensive survey of artificial intelligence and cloud computing applications in the sports industry. Wireless Network 30, 6973-6984 (2024). https://doi.org/10.1007/s11276-023-03567-3
18. Li, J. N., Quan, Z. P., & Song, W. J. (2024). Blockchain enhanced student physical performance analysis using machine learning-IoT and Apriori algorithm in physical education network teaching. Scalable Computing: Practice and Experience, 25(3). https://doi.org/10.12694/scpe.v25i3.2675
19. Lopez-Gonzalez, H., & Petrotta, B. (2023). Gambling-like digital assets and gambling severity: a correlational study with U.S. sports bettors consuming cryptocurrencies, NFTs, and fan tokens. International Gambling Studies, 24(2), 341-356. https://doi.org/10.1080/14459795.2023.2279125
20. Manoli, A. E., Dixon, K., & Antonopoulos, G. A. (2024). Football Fan Tokens as a mode of serious leisure: unveiling the dual essence of identity and investment. Leisure Studies, 44(2), 294-308. https://doi.org/10.1080/02614367.2024.2301949
21. Mehra, V., Bharany, S., Singh, P. et al. Impacts of digital technologies and social media platforms on advocating environmental sustainability in sports sector. Discov Sustain 6, 121 (2025). https://doi.org/10.1007/s43621-025-00932-4
22. Potts, J., Thomas, S., & Tierney, K. (2023). Blockchain innovation in sports economies. In 21st century sports (pp. 247-258). Springer. https://doi.org/10.1007/978-3-031-38981-8_15
23. Regner, F., Schweizer, A., & Urbach, N. (2022). Utilizing non-fungible tokens for an event ticketing system. In M. C. Lacity & H. Treiblmaier (Eds.), Blockchains and the token economy: Theory and practice (pp. 315-343). Springer International Publishing. https://doi.org/10.1007/978-3-030-95108-5_12
24. Sai Radha, K., Kalakota S., Harshavardhan R (2023), Performance prediction of cricket player using blockchain enabled HMM model, Proceedings of the Second International Conference on Emerging Trends

 doi:10.20944/preprints202412.1619.v3

in Engineering (ICETE 2023). (2023b). In Advances in engineering research/Advances in Engineering Research. https://doi.org/10.2991/978-94-6463-252-1

25. Schlimm, J., Mereu, S. and Breuer, C. (2024), Why do consumers buy sports NFTs? decoding consumer values and needs driving purchase intention, International Journal of Sports Marketing and Sponsorship, Vol. 25 No. 5, pp. 1163-1184. https://doi.org/10.1108/IJSMS-04-2024-0097
26. Shao, S. F., & Cheng, J. (2024). Time-varying connectedness between sport cryptocurrency and listed European football stocks: evidence from a LASSO-VAR approach. Applied Economics, 1-14. https://doi.org/10.1080/00036846.2024.2364938
27. Sherif, K., Mohamed, S. S. A., & Amanulla, R. (2025). Managing the environmental sustainability performance of mega-sport events: a blockchain-based smart control system. Sport, Business and Management: An International Journal. https://doi.org/10.1108/sbm-04-2024-0044
28. Shukla, A., Jirli, P., Mishra, A., & Singh, A. K. (2024). An overview of blockchain research and future agenda: Insights from structural topic modeling. Journal of Innovation & Knowledge, 9(4), 100605. https://doi.org/10.1016/j.jik.2024.100605
29. Sung, H.-M., Chen, T., Tseng, H.-C., Prayogo, B., Lin, J.-Y., & Hung, Y.-P. (2023). akaTick: Hybrid mobile e-ticketing system based on non-fungible tokens. In 2023 IEEE International Conference on Metaverse Computing, Networking and Applications (MetaCom) (pp. 686-687). IEEE. https://doi.org/10.1109/MetaCom57706.2023.00126
30. Tedesco, S. Scheurer, S., Brown, K. N., Hennessy L. & O'Flynn, B. (2022) A Survey on the Use of Artificial Intelligence for Injury Prediction in Sports, IEEE International Workshop on Sport, Technology and Research (STAR), 127-131, https//doi.org/10.1109/STAR53492.2022.9859939
31. Torrance, J., Heath, C., Andrade, M., & Newall, P. (2023). Gambling, cryptocurrency, and financial trading app marketing in English Premier League football: A frequency analysis of in-game logos. Journal of behavioral addictions, 12(4), 972-982. https://doi.org/10.1556/2006.2023.00066
32. Tripathi, G., Ahad, M. A., & Casalino, G. (2023). A comprehensive review of blockchain technology: Underlying principles and historical background with future challenges. Decision Analytics Journal, 9, 100344. https://doi.org/10.1016/j.dajour.2023.100344
33. UEFA Press Release (2021): https://www.uefa.com
34. Wilson, K. B., Karg, A., & Ghaderi, H. (2022). Prospecting non-fungible tokens in the digital economy: Stakeholders and ecosystem, risk and opportunity. Business Horizons, 65(6), 657-670. https://doi.org/10.1016/j.bushor.2021.10.00.
35. Yadav, J., Misra, M., Rana, N.P., Singh, K. and Goundar, S. (2022), Netizens' behavior towards a blockchain-based esports framework: a TPB and machine learning integrated approach, *International Journal of Sports Marketing and Sponsorship,* Vol. 23 No. 4, pp. 665-683. https://doi.org/10.1108/IJSMS-06-2021-0130
36. Eivazzadeh, S.; Mutyala, S.; Chinthala, J.; Fotrousi, F.; Khatibi, S. Blockchains' Impact on Enhancing Physical Activity, Rehabilitation, Sport, and Exercise-Based Therapeutics: A Systematic Review. *Appl. Sci.* 2025, *15*, 3683. https://doi.org/10.3390/app15073683