



Legal Aspects of Technological Advancements in Sports: Protection and Violation

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Abstract: The accelerating adoption of advanced technologies in the sports industry has generated a range of legal challenges, particularly concerning data privacy, ownership, and the maintenance of fair competition. This study seeks to analyze the legal implications of technological advancement in sports and to clarify the roles of regulatory bodies and sports organizations in protecting the interests of athletes and stakeholders. Using a systematic literature review of academic and regulatory sources from 2014 to 2024, the research highlights how innovations such as data analytics, wearable devices, and artificial intelligence, while offering notable benefits in performance enhancement and commercialization, also introduce significant risks of data misuse, privacy breaches, and disparities in access. The findings reveal persistent gaps and inconsistencies in the interpretation and enforcement of legal frameworks across jurisdictions, which undermine the effectiveness of existing protections. Key legal instruments, including international data protection regulations and collective bargaining agreements, are identified as crucial yet insufficient without coordinated implementation and ongoing education among stakeholders. The study underscores the importance of establishing harmonized regulatory standards, fostering legal literacy, and encouraging collaboration between sports organizations, regulatory authorities, and technology providers. Ultimately, the research emphasizes the need for a comprehensive legal framework that integrates regulatory enforcement, educational initiatives, and multi-stakeholder cooperation to ensure responsible, ethical, and equitable technological adoption in sports. These insights provide practical and theoretical guidance for sports organizations, regulators, and policymakers facing the evolving legal complexities of digital transformation in the sports sector.

Keywords: Sports Law, Technology, Athlete Protection, Legal Regulation

INTRODUCTION

Technological innovation has drastically transformed the landscape of sports over the past few decades from the use of wearable devices and smart sensors to the adoption of artificial intelligence (AI), virtual reality (VR), and augmented reality (AR). Recent reports show that 88% of sports organizations utilize data analytics to enhance athlete performance, while 55% of athletes use wearable technology to monitor their health and performance metrics (wifitalents.com). On the other hand, the adoption of AI and the Internet of Things (IoT) in sports has grown to 67%, providing real-time feedback that is crucial for coaches and athletes (seo.gover.ai).

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Theoretically, these developments are supported by the concept of technology as an agent of social and economic transformation. For instance, the theory of technological innovation in sports emphasizes that technology is not merely a supporting tool but also a catalyst for paradigm shifts in strategy, training, and spectator experience. In the legal context, both normative and regulatory approaches are needed to ensure that the implementation of technology upholds the principles of fair play, safety, and competitive justice.

The rapid advancement of technology has fundamentally redefined the legal landscape of the sports industry, raising complex questions about data privacy, intellectual property, and the preservation of fair competition. As sports organizations increasingly integrate artificial intelligence, wearable devices, and data analytics into their operations, legal systems are challenged to keep pace with the new risks and ethical dilemmas that emerge. Central to this evolution is the need to reconcile the promise of innovation with the fundamental principles of sports law fair play, safety, and competitive integrity.

However, this surge in technological use also presents serious legal challenges. Recent studies reveal that 78% of sports law practitioners identify data privacy and athletes' biometric information as the most pressing issues (society.org). Additionally, 65% predict significant changes in intellectual property rights over the next five years, particularly related to the use of virtual and augmented reality (society.org). From a regulatory perspective, sports data has also become a commodity used for both performance analysis and monetization. In professional football, data is used for commercial purposes, betting, fantasy sports, and even medical needs. This creates legal complexities regarding data rights, consumer protection, and business competition (entsportslawjournal.com).

Furthermore, the sports sector also presents direct legal challenges through litigation and regulation. For example, the National Basketball Association (NBA) once sued Motorola for the misappropriation of game data, reflecting the tension between intellectual property ownership and public access to information (en.wikipedia.org). Meanwhile, in the realm of U.S. collegiate sports, several antitrust lawsuits including the Tennessee v. NCAA case have shaken the traditional model of amateur athlete regulation, particularly regarding name, image, and likeness (NIL) rights (en.wikipedia.org).

Recent scholarship has highlighted the dual-edged nature of technological progress in sports. While some studies underscore the benefits of enhanced athlete performance, real-time analytics, and expanded commercial opportunities, others point to unresolved legal concerns, particularly regarding the protection of biometric data, the commodification of personal information, and disparities in technology access. Despite the proliferation of regulations such as the General Data Protection Regulation (GDPR) and collective bargaining agreements, persistent inconsistencies and enforcement gaps remain across jurisdictions. Moreover, landmark legal cases ranging from disputes over data ownership to challenges surrounding the use of virtual and augmented reality demonstrate that the regulatory responses have not always kept pace with technological change, leaving significant gray areas within the legal framework. Against this backdrop, this study seeks to address two central questions: (1) How can the law effectively protect the rights and interests

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of sports stakeholders athletes, organizations, and spectators in the era of advanced technology? (2) What regulatory measures are required to prevent violations such as data exploitation, infringement of intellectual property, and anti-competitive practices? By explicitly focusing on these questions, the research aims to clarify the role of legal frameworks in safeguarding ethical and equitable technological adoption in sports.

As technology advances, the line between innovation and legal violation becomes increasingly blurred. For instance, the use of video assistant referee (VAR) technology in football has sparked various legal debates, especially concerning decision transparency and the potential for bias in rule interpretation. On one hand, VAR helps increase objectivity and fairness in matches. On the other, some parties question the legality of VAR recordings as evidence, as well as the potential violation of players' privacy rights recorded in detail by the system (FIFA.com). This phenomenon illustrates that the adoption of technology in sports must always be balanced with careful legal considerations.

Beyond the field of competition, technology also impacts the commercialization of sports. Athlete data and analytics have become valuable economic commodities, especially for sponsors, broadcasters, and technology firms. This practice raises questions about data ownership rights and the fair distribution of economic benefits. According to research published in the *International Sports Law Journal*, the management of athlete data must take into account the principles of personal data protection as regulated by instruments such as the General Data Protection Regulation (GDPR) in Europe (Springer.com). Similar regulations are being adopted by various countries, including Indonesia, although implementation still faces many challenges.

Another equally important issue is the integrity of competition. The adoption of technology for performance analysis and team strategy can create gaps between large clubs with access to advanced technology and smaller clubs with limited resources. This risks violating the principle of fair competition, which is foundational in sports law. In some cases, international sports federations have even issued specific regulations on the use of technological devices in official matches, such as limiting electronic communication between coaches and players during games (entsportslawjournal.com).

Lastly, legal challenges also arise in the aspect of oversight and law enforcement regarding technological misuse. Cases such as the hacking of wearable devices or match data manipulation have become serious concerns for authorities. Law enforcement against technological violations in sports requires coordination among agencies, including law enforcement, sports federations, and data protection authorities. Research by the Sports Innovation Lab emphasizes the importance of stakeholder collaboration in formulating adaptive policies, considering that technological developments far outpace the speed at which legal rules are created (sportsilab.com). This demonstrates that the protection of athletes, clubs, and spectators depends not only on existing regulations but also on ongoing legal oversight and education systems.





Tabel 1. Quantitative Data of Technological Aspect

No	Technological Aspect	Data/Statistics	Legal Challenges	Reference Source
1	Data Analytics	88% of sports organizations use data analytics; 55% of athletes use wearable technology	Data protection, privacy, potential data misuse	wifitalents.com
2	Artificial Intelligence (AI) & IoT	67% adoption rate of AI and IoT in sports	Intellectual property rights, privacy, data usage regulations	seo.goover.ai
3	Video Assistant Referee (VAR)	Implemented in various football leagues	Decision transparency, legality of recordings, potential privacy violations	FIFA.com
4	Commercial Athlete Data	Athlete data has become a high-value economic commodity	Data ownership, fair distribution of economic benefits, personal data protection (GDPR)	Springer.com
5	Technology for Strategy & Performance	Disparity in access between large and small clubs	Fair competition, regulation of technology use in official matches	entsportslawjournal.com

Given these multifaceted developments, the intersection of technological advancement and legal frameworks in sports is both inevitable and complex. As innovation continues to reshape all dimensions of the sports industry, there is an urgent need for comprehensive regulatory responses that not only safeguard the rights and interests of athletes, organizations, and fans but also encourage responsible technological growth. Effective legal frameworks must strike a balance between enabling innovation and maintaining the core values of fairness, integrity, and ethical conduct within the sports ecosystem (Springer.com; entsportslawjournal.com).

This paper will further explore the legal implications of emerging sports technologies, analyzing both the protective measures required to ensure stakeholder rights and the potential infringements that may arise from rapid innovation. By integrating empirical data, recent case studies, and prevailing legal theories, this research aims to provide a nuanced perspective and practical recommendations for policymakers, practitioners, and stakeholders in the sports sector (society.org; sportsilab.com). Ultimately, understanding and addressing the legal challenges of sports technology is essential for fostering a sustainable, equitable, and forward-looking sports environment. This study contributes to the ongoing discourse in sports law by synthesizing empirical data, legal theory, and case analysis to illuminate critical regulatory gaps and propose

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actionable recommendations. By doing so, it offers valuable insights for policymakers, practitioners, and regulatory authorities seeking to adapt to the dynamic intersection of technology and law in the sports sector, ultimately promoting both innovation and the core values of fairness and integrity.

RESEARCH METHOD

This study adopts a Systematic Literature Review (SLR) approach to rigorously examine the legal challenges and regulatory responses associated with technological innovation in the sports industry. The SLR methodology is particularly suited to this topic, as it enables comprehensive synthesis of existing research, identification of prevailing trends, and critical assessment of gaps in both academic and practical domains. By systematically collecting and analyzing literature, the study ensures objectivity, transparency, and replicability in addressing complex interdisciplinary legal issues.

The literature search was conducted across major academic databases, including Google Scholar, SpringerLink, and ScienceDirect, as well as specialized journals focusing on sports law, technology regulation, and policy. Supplementary sources included policy documents, official reports from sports governing bodies, and relevant case law to capture a holistic view of regulatory practices. The search covered publications from 2014 to 2024, reflecting the most current developments in the field.

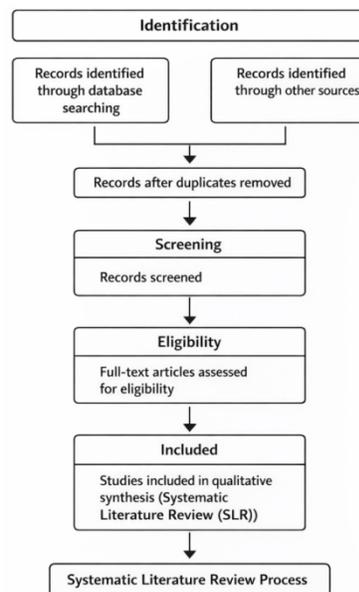


Figure 1. Chart Research Method

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Keywords used in the search included “sports technology,” “sports law,” “legal regulation,” “data protection in sports,” “innovation in the sports industry,” and “regulatory frameworks.” Each retrieved work was initially screened by title and abstract, followed by a full-text review to assess relevance. Inclusion criteria comprised peer-reviewed journal articles, conference papers, and research reports published in English within the specified timeframe and directly addressing the intersection of sports technology, law, and regulation. Exclusion criteria were applied to sources outside the topic scope, non-English publications, works lacking full-text access, and opinion pieces unsupported by empirical or theoretical evidence.

For data analysis, a thematic analysis technique was employed. After full-text screening, the selected literature was systematically coded to identify recurring concepts and issues. These codes were then grouped into overarching themes such as regulatory frameworks, ethical considerations, data privacy, competition integrity, and stakeholder roles. The themes were iteratively refined to ensure they accurately reflected the breadth and depth of the reviewed material. The results were synthesized to develop a coherent understanding of the legal implications of technological innovation in sports.

The selection of literature was guided by specific inclusion and exclusion criteria. Studies considered for inclusion were journal articles, conference papers, and research reports published within the last ten years (2014-2024), written in English, and directly related to sports technology, law, and regulation. Works that were not relevant to the topic, lacked full-text access, or were based solely on unsupported opinion were excluded from the review. The data collection process involved searching for relevant literature using keywords such as “sports technology,” “sports law,” “legal regulation,” “data protection in sports,” and “innovation in the sports industry.” Each search result was then screened by reviewing its title, abstract, and full content to ensure alignment with the objectives of this research.

Finally, the data analysis was conducted using thematic analysis to identify and categorize the main themes that emerged from the reviewed literature. These themes included regulatory frameworks, ethical considerations, data privacy, competition integrity, and the roles of stakeholders in implementing and responding to technological innovation in sports. The findings were systematically compiled to provide a comprehensive and coherent overview of the legal implications of technological advances in the sports sector.

RESULTS AND DISCUSSION

Technological Advancements in Sports: Trends, Adoption, and Legal Implications

The past decade has witnessed a dramatic rise in the adoption of advanced technologies in sports, including data analytics, wearable devices, artificial intelligence (AI), and the Internet of Things (IoT). According to recent industry data, approximately 88% of sports organizations now leverage data analytics to improve athlete performance, while wearable devices are used by over

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half of professional athletes to track health and performance metrics (wifitalents.com). This surge is further reflected in the global sports technology market, which continues to expand as teams, leagues, and governing bodies seek competitive advantages through digital transformation.

However, this technological proliferation has introduced significant legal complexities. The collection and processing of vast amounts of personal and biometric data raise questions about privacy, informed consent, and data security. The implementation of technologies such as AI-driven performance analysis and real-time monitoring has outpaced the evolution of legal and regulatory frameworks in many jurisdictions. As a result, organizations often find themselves navigating a patchwork of local, national, and international regulations, creating uncertainty and risk regarding compliance and liability (foley.com).

Beyond compliance, the integration of new technologies in sports also prompts ethical debates around the boundaries of surveillance, athlete autonomy, and the potential for misuse of sensitive information. These issues are especially pronounced in youth and amateur sports, where oversight may be weaker and the risks to privacy and well-being are heightened. As the use of technology becomes ever more central to modern sports, a balanced approach is required one that maximizes innovation and performance while safeguarding the rights and interests of all stakeholders.

Another significant finding relates to legal and privacy risks associated with biometric data in sports. In the U.S., biometric information is regulated under state laws like Illinois's Biometric Information Privacy Act (BIPA), which mandates informed consent, prohibits data sale, and imposes penalties between USD 1,000 and USD 5,000 per violation (sportslitigationalert.com). Professional leagues such as the NFL, NHL, and MLB have begun integrating consent protocols and privacy measures in their collective bargaining agreements to address these concerns (foley.com). In Australia, similar issues arise, particularly regarding continuous monitoring outside training hours and third-party access to sensitive data (digitalagelawyers.com).

The ownership and legal protection of biometric data emerge as another critical theme. In Canada, raw biometric data (e.g., heart rate, movement metrics) is considered factual and not eligible for intellectual property protection; however, curated datasets, algorithms, and analytical tools derived from that data may qualify as trade secrets or copyrightable compilations (iplaw.allard.ubc.ca). This highlights the complexity of data ownership and underscores the importance of contracts and privacy laws such as PIPEDA to determine control and usage rights (iplaw.allard.ubc.ca). Moreover, the literature highlights gaps in existing legal frameworks, particularly in the U.S., where no comprehensive federal biometric privacy law exists. State laws like BIPA vary in scope and definition, often leaving wearable data in a legal grey area. For example, while Illinois's law may not cover wearable data, newer legislation in Washington does

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(journals.library.columbia.edu). In Europe, the GDPR classifies biometric data as sensitive, requiring explicit consent, transparency, and data protection impact assessments (foley.com).

Table 2. Summary of Key Findings and Legal Implications

Theme	Key Findings	Legal Implications
Adoption of Technology	88% of organizations use data analytics; 55% of athletes use wearables; USD 18.4B market in 2023	Escalating volume of sensitive data needing legal safeguards
Biometric Privacy Regulation	BIPA mandates consent, prohibits data sale, imposes penalties	Teams must ensure compliance or face litigation and fines
League Policies & Consent	Leagues include data provisions in CBAs; player consent required	Enhances athlete protection but highlights need for stronger regulation
Data Ownership & IP	Raw data not IP; curated datasets and algorithms may be protected	Legal rights depend on contracts and data structuring practices
Legal Gaps & Jurisdiction	No federal U.S. biometric law; GDPR sets strict standards; state laws vary	Legal uncertainty; calls for harmonized frameworks at federal or international level

Source: Adapted from journals.library.columbia.edu

Despite the growing adoption of advanced technologies in sports, the lack of uniform regulatory standards remains a major issue. For example, while the European Union’s General Data Protection Regulation (GDPR) provides a comprehensive framework for data protection including biometric and health data the implementation and enforcement vary significantly across member states and sports organizations. In contrast, the United States adopts a fragmented regulatory approach, where states like Illinois enforce stringent laws such as BIPA, but many others have minimal or no biometric data protections (foley.com; journals.library.columbia.edu). This inconsistency creates legal uncertainty for international sports organizations and complicates compliance for global events.

Another significant concern is the ethical and psychological impact of constant data monitoring on athletes. Wearable devices and performance analytics are now used not only during competition but also throughout training and off-field activities. Studies highlight that continuous surveillance can lead to increased pressure, privacy anxiety, and even changes in athlete behavior or performance due to perceived monitoring (digitalagelawyers.com). Ethically, this raises questions about the limits of consent and the need for clear guidelines on what data can be collected, how it is used, and who has access to it.

Privacy, Data Ownership, and Regulatory Responses in the Sports Industry

Privacy concerns are at the forefront of legal discussions surrounding sports technology. The use of wearables and biometric data collection has heightened awareness of the risks associated with unauthorized access, data breaches, and surveillance. Laws such as the European Union’s General Data Protection Regulation (GDPR) and the Illinois Biometric Information Privacy Act (BIPA) in the United States set important benchmarks for consent and data protection, but their

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application across the sports sector varies widely (Springer.com). Athletes and organizations must navigate these complex legal landscapes to ensure that personal information remains protected.

Data ownership has emerged as a contentious issue, particularly as the commercial value of sports data continues to grow. Questions persist regarding whether raw biometric data should be classified as personal property, intellectual property, or public domain. In some jurisdictions, raw data is not protected as intellectual property, while processed or aggregated datasets may qualify for copyright or trade secret status (iplaw.allard.ubc.ca). Contractual agreements, such as those found in collective bargaining agreements (CBAs), play a crucial role in defining data ownership and usage rights between athletes, teams, and third-party technology providers.

Regulatory responses to these challenges vary significantly around the world. Some sports leagues and governing bodies have introduced internal policies and data protection standards to fill legal gaps, while others rely on national or regional legislation. The lack of harmonization can lead to enforcement challenges, particularly for international competitions and athletes who participate in multiple jurisdictions. Moving forward, the sports industry will benefit from greater collaboration between regulators, organizations, and technology companies to develop clear, enforceable, and athlete-centric data governance frameworks (sportsilab.com).

The role of sports governing bodies and leagues in setting data protection standards has become increasingly important. Professional leagues such as the NBA, NFL, and MLB have implemented collective bargaining agreements (CBAs) that specifically address the collection and use of biometric and performance data (foley.com). These agreements often require explicit player consent and set limits on data usage, but they also highlight disparities between different leagues and countries regarding the scope and enforcement of such policies. There is a growing call for international harmonization of standards to ensure athlete protection regardless of jurisdiction.

From a commercial perspective, the monetization of athlete data presents both opportunities and risks. Data-driven insights are valuable for broadcasters, sponsors, and fantasy sports platforms, contributing to substantial revenue growth in the sports tech sector (wifitalents.com). However, the commercialization of personal and biometric data introduces new legal risks, including unauthorized data sharing, breaches of confidentiality, and disputes over data ownership and profit-sharing. These concerns are particularly pronounced in the context of emerging technologies such as virtual reality (VR) and augmented reality (AR), which generate increasingly complex data sets (Springer.com).





Table 3. Comparative Overview of Legal Frameworks in Sports Technology Across Regions

Region	Key Regulations	Coverage of Biometric Data	Consent Required	Enforcement Level	Notable Challenges
EU	GDPR	Yes	Explicit	High	Varying implementation, cross-border compliance
USA (Illinois)	BIPA	Yes	Explicit	Moderate-High	Limited to certain states, no federal standard
USA (Other)	State Laws/None	Rarely/No	Varies	Low-Moderate	Patchwork, many gaps in athlete protection
Australia	Privacy Act + State Laws	Partial	Explicit	Moderate	Ongoing legal adaptation, third-party access risks
Canada	PIPEDA + Provincial Laws	Yes (limited)	Explicit	Moderate	Raw data not IP, complex ownership issues
International Sports Leagues	Internal CBA Policies	Yes	Explicit	Varies	Differing standards, enforcement inconsistencies

Source: Adapted from foley.com, iplaw.allard.ubc.ca, Springer.com

The discussion would be incomplete without addressing the implications for fair competition and integrity in sports. Access to advanced technologies and detailed analytics can create disparities between well-funded teams and those with fewer resources, challenging the foundational principle of a level playing field (entsportslawjournal.com). In response, some international federations have introduced specific regulations to restrict or standardize technology usage during competitions. However, the rapid pace of innovation often outstrips the regulatory process, leading to gray areas and potential disputes. Finally, the challenge of enforcement and cross-border cooperation is significant. As cyber threats and data breaches become more sophisticated, sports organizations must work closely with law enforcement, regulators, and technology providers to develop robust security protocols and response strategies (sportsilab.com). Effective legal protection for athletes and teams depends not only on regulation but also on ongoing education, awareness, and a culture of compliance throughout the sports industry. Moving forward, collaboration between stakeholders will be crucial to establishing legal frameworks that are both adaptive and resilient in the face of technological change.

CONCLUSION

This study aims to analyze the legal implications of technological advancements in the sports industry and the roles of regulatory bodies in safeguarding athlete and organizational rights. The findings reveal that legal frameworks provide essential protections against risks such as data

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misuse, privacy violations, and unfair competition, while also encouraging ethical and responsible use of sports technologies. However, uneven understanding and inconsistent implementation of legal provisions among stakeholders including athletes, organizations, and sports regulators limit their overall effectiveness.

The research also highlights the vital role of transparent data governance policies, routine education and training on legal compliance, and collaborative efforts among sports organizations, regulators, and technology providers to ensure a secure and fair competitive environment. Limitations of this study include reliance on secondary data through a systematic literature review and potential gaps regarding the real-world application of legal protections in diverse sporting contexts. Future research should focus on empirical studies assessing the effectiveness of current legal frameworks, the development of standardized international guidelines for data protection and ownership, and the exploration of collaborative regulatory models to enhance comprehensive protection for all stakeholders in the evolving landscape of sports technology.

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