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The impact of big data on the sports industry: Enhancing athlete training, evaluation, and minority empowerment

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Abstract. The sports industry has witnessed a transformative shift with the advent of big data technologies. This paper explores the profound influence of big data on athlete training and evaluation, examining how it has emerged as a catalyst for empowering athletes from minority backgrounds. By leveraging vast amounts of data, sports organizations and athletes gain valuable insights, make informed decisions, and optimize performance. Traditional, subjective methods of athlete evaluation are being replaced by objective, data-driven approaches that provide a more accurate assessment of performance. Big data also promotes inclusivity within the sports industry by identifying talented individuals from minority backgrounds who may have been overlooked in the past. Several case studies highlight the role of big data in revolutionizing sports, such as its use in basketball for improved decision-making and soccer for optimized training regimens. In conclusion, big data transforms athlete training, evaluation, and inclusivity in sports while shaping the future of the industry.

Keywords: Big Data, Sports, Training, Evaluation, Minority Empowerment.

1. Introduction

The sports industry has undergone a dramatic transformation in recent years with the integration of big data technologies. Big data is enabling innovative approaches to athlete training, evaluation, and empowerment, revolutionizing the way sports organizations operate. This paper will explore the impact of big data in three key areas: athlete training, athlete evaluation, and minority empowerment. The first section will examine how wearable devices and data-driven performance analysis are being utilized to provide athletes with personalized training programs and tactical decision-making strategies. The second section will focus on how big data is transforming athlete scouting and recruitment processes. The third section will explore how big data can overcome biases and enable athletes from underrepresented communities to access resources and opportunities. Finally, the challenges and ethical considerations surrounding big data in sports will be discussed, including data privacy and security, as well as fairness and transparency. By analyzing the multifaceted role of big data in sports, we can gain a comprehensive understanding of how it is driving innovation and shaping the future of the sports industry.

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2. Big Data and Athlete Training

2.1. Wearable Devices and Data-Driven Performance Analysis

2.1.1. Wearable devices and athlete training. Advancements in wearable devices and sensors have revolutionized athlete training by providing real-time data on various physiological and biomechanical parameters [1-2]. These technologies have become increasingly prevalent in professional sports, enabling coaches, sports scientists, and athletes to gain valuable insights in performance, workload management, and injury prevention. One major application of wearable devices and sensors is the tracking of athletes' movements and physical exertion. GPS trackers, accelerometers, gyroscopes, and inertial measurement units (IMUs) are commonly used to collect data on metrics such as distance covered, speed, accelerations, decelerations, changes in direction, and jump height. One example is the use of the VERT wearable device to monitor jumping loads in elite volleyball athletes [3]. These devices are typically integrated into sports clothing, shoes, or accessories, ensuring unobtrusive data collection during training and competitions. By leveraging wearable technology, coaches and sports scientists can monitor and analyze athletes' performance in real-time.

2.1.2. Wearable devices and injury prevention. Injury prevention is a critical aspect of athlete training and performance optimization, and wearable devices play a crucial role in injury prevention strategies [4-6]. One of the primary ways wearable devices help in injury prevention is through monitoring workload and fatigue levels. By tracking metrics such as heart rate and its variability, and exertion levels, these devices can provide an objective assessment of an athlete's physiological responses during training sessions and competitions [7]. Deviations from baseline values or predetermined thresholds can indicate excessive stress or fatigue, which alerts coaches and athletes to the need for modifications in training intensity. This proactive approach allows for better management of an athlete's workload to reduce the risk of injuries.

Another area where wearable devices prove beneficial is in monitoring movement patterns and biomechanics. For instance, wearable sensors can track joint angles, force distribution, and movement kinetics, providing valuable information on an athlete's technique and movement efficiency [8]. By analyzing this data, coaches and sports scientists can identify faulty movement patterns or imbalances that could predispose an athlete to injuries.

2.1.3. Case study: The use of Catapult Sports technology in elite soccer teams. The use of Catapult Sports technology in elite soccer teams Catapult Sports is a leading provider of wearable technology in the sports industry. Their technology has gained significant traction in elite soccer teams, revolutionizing athlete training and performance analysis. Catapult wearable devices, such as GPS trackers and accelerometers, collect data during training sessions and matches, enabling coaches and athletes to gain valuable insights into player performance, workload, and injury prevention. One prominent example of Catapult Sports technology implementation is seen in the English Premier League club, Arsenal FC. The club partnered with Catapult to enhance player performance analysis and optimize training regimens. Arsenal's players wear Catapult's GPS trackers during training sessions and matches, which collect data on various metrics, including distance covered, speed, accelerations, decelerations, and changes in direction. The collected data is then analyzed using Catapult's analytics platform, providing coaches and sports scientists with detailed information about player performance. The insights gained from this analysis help identify optimal training loads, assess fatigue levels, and monitor injury risks. Coaches can make informed decisions on player rotation, workload management, and injury prevention strategies. Catapult's technology has also been employed by national teams in major soccer tournaments. For instance, during the FIFA World Cup 2018, several national teams, including England, France, and Belgium, utilized Catapult's wearable devices to track player performance. The data collected and analyzed by Catapult's system enabled these teams to tailor training programs, optimize player recovery, and fine-tune tactical strategies based on individual and team performance insights.

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2.2. Personalized Training Programs

2.2.1. Utilizing historical and real-time data to customize training. Big data helps athletes develop their performance overall by collecting data and help coaches identify what is the best for the athletes. It helps to grow the competition of the sport field. For example, NBA trainers utilize wearable devices to track players heartbeat, in order to see if players are exerting their optimal effort level during training sessions. Additionally, by analyzing game films, coaches can discern areas of improvement for each player. For example, if a player consistently misses shots from a particular area on the court, data analytics will highlight these week points. Based on this information, coaches can design tailored drills to address these specific weaknesses. Historical data analysis allows coaches to identify performance trends over an athlete's career. By examining historical data collected throughout the athlete's career, coaches can determine areas of improvement, stagnation or decline in the performance. This will enable coaches to design training programs that address an athlete's long-term development needs. Real-time data collected from wearable devices, sensors, and tracking systems provide immediate feedback on an athlete's performance during training sessions or competitions. Coaches monitor athlete's real-time metrics such as speed, heart rate and movement patterns and this data allows for on-the-spot adjustments.

2.2.2. Tracking individual progress and identifying areas for improvement. By analyzing performance data, coaches can identify an athlete's strengths and weaknesses. The insight is crucial in leveraging the strengths to achieve competitive advantages, and in developing targeted interventions to address the weaknesses. For example, if a basketball player is suffering to shoot corner 3s, using technology such as video analyzing could help coach to identify where they need to improve on, it could be their stance, their form or their flow overall. Comprehensive data on performance provides a basis for setting measurable and achievable goals. By tracking the historical data, coaches can set realistic targets that are consistent with an athlete's current performance level and these goals can serve as motivational tools for athlete's training and development. For example, consider a team whose players all average similar points over the past games. If coaches make a scoring leaderboard within the team, it could foster a competitive environment. Such internal competition can bolster a players' work ethic and create a more growth-oriented team culture. Despite the motivation within the teams, these metrics also help coaches to set individual goals for players. For example, if a player averages only 2 assist per game, the coach can set a goal of 5 assists per game, guiding and challenging the player to contribute more on the court.

2.2.3. Case study: The NBA's use of player tracking data for tailored training programs. NBA has embraced the use of player tracking data to enhance player performance analysis and optimize training programs. NBA first tracked all games at the start of the 2013-14 season and provides a variety of statistics to the public based on the data produced by player tracking. The league has also implemented advanced wearable technologies, such as GPS trackers and motion sensors, to collect a vast amount of data during games and training sessions [9]. Big data provides a comprehensive view of players' performance and is of great value for athletes and coaches. For example, in the system of 2-3 defense, athletes must be aware of their positions on the court and understand their roles within this defense. Game films can track player's positioning and shed light on their defensive decision making. With all this information, team practices can be optimized, focusing on specific areas of improvement. This approach ensures that athletes not only understand their roles in certain games, but also evolve into more effective players in general.

2.3. Tactical Decision Making

2.3.1. Real-time data for in-game decision making. Real-time data has become a game-changer in the sports industry, enabling coaches and athletes to make data-driven decisions even during live competitions. The data collecting tool and analyzing platform can help teams to gather more data during games, like how player moves, and new strategies teams have developed. Real-time processing of the

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live data allows teams to analyze opponents' strategies and other key metrics. Coaches can identify patterns in opponents play, adjust defensive strategies and identify offensive opportunities, which optimizes performance during the game and increases the likelihood of success. Athletes can also use wearable devices that enable them to track their movement, monitor their conditions, and make tactical adjustment based on their in-game performances. The ability to analyze real time data not only improves player performance but also allows audience to have a better experience. For example, the fun facts that pop up in between games, which is calculated through real time big data, greatly engage fans. It can help fans to understand the impact of the tactical decisions made by coaches.

2.3.2. The use of IBM's Watson in tennis for match analysis and strategy development IBM's Watson is a computing system that can process data and give insights to athletes and coaches. It can assess opponent's strengths and weaknesses to improve players game performances. This collaboration with technology and tennis affects how the game of tennis is played and creates more competitive tennis games. They collect statistics, historical data, and match outcomes into Watson system for analysis. Based on the analysis, it gives suggestions about shot selection, using player's strength on their max capacity. During live matches, Watson's real-time data analysis provides immediate decision support to coaches and players. It helps identify successful patterns of play and provides suggestions on optimal shot selection, court positioning and tactical adjustments. The analysis also aids in identifying opponent's strategies and preferred shot selections, allowing players and coaches to develop counterstrategies that exploit those patterns. Watson analysis improves players training as well, it helps coaches and athletes in training design and identification of players' weaknesses. Players can review their performance data and compare it with their opponents and in different games to track their progress over time. It also plays a crucial role in motivating workers. Overall, it makes a huge impact when it comes to the development of players.

3. Big Data and Athlete Evaluation

3.1. Comprehensive analysis of player statistics and performance data

Big data has revolutionized athlete evaluation in scouting and recruitment process across various sports. Traditional scouting relied on limited data, such as basic statistics and observational assessments. With big data, teams can delve into a plethora of performance metrics, including detailed game stats, tracking data, biometrics, and video analysis [10]. For example, in team sports like basketball and soccer, performance metrics like points and assists per game can inform an athlete's ability. Heat maps and pass maps can visually represent an athlete's movement patterns and passing patterns during games. Moreover, advanced analytics such as Expected Goals in soccer, Player Efficiency Rating (PER) in basketball, provide more sophisticated evaluations of player performance [11].

3.2. Identification of talent from diverse backgrounds

Big data allows for a more inclusive approach to talent identification, enabling the discovery of players from diverse backgrounds [12]. Traditional talent identification relies heavily on local networks, regional tournaments, and established pipelines, which may have limited the scope of talent discovery. However, with the advent of big data analytics and advancements in sports technology, teams and organizations now have the tools to cast a wide net. For example, the best shooters in NBA history Stephen Curry, experienced severe ankle injuries before the NBA Combine Draft. These injuries led many NBA teams to be skeptical about drafting him. However, by collecting big data of Stephen Curry's games after his injury during college, they found that these setbacks had not impacted his scoring prowess. Through video, the Golden State Warriors discovered his quick release and remarkable shooting range are phenomenal which would greatly benefit their team overall. Therefore, rather than dismissing Curry due to injury concerns, the Warriors leveraged the insights from big data and video analyses to make an informed decision to draft him. This choice turned out to be one of the best decisions that they've ever made.

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3.3. Case study: Moneyball approach in baseball and soccer

One prominent case study of big data's impact on scouting and recruitment is the Moneyball approach in baseball, which was later introduced in soccer as well. In 2002, the Oakland Athletics adopted a data-driven method to identify undervalued players. Their use of advanced statistics, such as on-base percentage and slugging percentage, helped them find cost-effective players who performed well despite being overlooked by traditional scouting methods. Similarly, the soccer world embraced analytics to identify undervalued players with exceptional performances. Soccer clubs use big data to assess various player attributes such as positioning, finishing, ball control, reactions and shot power for forwards, sliding tackle, standing tackle, interceptions, reactions and defensive awareness for defenders. Clubs can then make informed decisions in recruiting players from lesser-known leagues or academies who demonstrate high potential based on these statistics. The Moneyball method helps build teams of exceptional players with limited budgets. These applications of Moneyball demonstrate how big data analytics have disrupted conventional scouting methods, leading to more efficient talent identification and recruitment strategies in the sports industry.

4. Big Data and Minority Empowerment

4.1. Overcoming Bias in Player Selection

4.1.1. Objectivity in evaluating performance to eliminate bias. Big data provides an objective and data-driven approach to evaluate players. Old ways of scouting rely heavily on subjective assessment. Using big data, teams can make better decisions based on actual game performance rather than stereotypes and biased information on social media. For example, suppose a college applicant is closely related to an NBA star. If scouts extend him an offer because of the popularity of the NBA player with whom he has a close relationship, the recruitment process becomes biased. However, big data analytics can objectively measure a player's shooting accuracy, defensive statistics, and overall performance. Such data-driven insights offer scouts with a comprehensive view of the player's potential contribution to the team, enabling fairer and more accurate player evaluation. Using big data in recruitment ensures that players are selected based on their skills, not because of their privileged socioeconomic status.

4.1.2. Increased opportunities for athletes from underrepresented communities. Big data helps identify talent from diverse backgrounds and underrepresented communities. By casting a wider net and analyzing performance data from various leagues and regions, teams can uncover talented athletes who may not have had the same exposure or opportunities as others from more established talent pipelines. For example, big data can find players who play in lower- tier leagues like G league or some amateur leagues. This provides an opportunity for players that are not noticed and gives them a chance to show their skills to play in a higher level.

4.1.3. Case study: NFL's Rooney Rule and data-driven diversity initiatives. The NFL's Rooney Rule is a well-known example of a data-driven diversity initiative aimed at overcoming bias in coaching and executive hiring. First introduced by the NFL in 2003, the Rooney Rule mandates league teams must interview at least one woman and one underrepresented minority in the slate of candidates for senior and coaching positions. To implement the Rooney Rule, the NFL leverages big data analytics to track and assess hiring practices and outcomes. The league analyzes hiring data and trends to identify any disparities or biases in the hiring process. By using data-driven insights, the NFL can monitor and address potential biases in the hiring process and promotes diversity and inclusion in the leadership positions. Existing studies have shown that the Rooney Rule had a significant, positive impact on the probability of hiring minority coaches, especially the African American coaches [13-14]. The Rooney Rule, originated in football, also broke into the corporate world in 2015 when then President Obama encouraged technology companies to hire more women and minorities by implementing the Rooney Rule. Overall, the case study of the NFL's Rooney Rule exemplifies how data-driven diversity initiatives

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can drive positive change and foster an inclusive environment both inside and beyond the sports organization.

4.2. Access to Resources and Opportunities

4.2.1. Providing equal access to training facilities, equipment, and technology. Big data can be used to identify disparities in the availability and accessibility of training facilities, equipment, and technology in different communities. By analyzing data on the distribution of these resources, sports organizations can identify areas that lack proper infrastructure and address these imbalances. For example, big data can be used to map the locations of training facilities and sports complexes. This analysis helps identify areas that lack proper resources and guides organizations in directing funding and investments to ensure equal access to training opportunities, especially for athletes from underrepresented communities.

4.2.2. Case study: NBA Foundation's commitment to investing in underserved communities. The NBA Foundation is an example of a data-driven initiative focused on investing in underserved communities. Launched in 2020, the NBA Foundation is committed to furthering economic empowerment in the Black community. It aims to address racial inequities and support education, employment, health, and wellness initiatives in these communities. Big data can play a significant role in the NBA Foundation's initiatives. By analyzing data about disparities in economic conditions, educational attainment, and health in the Black communities, the NBA Foundation can identify areas that require targeted investments. For example, the median white family holds more than 10 times the wealth of the median black family. The unemployment rate (12.9%) in the Black communities is considerably higher than the national average (7.9%). Only 50% of Black students went on to pursue post-secondary education, compared to 67% among White students. Based on those statistics, the NBA Foundation prioritizes addressing income, employment, and education disparities. Big data enables the NBA Foundation to make informed decisions and allocate resources in a more effective way, maximizing its impact on the underrepresented communities.

5. Challenges and Ethical Considerations

5.1. Data Privacy and Security

5.1.1. Protecting athletes' personal information and sensitive data. Data privacy and security are critical considerations in the sports industry, especially in the era of big data where sports organizations increasingly utilize athlete's personal information and sensitive data [15]. Athlete's personal information, such as names, contact information, medical records, and financial information, are sensitive data that affects not only athletes' career but also personal life. Therefore, sports organizations must implement robust security measures, such as encryption, access controls, and secure data storage, to safeguard this information from potential data breaches and cyberattacks [16]. Moreover, data collected from wearable devices and other tracking technologies can be anonymized or pseudonymized for broader analysis. This protects athletes' privacy while still enabling data-driven insights.

5.1.2. Ensuring compliance with privacy regulations. Sports organizations should adhere to privacy regulations imposed by governments, such as the General Data Protection Regulation (GDPR), California Consumer Privacy Act (CCPA) and other data protection laws which set guidelines for collecting, processing, and storing personal data. Sports organizations should obtain consent from athletes for data collection, specify the purpose of data collection, and provide transparent information about the data processing and analysis.

5.1.3. Case study: GDPR impact on sports organization. The GDRP, implemented in 2018 by the European Union, significantly impacted sports organizations operating in EU. The main reason that

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GDRP succeeded is because of its transparency. They explicitly explained the uses of the data they collected from athletes and athletes are free to withdraw from the program anytime. The GDPR strengthened athletes' data rights, giving them greater control over their personal information. For example, sports organizations under GDPR have implemented the following measures: ensuring explicit consent from athletes for data collection and processing; implementing data breach notification procedures to report security incidents to relevant authorities. Anonymizing or pseudonymizing athlete data for research purposes. The GDPR's impact on sports organizations serves as a reminder of the importance of data privacy and the need for compliance with privacy regulations to protect athletes' personal information.

5.2. Fairness and Transparency

5.2.1. Addressing concerns of algorithmic bias and discrimination. Algorithmic bias is the potential for algorithms to produce biased outcomes, leading to unfair or discriminatory decisions. In the sports industry, algorithms may be used for player evaluation, referee decisions, or talent identification. For example, in player evaluation, algorithms should not favor certain attributes based on race, ethnicity, or other protected characteristics. Rigorous test of the algorithm can help minimize the impact of algorithmic bias and ensure equitable treatment for all athletes. For example, within the NBA, teams use algorithm to analyze players' speed, shooting accuracy and game statistics. Often, these algorithms draw from historical data, which might inadvertently factor in players' ethnic and financial backgrounds. A player with a higher socioeconomic status may have had better training resources, leading to a better shooting percentage and a broader network to open doors. In contrast, players from less privileged backgrounds might not have had the same opportunities to produce or record such data. As a result, there is a potential for these algorithms to unintentionally underrepresent talented from a disadvantaged social background.

5.2.2. Establishing transparent data collection and evaluation practices. Transparency in data collection and evaluation is crucial to maintaining trust inside the team. Sports organizations and coaches should communicate clearly with athletes about the types of data being collected, and the purposes for which it will be used, and the evaluation criteria being employed. This openness helps athletes understand the factors influencing decisions and fosters accountability within the sports organizations. In Basketball games, teams set up cameras during games to record footage, which players and coaches later review to analyze performance. With the transparent video and data in hand, coaches can analyze aspects like shooting accuracy, defensive positioning, and players' reactions on the court. games for players to break down game footage and work on player's performance. This objective analysis by both players and coaches, devoid of ambiguity, is pivotal in building a healthier team culture.

5.2.3. Case study: FIFA's VAR technology controversy and fair decision-making. The Video Assistant Referee (VAR) technology was introduced by FIFA to assist on-field referees in making decisions during soccer matches. While it was introduced to improve decision-making, VAR faced controversies related to its implementation and interpretation. One challenge was the lack of transparency in how VAR decisions were made. Players, coaches, and fans were often uncertain about the criteria used to review incidents, leading to debates and criticism. There were also instances of inconsistency in VAR decisions across different matches. To address these concerns, FIFA has been working to improve the transparency of VAR by sharing more information about how decisions are reached and by standardizing the application of VAR across competitions.

6. Conclusion

In the rapidly evolving landscape of sports, the influence of big data is undeniable and far-reaching. From intricate athlete evaluations and the development of personalized training programs to proactively

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addressing bias and ensuring transparency, the multifaceted impact of big data has touched every corner of the sports world.

Harnessing the power of vast and varied data sets, sports organizations worldwide are ushering in a new era of data-driven decision-making. This innovation is enabling them to streamline their operations, make more informed choices, and build strategies that are both efficient and effective. By replacing older, subjective methods of evaluation that were often prone to human biases and errors, these data-driven approaches are revolutionizing the realms of talent scouting, team selection, and player development.

Big data's role doesn't stop at mere evaluation. It has played a pivotal part in democratizing sports by empowering athletes from minority backgrounds. By analyzing granular data points, big data tools uncover hidden talents, ensuring that budding athletes, irrespective of their backgrounds, are provided with equal opportunities to shine.

However, as with all technological advancements, there are inherent challenges to consider. Ethical considerations, especially around data privacy, are paramount. Sports organizations must adhere to stringent privacy regulations and implement robust data protection measures to safeguard personal information. Additionally, there's an imperative need for the continuous evaluation and refinement of data models. This ensures biases are mitigated, promoting fairness in talent identification and equitable resource allocation.

In conclusion, as the sports industry continues its journey of leveraging the vast potentials of big data, a conscious effort must be made. Striking the right balance between harnessing data-driven innovations and upholding ethical concerns will be pivotal.

References

[1] Cardinale, M., & Varley, M. C. (2017). Wearable Training-Monitoring Technology: Applications, Challenges, and Opportunities, International Journal of Sports Physiology and Performance, 12(s2).

[2] Seshadri, D. R., Li, R. T., Voos, J. E., Rowbottom, J. R., Alfes, C. M., Zorman, C. A., & Drummond, C. K. (2019). Wearable sensors for monitoring the physiological and biochemical profile of the athlete. NPJ digital medicine, 2(1), 72.

[3] Damji F, MacDonald K, Hunt MA, Taunton J, Scott A (2021) Using the VERT wearable device to monitor jumping loads in elite volleyball athletes. PLoS ONE 16(1).

[4] Li, R. T., Kling, S. R., Salata, M. J., Cupp, S. A., Sheehan, J., & Voos, J. E. (2016). Wearable performance devices in sports medicine. Sports health, 8(1), 74-78.

[5] Adesida, Y., Papi, E., & McGregor, A. H. (2019). Exploring the role of wearable technology in sport kinematics and kinetics: A systematic review. Sensors, 19(7), 1597.

[6] Zadeh, A., Taylor, D., Bertsos, M., Tillman, T., Nosoudi, N., & Bruce, S. (2021). Predicting sports injuries with wearable technology and data analysis. Information Systems Frontiers, 23, 1023-1037.

[7] Kramberger, I., Filipčič, A., Germič, A., & Kos, M. (2022). Real-life application of a wearable device towards injury prevention in tennis: A single-case study. Sensors, 22(12), 4436.

[8] Jenkins, L., & Weerasekera, R. (2022). Sport-related back injury prevention with a wearable device. Biosensors and Bioelectronics: X, 11, 100202.

[9] Macdonald, B. (2020). Recreating the Game: Using Player Tracking Data to Analyze Dynamics in Basketball and Football . Harvard Data Science Review, 2(4).

[10] Mamo, Y., Su, Y. and Andrew, D.P.S. (2022), "The transformative impact of big data applications in sport marketing: current and future directions", International Journal of Sports Marketing and Sponsorship, Vol. 23 No. 3, pp. 594-611.

[11] Sarlis, V., & Tjortjis, C. (2020). Sports analytics—Evaluation of basketball players and team performance. Information Systems, 93, 101562.

[12] Torgler, B., (2020) "Big Data, Artificial Intelligence, and Quantum Computing in Sports", 21st Century Sports, pp 153-173.

DOI: 10.54254/2755-2721/46/20241044

[13] DuBois, C. (2015). The impact of “soft” affirmative action policies on minority hiring in executive leadership: The case of the NFL’s Rooney Rule. American Law and Economics Review, 18(1), 208-233.
[14] Fanning Madden, J., & Ruther, M. (2011). Has the NFL’s Rooney Rule Efforts “Leveled the Field” for African American Head Coach Candidates? Journal of Sports Economics, 12(2), 127–142.
[15] Dietrick, T. A. (2020). Biometric Monitoring Devices: Modern Solutions to Protecting Athletes’ Data Privacy. Pitt. J. Tech. L. & Pol’y, 21, 61.
[16] Katrina Karkazis & Jennifer R. Fishman (2017) Tracking U.S. Professional Athletes: The Ethics of Biometric Technologies, The American Journal of Bioethics, 17:1, 45-60.