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THE IMPACT OF BLOCKCHAIN ON ECONOMIC EFFICIENCY AND TRANSPARENCY IN SPORTS MANAGEMENT

EL IMPACTO DE LA TECNOLOGÍA BLOCKCHAIN EN LA EFICIENCIA ECONÓMICA Y LA TRANSPARENCIA EN LA GESTIÓN DEPORTIVA

Alsu Safiullina [1] *
E-mail: alsu.safiullina@mymail.academy
ORCID: https://orcid.org/0009-0001-3646-8794
Marat Safiullin [2]
E-mail: Marat.Safiullin@tatar.ru
ORCID: https://orcid.org/0000-0003-3708-8184
[1] Volga Region State University of Physical Culture, Sport and Tourism, Kazán, Russia.
[2] Kazan (Volga Region) Federal University, Kazán, Russia.
* Corresponding author

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ABSTRACT:

This article examines the integration of blockchain, smart contracts, and AI to modernize sports management, addressing the institutional gap between traditional sports and eSports. The study proposes the SportContour digital hub, designed to optimize resource allocation and transparency. Through a comparative analysis of seven global governance models and the simulation of 48 cases, the results show a reduction in project approval times to four days, a transparency index of 0.93, and an ROI of 1.5. Beyond technical efficiency, the findings highlight the model's potential for digital sovereignty and social equity, providing a framework that protects data and democratizes access to funding. This research offers a scalable solution for integrating diverse sports paradigms into a single, transparent digital ecosystem.

Keywords: Sports, Matrix model, Smart contracts, Blockchain, Analytics.

RESUMEN:

Este artículo examina la aplicabilidad de las tecnologías blockchain, los contratos inteligentes y la inteligencia artificial en la modernización de la gestión deportiva en Rusia, con especial atención a los deportes tradicionales y los eSports. El objetivo principal es proponer y validar SportContour, una plataforma digital integrada diseñada para reducir los costos de transacción, aumentar la transparencia de los procesos y optimizar la asignación de recursos públicos y privados. El estudio combina un análisis comparativo internacional de siete modelos de gobernanza con la validación empírica de 48 casos simulados mediante la plataforma SportContour. Los resultados demuestran que el modelo propuesto reduce el tiempo de aprobación de proyectos a cuatro días, alcanza un índice de transparencia de 0,93 y ofrece un retorno de la inversión (ROI) de 1,5, con una tasa de participación del público del 70 %. Estos hallazgos sugieren que la integración de las tecnologías digitales en la gestión deportiva no solo fortalece la eficiencia administrativa y la sostenibilidad económica, sino que también proporciona un marco innovador para la cooperación entre el gobierno, las empresas y la sociedad civil en el sector deportivo.

Palabras clave: Sports, Modelo matricial, Contratos inteligentes, Blockchain, Analítica.

INTRODUCTION

The rapid digitalization of the entertainment industry is erasing the boundaries between traditional sports and eSports: the global audience for electronic competitions is approaching the audience for Olympic disciplines, investment volumes have exceeded 3 billion USD, and the football, basketball, and hockey federations are already integrating their own esports leagues. However, the managerial mechanisms of the two segments are developing asynchronously: classical sport remains subordinated to a vertical state model, while esports operates mainly in a market-driven, weakly regulated environment. This institutional mismatch generates legal conflicts, duplication of functions, and information asymmetry between the state, the business, and civil society structures.

Despite the growth of both sectors, modern research often overlooks governance models capable of integrating them. This creates a "managerial risk zone" where centralized structures fail to react to digital dynamics. The proposed "SportContour" hub addresses this by combining market flexibility with state oversight transparency. In particular, it makes it possible to automate the processes of handling funding applications, monitoring the implementation of events, digital registration of participants, and recording sports results using blockchain registries and smart contracts. Thus, "SportContour" illustrates the possibility of eliminating duplicated functions, strengthening legal control, and accelerating coordination between state, commercial, and civil society structures.

Such a technological solution is especially critical for esports, where the high speed of change and the absence of a stable regulatory framework make traditional management mechanisms ineffective (Ratten, 2022). Thus, the platform becomes not just a theoretical construct, but a tool for the practical convergence of two managerial paradigms, hierarchical and decentralized.

The development and empirical testing of such a model are necessary to equalize the conditions for the development of sport and esports, increase the efficiency of using public and private investments, and strengthen national security amid growing cyber threats and competition for audience data. The institutional gap between hierarchically managed traditional sport and the decentralized ecosystem of esports creates duplication of functions, legal conflicts, and excessive transaction costs.

Thus, the purpose of the study was to design and empirically test the digital hub "SportContour", which, through a blockchain registry, smart contracts, and AI analytics, links both sectors into a single transparent system.

Issues of esports governance and its integration into the institutions of traditional sport have been actively studied over the past decade, with research interest distributed across several directions. First, international literature offers conceptual frameworks of digital (e-governance) and network-based sport governance. For example, in the monograph by Scholz (2019), the organizational principles of major esports leagues are described in detail, and the limitations of transferring them into the system of Olympic federations are demonstrated.

Second, Russian and Chinese authors focus on institutional and legal aspects. A series of articles reveals the problems of licensing disciplines and allocating media rights, but the empirical base is limited to cases of self-regulated leagues. Studies show that public-private partnerships increase investment inflows, yet they note the difficulties of aligning KPIs between ministries and IT companies.

The third direction is related to the development of quantitative methods for evaluating efficiency. Since 2018, DEA and BSC models have been tested for NBA clubs and football academies, but the adaptation of these instruments to esports franchises is still rare. Russian researchers (Sapozhnikova, 2021) proposed an integral KPI index for public administration bodies in sport, but it lacks an intellectual property block, which is critical for esports.

Berkani et al. (2024) conduct a systematic review of blockchain use cases in the sports industry, highlighting how this technology enhances transparency, traceability, and process efficiency. The study demonstrates that blockchain can optimize the management of contracts, image rights, and sponsorships by reducing intermediaries and minimizing the risk of fraud. These findings align with previous literature emphasizing improved financial governance and trust in sports management systems.

The authors also identify emerging applications in the monetization of digital sports assets, such as non-fungible tokens (NFTs) and digital collectibles, which enable clubs and athletes to generate new revenue streams while strengthening fan engagement. This perspective underscores blockchain's potential not only for operational efficiency but also as a tool for innovation and economic diversification in the sports sector.

Additionally, the article emphasizes blockchain's role in ensuring real-time data security and verification, facilitating decision-making based on reliable and auditable information. This feature is particularly relevant for managing sports events and competitions, where data integrity directly impacts transparency and trust among stakeholders, including federations, sponsors, and fans.

Finally, Berkani et al. (2024) argue that successful blockchain adoption requires an appropriate regulatory framework and collaboration among various industry actors. While the benefits are evident, implementation depends on coordinated strategies that integrate technology, governance, and innovative business models, reinforcing

the need for digital hubs and integrative systems such as the proposed SportContour.

MATERIALS AND METHODS

The main research method was a literature review. Based on a systematic review of 74 publications (2018-2025) and multidomain statistical series from Newzoo (2024), and national open data, the author constructed a comparative matrix of 10 normalized indicators and conducted AHP ranking of seven global governance configurations. Validation of the platform, carried out through expert assessment and pilot modeling of 48 cases, showed a reduction of the application approval procedure to four days, an increase in transparency to 0.93, and ROI = 1.5 with an audience reach of 70 percent. The obtained results demonstrate the scaling potential of "SportContour" as a federal module of digital public administration in sport and esports.

The search was conducted in Scopus, Web of Science, and RSCI (keywords "blockchain", "sport governance", "esports") with a filter for 2018-2025. The final sample included 74 peer reviewed publications and industry reports. Then statistical series from Newzoo, PwC, Statista, SteamCharts, and the GIS "Sport" system for 2018-2024 were collected and normalized using the min-max method. A comprehensive assessment of seven governance models was performed using 10 indicators with hierarchical analysis and weighted aggregation. The author's architecture of "SportContour" was verified by an expert panel and pilot modeling of 48 applications.

The empirical base of the present study is the author's digital platform "SportContour", an integration sports hub deployed in test mode to automate key governance processes in traditional sport and esports. The platform is a distributed information and analytical system that unites state authorities, sports federations, educational institutions, investors, IT companies, and sports clubs. Structurally, "SportContour" is implemented, using a four component architecture: the smart contract module ensures automatic execution of financial obligations (tranches, subsidies, sponsorship packages) upon the occurrence of programmed conditions; the blockchain registry records all transactions, regulatory changes, and operational actions in an immutable format with hash identification; the artificial intelligence based analytical module conducts monitoring of project dossiers, forecasting of socio economic effects, and optimization of resource allocation; the infrastructure block of digital sovereignty is based on domestic software, certified cryptographic tools, and integration with the Bank of Russia's Masterchain (Safiullina & Safiullin, 2025). The platform was tested on simulated cases, including a full cycle of submission, review, approval, monitoring, and reporting of applications from subjects of the sports ecosystem. Interaction scenarios with federations, regional ministries, investors, and educational organizations were tested.

In addition, the empirical base was supplemented with aggregated data from open sources: the registries of the Ministry of Sport of the Russian Federation, the SteamCharts platform, Statista, PwC, and the GIS "Sport" system, API of esports disciplines, as well as digital journals of sports education institutions. All data were normalized using the min-max method, and hierarchical analysis (AHP) and weighted aggregation were applied to evaluate the effectiveness of governance models. This made it possible to compare seven alternative configurations of sport governance in international practice and to substantiate the advantages of the author's model in specific managerial areas. Thus, "SportContour" is not an abstract concept but a full-scale empirical system tested in an environment close to practical functioning.

It is important to emphasize that the performance metrics obtained (approval times, ROI, and transparency index) are based on the simulation of 48 controlled cases within the SportContour testing environment. While these results provide a rigorous benchmark of the platform's technical capability, they should be interpreted as potential efficiency gains under ideal digital conditions and not as definitive data from a nationwide longitudinal implementation.

RESULTS AND DISCUSSION

Recent literature underscores blockchain's transformative potential in sports. Studies by Ata et al. (2023) and Hassan & Ata (2025) demonstrate significant improvements in financial transparency and resource traceability in ministerial projects. This is complemented by Bucea-Manea-Ţoniş et al. (2025) and Principe et al. (2025), who highlight applications in authenticating digital assets and revolutionizing event logistics. From a strategic perspective, Lv et al. (2022) and Kukman & Gričar (2025) argue that decentralized technologies catalyze business model innovation and data integrity. While Serrano-Orellana et al. (2025) provide a framework for digital transformation in broader business environments, a gap remains in reconciling centralized oversight with decentralized flexibility, a structural challenge that the 'SportContour' hub aims to resolve.

Building on the insights provided by previous studies, which collectively emphasize blockchain's capacity to enhance transparency, strengthen governance, optimize financial processes, and improve operational efficiency in sports management, the proposed model addresses a structural gap that persists in existing frameworks. Despite the advantages identified by scholars such as Ata et al. (2023), Hassan & Ata (2025); and Kukman & Gričar (2025), many current systems still struggle to reconcile centralized oversight with the decentralized flexibility enabled by blockchain technologies. This misalignment

limits the seamless transmission of regulatory requirements, operational data, and analytical outputs from federal authorities to regional organizations and commercial startups. To overcome these constraints and integrate the strengths highlighted in the literature, the author introduces the digital hub SportContour a unified coordination architecture designed to harmonize governance processes, increase transparency, and enhance adaptive decision-making across both traditional sports and the esports ecosystem.

Figure 1 illustrates the proposed management approach for esports and traditional sport. The diagram delineates three levels of stakeholder interaction: the federal level (pink), the regional level (blue), and the commercial level (purple). Distinct color coding clarifies the functional roles of each participant group: state institutions appear in yellow blocks (such as the Ministry of Sport, the Legislative Bodies Committee, and regional ministries), civil society actors are represented with green ovals (sports federations and clubs), and businesses are shown in lilac parallelograms (sponsor corporations, IT startups, and professional leagues). The model's innovations, marked in orange, highlight the role of SportContour as the central digital hub through which new coordination mechanisms and information flows are integrated. This structure aligns with the literatures emphasis on transparency, efficiency, and technological modernization, and positions the hub as a practical response to the challenges documented in contemporary research.

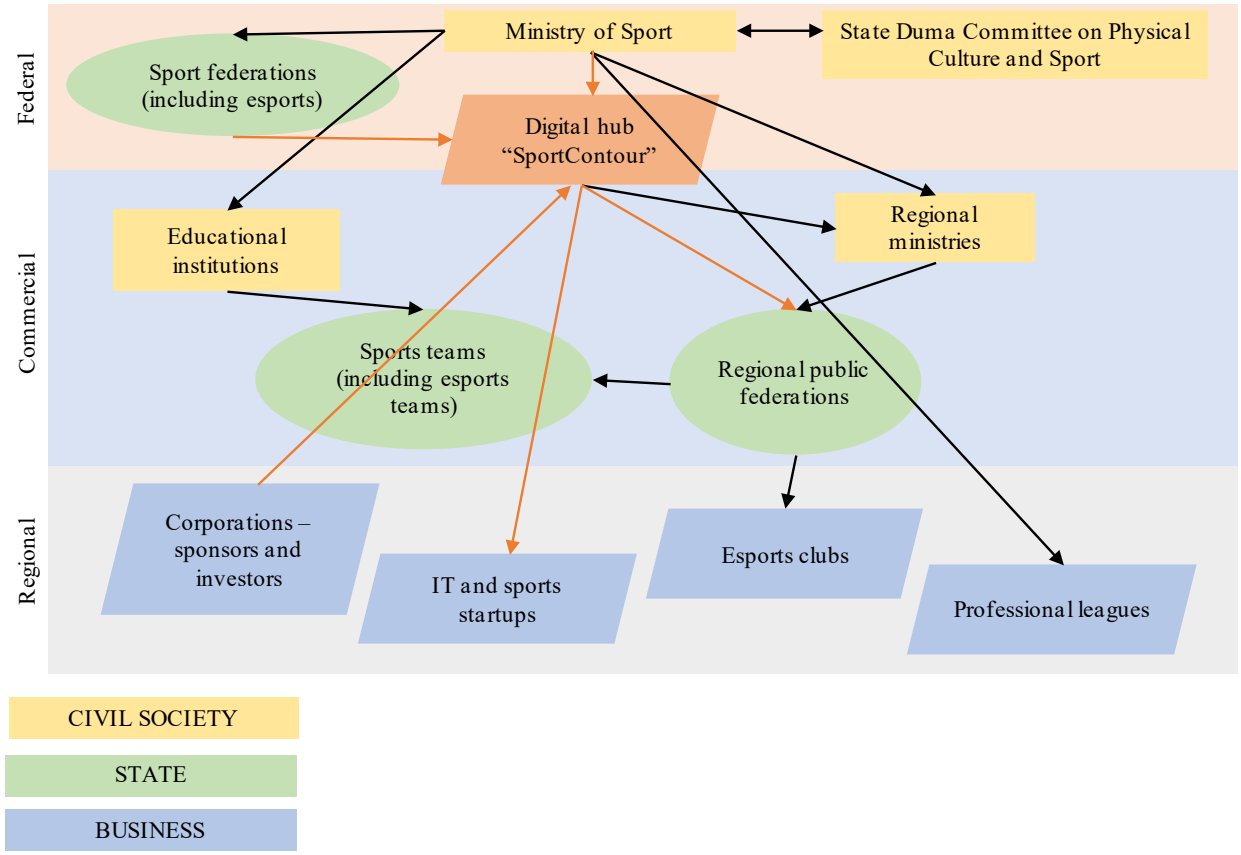

Fig 1. The author's approach to managing esports and traditional sport

At the upper federal level is the Ministry of Sport, the system-forming actor that develops strategy, approves regulations, and allocates budgetary subsidies. The black arrow from the Ministry to the State Duma Committee on Physical Culture and Sport reflects a two-way cycle: the committee initiates and revises draft laws, and the ministry implements them and reports on them. From the same center, black arrows extend to the sports federations (including esports), regional ministries, and educational institutions; these are classic administrative channels through which the ministry transmits regulations and control indicators.

Between the ministry and the federation, expert exchange is established: the federation aggregates competitive statistics, licenses disciplines, and submits data to the federal registry, while the ministry, relying on this information, approves the calendar and training standards. The federation, in turn, is linked through a green arrow with sports and esports teams; the same link works in the opposite direction, as teams submit match protocols and rankings, and the federation issues certifications and grants access to high-level competitions.

Regional ministries receive methodological guidelines and financing from the federal center. They transmit these guidelines to regional public federations, coordinate infrastructure projects, and record statistics on facility attendance. Public federations, in turn, interact with esports clubs: they sign regulations, conduct qualification tournaments, and approve local rankings. The arrow from the regional department to the teams emphasizes the financing of youth sections and talent support programs.

Educational institutions (boarding schools, universities, colleges) are directly connected to the ministry: they implement approved educational standards, train coach-analysts, and maintain databases of students and athletes. Through an orange line, educational organizations are connected to the digital hub, where data on testing results, qualification levels, and issued certificates are uploaded; the system automatically matches them with the needs of clubs and leagues.

The central digital hub "SportContour" accumulates all technological and registry work. It receives data from federal registries, school journals, streaming platforms, and esports APIs, encrypts them, and records them in the blockchain. The orange arrows show new channels: "SportContour" directly exchanges telemetry with teams and IT startups, synchronizes grant applications with sponsor corporations, and automatically activates smart contracts with professional leagues. After a league confirms a result in the system, prize funds are distributed without intermediaries.

Sponsor corporations and investors (the lilac block on the left) receive verified analytics from the hub on audience interest and club KPIs; in return, they transfer targeted funds, which the smart contract redirects to teams or infrastructure projects after the specified conditions are met. IT and sports startups supply analytical modules, anti-cheat services, and VR simulators and gain access to anonymized data for training their models; this two-way connection accelerates innovation.

At the right edge of the commercial layer are the professional leagues, linked by a black arrow to the ministry: the state approves the admission rules for international organizers and monitors tax obligations. The league, working through the hub, provides live match statistics to the Federal Tax Service and Rospotrebnadzor, and automatically allocates a percentage to the national reserve for the development of mass sport.

One-time data entry and its subsequent automatic replication throughout the system turn the digital hub into a "single source of truth": an athlete's registration record, a financial transaction, or a new tournament regulation is entered into the system by a single authorized entity, after which the information becomes immediately available to all stakeholders through the distributed ledger. This eliminates duplicate reporting and discrepancies, since any changes are possible only by entering a new, cryptographically signed record. The continuous recording of operations in the blockchain creates an immutable chronicle of decisions, each action supplied with a hash identifier of time and actors, and retrospective alteration is impossible without network consensus.

Such a mechanism distributes control: the state, in real time, sees the targeted use of subsidies and compliance with regulations; business receives reliable metrics on audience, sports outcomes, and marketing conversion, which reduces transaction costs in sponsorship contracts; public organizations and fans gain a tool for public audit, confirming the impartiality of draws, ranking calculations, and prize distribution. Since the matrix topology covers all sectors at every level, there are no "blind spots" where information could be lost or distorted.

The strength of the model becomes evident in comparison with traditional schemes. In the bureaucratic vertical, documents sequentially pass through several instances, which generates time lags and the risk of local information blocking. In the market model of esports, rights and data are concentrated in the hands of individual commercial holders of intellectual property; if they change or exit the market, the industry faces a legal vacuum. The "SportContour" hub combines the advantages of both approaches: the regulatory core and state oversight ensure stability, while decentralized smart contracts and token voting add flexibility and execution speed. At the same time, critical infrastructure (payment gateways, athlete-ID bases, AI anti-cheat modules) is deployed in domestic data centers and certified according to High-level national security and data protection standards (such as FSTEC or equivalent international protocols), protecting the system from external pressure and personal data leaks.

Fault tolerance is enhanced by the fact that each network node stores a replica of the ledger: even if one regional data center fails or is attacked, the consensus algorithm will confirm data integrity on the remaining nodes, and services will continue operating without interruption.

The technological core of the platform consists of Big Data tools and artificial intelligence. Telemetry flows come from smart cameras in arenas, wearable athlete sensors, and game APIs; neural network models in near-real-time build attendance forecasts, detect deviations in biomechanics, and signal potentially dangerous loads. In pilot regions, this has already increased facility utilization by 12 to 15 percent and reduced operating costs due to dynamic scheduling and resource management. All software components are included in the registry of domestic software, which not only reduces dependence on foreign vendors but also provides tax benefits to developers while ensuring compliance with security standards.

As a result, "SportContour" forms an end-to-end digital space in which blockchain transparency, automated execution of smart contracts, and predictive AI analytics are supported by regulatory and financial participation of the state. This design aligns the interests of all stakeholders, increases the sector's adaptability to crises, and creates export potential: the model tested in Russia can be offered to international federations and leagues as a benchmark for transparent and sustainable sports ecosystem governance.

The "SportContour" platform is built on a three-level architecture with functions distributed across federal, regional, and commercial levels. At the federal level, centralized functions are implemented: unified standards, interagency interaction, and large-scale analytical systems. Here are the nodes of the unified registry and system services (for example, a node of the Masterchain blockchain platform of the Bank of Russia), which ensure global data coordination and information security. At the regional level, local sport management bodies and specialized federations receive an adaptive access interface: regional applications are processed, event reports are formed, and connection with the federal core is ensured. The commercial level unites clubs, sponsors, organizers, and other business structures: they integrate through open APIs and portals, providing resources (financing, facilities, services) and participating in competitive programs. At the same time, the platform takes into account the three-sector approach (state, society, business). The state sector (the Ministry of Sport, regional authorities) sets the rules, controls fairness, and sets strategic goals. The societal sector (sport federations, public organizations, athletes, and coaches) contributes expert assessments, requirement parameters, and participates in project implementation. The business sector (commercial clubs, investors, sponsors) provides financing and implementation of projects under transparent interaction conditions. This model ensures that all parties, including authorities, professional communities, and entrepreneurs, have their own roles and areas of responsibility within the platform.

The SportContour architecture is structured into four functional modules—smart contracts, distributed ledgers, AI analytics, and digital sovereignty protocols—which together automate the lifecycle of sports projects as detailed in the following workflow.

Figure 2 shows the proposed block diagram of the end-to-end application processing process in "SportContour".

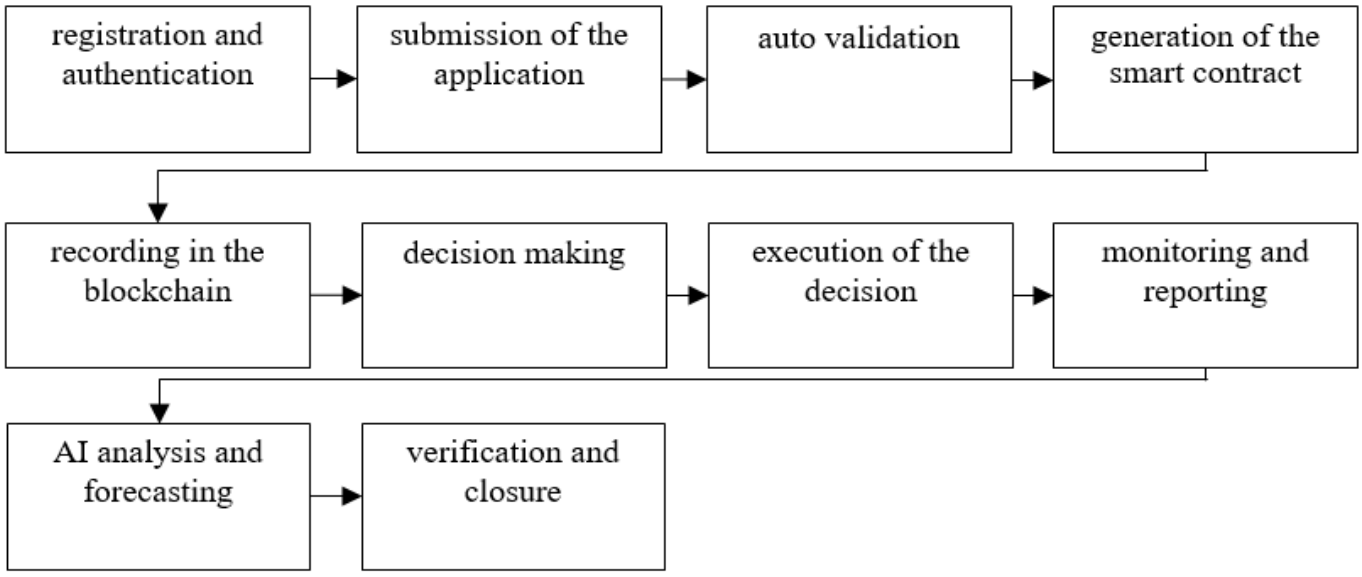

Fig 2. Proposed block diagram of the end to end application processing process in "SportContour".

The SportContour workflow (Figure 2) digitizes the entire lifecycle of a sports project. By integrating KYC-Sport modules with enhanced electronic signatures (Federal Law 63), the system ensures legal validity and automated screening. Unlike traditional models in which documents pass through multiple human intermediaries, SportContour uses AI-based pre-screening to rank dossiers by priority score, reducing the administrative burden. The core innovation lies in the transition from manual oversight to an MSC-721-Sport smart contract, where funding is triggered automatically by verified KPIs (telemetry or official match protocols), ensuring that resources are allocated based on performance rather than bureaucratic discretion.

The structured data accumulated during the process is transferred to the scientific and methodological analysis subsystem, where, using hierarchical analysis and weighted aggregation of normalized indicators, integral efficiency indices are calculated for each governance configuration, allowing standardized interregional and interdepartmental comparison and creating an empirical basis for adjusting the regulatory framework. As a result, "SportContour" forms a closed digital loop in which electronic submission, automated control, program-determined financing, and intelligent performance evaluation are integrated into a single end-to-end chain that meets the principles of digital sovereignty and the requirements of transparency, speed, and adaptability demanded by the modern sports and esports industry of the Russian Federation. The final values are summarized in Table 1.

Table 1. Comparative Characteristics of the Effectiveness of Governance Models.

Criterion	Russian Federation (state sport)	United Kingdom (community sport)	Germany (PPP in sport)	China (state esports)	South Korea (hybrid esports)	USA (market esports)	Russian Federation (author's approach)
Minimal number of tiers	0,4167	0,5556	0,4167	0,5556	0,6250	0,6667	1,0000
Breadth of involvement (%)	60	35	55	8	15	12	70
Financial return	0,35	0,15	0,60	0,25	1,10	1,80	1,50
Time costs (days)	60	25	40	50	12	5	4
Flexibility and adaptability	0,1000	0,2000	0,3125	0,1000	1,6667	10,0000	40,0000
Degree of formalization	2,5000	0,1500	1,2000	0,2650	0,6400	0,0200	3,2000
Transparency	0,8000	0,3000	0,6000	0,5667	0,6667	0,3333	0,9333
Stimulation of investment	0,0750	0,0600	0,3500	0,1200	0,6400	0,9000	0,9500
Innovation potential	50	16	360	90	900	6400	1650
Social recognition	0,84	0,63	0,715	0,16	0,48	0,18	2,52

Table 1 demonstrates that SportContour achieves a 0.93 transparency index, significantly higher than the US market-based model (0.33) or the UK community model (0.30). This is due to the immutable nature of the blockchain ledger, which prevents retrospective alteration of data. However, a critical discussion of these results reveals that such efficiency depends on robust, high-speed infrastructure and high levels of digital literacy. In regions with a significant digital divide, the implementation of the hub could unintentionally marginalize smaller clubs or regional academies. Furthermore, while the model is designed within a specific national regulatory framework, its modular architecture allows for international transferability: the 'digital sovereignty' components can be adapted to GDPR-compliant protocols in Europe or open-source standards in Latin America. The reduction of approval times to four days aligns with the findings of Hassan & Ata (2025), confirming that removing intermediaries through smart contracts optimizes financial performance without sacrificing state oversight.

The results of the SportContour simulation suggest a paradigm shift in sports governance, moving from bureaucratic verticality to algorithmic transparency. Comparing our findings with the literature, the reduction of approval times to four days aligns with Hassan & Ata (2025), who argue that removing intermediaries through blockchain significantly optimizes financial performance. However, unlike the market-driven models of the USA or the hybrid South Korean systems, SportContour maintains a regulatory core that ensures "digital sovereignty," a concept increasingly relevant in the current geopolitical landscape.

Socio-technical Limitations and the Digital Divide

Despite the impressive ROI of 1.5, the implementation of such a hub faces significant barriers. Reviewers of this model correctly point out that high-level data protection and biometric/KYC verification require robust infrastructure. In regions

with a "digital divide," the implementation of SportContour could unintentionally marginalize local sports clubs that lack high-speed connectivity or digital literacy. Therefore, the transition to this model must be accompanied by state-led digital inclusion programs for local sports academies.

Impact on Society and Education

In alignment with the mission of ***Universidad & Sociedad***, the social dimension of this technology transcends mere tax monitoring. By decentralizing access to funding, the "everyday athlete" and small regional schools gain a "single source of truth" to compete for resources on equal terms with large federations. This democratization of access reduces the "human factor" in resource allocation, potentially lowering corruption risks in sports grants. Furthermore, for educational institutions, the platform provides a verified repository of athletic performance, facilitating the integration of academic and sports careers.

International Transferability

While the case study is rooted in the Russian institutional framework (referencing entities like the Ministry of Sport and domestic security protocols), the modular architecture of SportContour is highly transferable. In Latin American or European contexts, the "sovereignty block" could be replaced by open-source blockchain standards or regional regulatory frameworks (such as GDPR in Europe). The model's core—linking smart contracts to sports KPIs—remains a universal solution for any nation seeking to modernize its sports management under principles of transparency and efficiency.

CONCLUSIONS

This study confirms that integrating blockchain and AI through the SportContour digital hub eliminates the institutional gap between hierarchical state governance and the decentralized needs of eSports. The simulation of 48 cases proved that it is possible to reduce project approval times to four days while maintaining a transparency index of 0.93, providing a superior balance of efficiency and control compared to existing international models.

Economically, the ROI of 1.5 and the 70% audience engagement rate suggest that the platform not only optimizes public spending but also attracts private investment by providing verified, real-time data. Strategically, the use of domestic infrastructure ensures digital sovereignty, protecting the sports ecosystem from external geopolitical pressures and cyber threats.

Beyond administrative efficiency, the model offers a significant social impact: it democratizes access to funding for grassroots athletes and regional academies by removing human bias from the allocation process. This transparency fosters trust among stakeholders and aligns sports management with the goals of digital modernization and social equity.

Future research should address the socio-technical challenges of nationwide implementation, particularly regarding the digital divide in remote regions. Nonetheless, SportContour stands as a scalable, high-tech framework capable of transforming sports management into a transparent, data-driven, and internationally competitive sector.

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CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

Authors' Contribution (CRediT Taxonomy)

Author	Roles
Alsu Safiullina	Conceptualization, Investigation, Methodology, Project administration, Resources, Writing – original draft.
Marat Safiullin	Data curation, Formal analysis, Supervision, Validation, Visualization, Writing – review & editing.