Role of Big Data and AI in Improving Sports Performance - Proposing Effective Framework

Divyam Gupta
Bal Bharati Public School, Pitampura, Delhi

Abstract: It has always been important to understand collective tactical behavior in sports data visualization and analysis. Automatic and interactive data analysis is important to use rising amount of compound data. In team sports, analyzing and collecting data of sportsperson is very common in order to determine fatigue and succeed adaptation responses, reduce the risk of illness and injury, and determine performance potential. In this age of big data analytics, data visualization technology offers solid foundation for developing fitness tools further as per artificial intelligence (AI). Hence, the objectives of this study are to discuss the role of “Big Data Analytics (BDA)” to improve sports performance, propose sports data visualization framework and synergy between fan engagement and performance improvement.

This study discusses classification of sports video with machine learning approach by gathering both spatial and temporal features of videos. This system relies on “convolutional neural networks” combined with temporal layers of pooling.

The combination of sports analytics and data science has been a strong catalyst to revolutionize the landscape of fan engagement and sports performance. This study explored multi-dimensional role of big data analytics to improve overall experience for sports lovers and performance of athletes. In order to optimize performance, data science has been important for analysts, coaches, and athletes.

Keywords: big data analytics, artificial intelligence, data analytics, machine learning, data visualization framework

1. Introduction
Competitive sports are mainly aimed to achieve significant sporting performance and, at the end, to win the games by improving standards for achievement, building discipline, encouraging physical activity, teaching how to deal with disappointment and creating teamwork (Du & Yuan, 2021). Data are at the core of competitive sports for athletes and their behavior. Sports consist of physical activity of athletes and behavioral actions among athletes to enable description, time, and count data on recording action (Vu et al., 2020). The advancement of competitive data has fueled to research in sports and provides platform to determine the law of human inclinations and human life (Brewer & Van Brewer, 2020).

The age of big data has had an unexpected impact on development of sports (Nguyen et al., 2016). Big data services were mostly connected like statistics on training, health data, exercise, and analysis may help athletes to come up with game plans and became important to win contests (Zhao & Li, 2020). Modern big data technologies have redefined the realm of sports. The rise in sports data has come up with new challenges in big data for sports (Ranjan et al., 2020). The rise of sports and internet are caused by big data. For all key sports, analysts may constantly gather a lot of data that athletes, fans, media, and companies can use (Manogaran et al., 2019).

These efforts constantly go together with leading tech providers who have realized a lot of benefits of analytics. The diversity, ubiquity, and easy accessibility of data to make it attractive to a lot of researchers (Liu et al., 2017). Computer vision and artificial intelligence (AI) technologies are being trendy when it comes to do video analysis in the field of sports (Liu, 2020). A “convolutional neural network (CNN)” model has been widely used to solve complex translation, tasks related to computer vision and signal processing (Manogaran et al., 2020). However, computer vision is changing constantly from mathematical approaches to ML models because of its effectiveness in gathering compound features without human intervention (Wang et al., 2013). There is a lot of opportunity to start development and innovation. AI-based predictive analysis can be used to improve fitness and health (Shi et al, 2012). Wearable technologies provide data in tear and strain of players, reducing risk of injury for athletes. Additionally, AI can observe trends in sports’ plans, techniques and weaknesses (Huifeng et al., 2020).

Data are the important part of sports sector for performers, trainers, sports medicine, management, and supporters (Su et al., 2015). Data analytics can help teams to victory-based sports and these data can improve performance of
sportsperson, inspire fans to enter games, and reduce injuries (Huifeng et al., 2021). Additionally, big data develops improved strategies for sports. Whether it is a team sport or individual sport, strategic management is important for a sport. These approaches rely on professional athletes and teams to play against rivals. Large datasets are used by modern coaching to develop successful techniques for team and individual athletes (Wang et al., 2021).

Indeed, people would want to follow credible coaches and leaders who have the edge over younger ones as they could access greater data bank. Collection of statistics and figures is the most common application of data. Sports industry data are important for coaches, players, and management, spectators, and medical professionals. Though data analytics can be helpful to a team to improve player performance and win games, same numbers can also encourage fans to go to venues. Data analytics helps professional team coaches to develop hyper-personalized games and other strategies for each match (Sheron et al., 2021).

Analyzing sports performance is helpful for players and coaches to reach their goals and they can identify activities to help in decision-making, help them on road to achieve excellence, and improve performance. They often cover movement analysis, tactical evaluation, statistical models, videos, and player/coach data displays. Because of technological improvements, data collection, coaching, and storage needs for presentation of data have redefined where analysts need a lot of knowledge in different tracking software and device. Recording video of a game can avoid those biases and provide more neutral insight to what is emerged. To get an insight to what went wrong or well, players and coaches can use performance analysis to gather data from all events on the field.

Sports like soccer, basketball, football, and fantasy sports have increased effectiveness of players and predicted future performance as per big data (Javed et al., 2020). Big data is a crucial element in sports sector, whether in terms of scorekeeping, forecasting, historical data, or player statistics (Wu et al., 2018). Big data allows companies and teams to stay tuned on performance, perform forecasts, and enables organizations and teams to stay relevant to forecast on performance and be determined in sports (Li et al., 2020). Ahead of that, all parties in the sports like experts, analysts, and supporters constantly alter data to make predictions and update “play-by-play” (Lin et al., 2021). AI and big data analytics have truly redefined sports sector by managing qualitative and quantitative data and clarifying statistical data and making it stable and understandable content (Shakeel et al., 2019).

Visualizing the data is the first step to understand the data. Users can organize data on an understandable form, highlight outliers, and patterns with data visualization. Along with avoiding the noise from data and showing relevant data, great visualizations come up with a story. It takes proper balance among function and design to create the right data visualization. Hence, data analysts use different tools like diagrams and graphs, maps, etc. to show and translate data.

2. Literature Review

Rafiq et al. (2020) recommended “transfer learning (TL) for summarizing sports video by classifying the scene. This study has worked on practical implementations in current methods and suggested a way to achieve top-grade categorization of scenes. They considered cricket as a case study which categorizes five categories – bowling, batting, crowding, bordering, and close-up for categorization of scene with AlexNet. The proposed technique used encoder like well-linked and new layers. They increased information by 99.26% over reduced datasets to achieve utmost accuracy. Finally, the results were compared to basic techniques to show superiority of strategy as well as recent models. Their performance outcomes were determined on cricket videos and several models were compared like VGGNet16, Inception V3, and AlexNet. AlexNet provided best results.

Li et al. (2020) proposed “neutrosophy theory (NT)” to show sports news information. They selected two kinds of sports events of various sizes and types and used Excel for data statistics, messy dynamics, and Newtonian analysis, etc. to classify and identify events in sports media and visualization has reported on developing sports rules media. Sports media events have positive impact on sports activities. Evolution consists of 3 times like “high-tide period”, “beginning period”, and “decent period”, a period to compare evident chaos and process like innate randomness, starting values, and fractal resemblance, etc. Finally, data visualization of sports news is based on neutrosophy in news industry.

Fenil et al. (2019) proposed the “Histogram of Oriented Gradients and Bidirectional Long Short-Term Memory (HOG-BDLSTM)” for detecting violence in real-time in a football stadium. This study has suggested a system to perceive violence in real-time, where a lot of data can be processed and simulation of human intelligence has realized the aggression. The input of the system includes several real-time video feeds of different sources analyzed by Spark Frames. It separated features extracted and frames using HOG model. Then, the frames were labeled as per violent
model and negative model uses “BDLSTM network” for identifying violent situations. The output was created along with both past and future information.

Pavitt et al. (2021) investigated the “natural language processing and conversational interfaces (NLP-CI)” for scouting and match analysis with AI. They discussed how athletes can help in analysis to explore traditional data sources in some of the AI applications which are widely available. They especially leveraged “conversational interfaces” and “natural language processing (NLP)” so users can discover datasets and results from analysis with time-saving and simple toolbox. They showed presentation to domain experts of strong analytic and AI techniques showing the potential for impact on elite sports where analysis and AI are available and access to expert resources is limited on a common level.

Ye et al. (2020) developed ShuttleSpace to help badminton players to determine trajectory data like ball and player movements. It has a lot of information related to player behavior. Hence, it is used by analysts and coaches widely to improve the players’ performance. They could experience 3D trajectories with virtual reality because of recent advancements.

Cao et al (2020) developed Sports Gene Database (SGDB)” web server when 8 gene datasets were combined from skeletal muscle. Looking for genes expressed after and without workout was possible with SGDB database. While visualizing changes in males and females, effects of physical activity can be identified on gene expression after data analysis. it is possible to find additional data on various types of exercise and association between age and activity.

2.1. Research Gap
The integration of sensors and wearables further intensifies the coarseness of data, enabling more in-depth knowledge of mental and physical well-being of an athlete. Ahead of the limits of playing field, data science has drastically redefined the landscape of fan engagement. With social media analytics, big data, and behavioral patterns, sports clubs can tailor interactions and content to come up with more personalized and immersive experience for fans. Predictive modeling anticipates fan choices, makes targeted marketing strategies, and creates innovative platforms to build a deep connection among teams and fans. Hence, this study will discuss the role of Big Data Analytics (BDA) to improve performance and propose effective framework for analyzing sports performance.

2.2. Objectives
- To discuss role of Big Data Analytics (a technique to organize a huge amount of data in an easy way to understand) in performance Optimization
- To propose effective framework for Sports Performance Analysis
- To discuss the synergy between Fan Engagement and Performance Optimization

2.3. Research Questions
- How Big Data Analytics (BDA) helps in improving sports performance?
- What is the effective way to analyze overall performance status in sports?
- What is the association between improved performance of athletes and fan engagement?

3. Research Methodology
This study is based on secondary data to fulfil the objectives which is collected through a literature survey conducted using search terms like “big data analytics”, “sports performance optimization”, “sports performance analysis”, “fan engagement”, etc.

4. Data Analysis

4.1. Role of Big Data Analytics in performance Optimization
In the world of modern sports, the combination of analytics and data science has redefined the way performance optimization is approached by coaches and athletes (Su et al, 2022). From traditional statistics of players to modern ML models as well as biomechanical data, this section digs into multidimensional landscape of revolutionizing data science and improving performance of players. Usually, player performance has been determined with standard measures like rebounds, points scored, shooting percentages, and assists. However, data science has increased analysis by adopting modern statistical models. Along with just point tallies, these models keep in mind nuanced levels of contributions of players, providing more holistic insight to performance (Ubochi, 2023).
For example, “Player Efficiency Rating (PER)” is a smart metric which combines several statistics to determine the overall impact of the player on the court. Along with scoring, it also helps, blocks, rebounds, and steals. It provides complete evaluation of effectiveness of players. The advancement of metrics has further redefined performance analysis of the player (Terner & Franks, 2021). Metrics, such as “True Shooting Percentage (TS%)” account for efficiency of scoring of a player by adopting free throws, 2-pointers, and 3-pointers. The field goal percentage is adjusted with “Effective Field Goal Percentage (eFG%)” to reflect value of 3-pointers. These modern metrics reveal data on scoring efficiency of the player, allowing coaches to make wise decisions on offensive strategies (Born, 2022).

Along with scoring, metrics, such as “Box Plus-Minus (BPM)”, quantify the overall effect of players on both sides of court, covering defensive and offensive strategies. It is a holistic method which gives nuanced knowledge of value of a player ahead of statistics, encouraging teams to boost player strategies and combinations. Data science plays a vital role to avoid injuries and predict the same. It is a significant challenge for sports. Huge datasets are analyzed by machine learning models, given the factors like fatigue levels, player workload, and biomechanical data for detecting patterns which indicate the risk of injuries (Impellizzeri et al., 2020).

Teams can use predictive analytics to predict the risk of injury for an athlete and adopt preventive measures. For example, load management can be tailored as per player data, to ensure that athletes stay in the right thresholds for performance while reducing the risk of injury and overexertion (Oliveira and Newell, 2023). Personalization is an important theme in this modern approach for training athletes and data science helps in customizing training patterns. ML models analyze biomechanical metrics, performance insights, and patterns of recovery to come up with personal training models for each athlete (Teikari and Pietrusz, 2021).

For instance, if a basketball player struggles constantly with fatigue later on the game, these data will help in developing targeted exercises for endurance. It is an individualized approach to improve performance and reduce the risk of injuries related to lack of preparation or overtraining. Along with real-time monitoring, biomechanical data is helpful in refining game tactics and post-game analysis. After determining biomechanics of plays and detecting patterns related to certain outcomes, coaches can make strategies for games in future (Shan et al., 2019). Coaches can use biomechanical information to focus on shooting techniques, refine offensive game, and place players strategically to improve scores.

Data analytics has been through a significant progress in the field of cricket, which was once dependent on subjective insights and scouting methods. It has now become a data-based domain where statistics and numbers change the game. With technological advances and several tracking devices, teams can collect a lot of data on match results, player performance, and strategies. Coaches and cricket teams can now use data analytics to achieve valuable insights to strengths and weaknesses of players, ideal playing conditions, and opposition strategies.

This shift for more analytical approach has not just redefined the way teams are prepared for matches, but also make more strategic and informed approach to match planning, decision-making, and team selection. Data analytics plays a vital role in cricket and it has been evident that those who can apply data-based insights and interpret them can have a great competitive edge in the game. Big data has revolutionized the performance optimization and analysis in cricket. It gathers a lot of statistical data for teams to dig deeper into performance of players and helps them to make more data-driven decisions on match strategies and team selection. This informed approach enables analysts and coaches to identify trends, patterns, and room for improvement.

Using big data in cricket has also made way to personalize training programs which are personalized to improve strengths and deal with weaknesses in players. It tracks player data over time and helps teams to develop targeted regimens to improve performance indicators like stamina, technique, and decision-making. This level of granularity has been helpful to boost overall performance of team.

### 4.1.1. Statistical Analysis for Selecting players

Statistical analysis has been important in modern cricket, especially when choosing the best team. By getting into performance metrics of the player like bowling and batting averages, fielding, and strike rates, teams can make wise decisions as per objective data instead of subjective opinions. This data-based approach enables team selectors to handpick only top-form players to increase odds of success in different matches. Team selection was once based on gut feeling or reputation. These days, big data analytics makes the best squad possible to adapt to various situations. BDA considers ground conditions, previous data, weaknesses and strengths of opponent’s team, and other factors to optimize the lineup to increase winning odds. Statistical analysis has been very important in this competitive world for team selection.
4.1.2. Data-Driven Insights to improve strategies
Data analytics has truly revolutionized decision-making during matches for cricket teams. It analyzes a huge chunk of data for teams by providing valuable insights to strengths and weaknesses of opponent’s players and detects patterns in performance. This approach enables teams to make informed decisions on bowling strategies, field placements, and game techniques as per statistical data instead of just gut feeling. With data analytics, teams can make decisions during the game in real-time. Captains and coaches can get feeds instantly on players’ performance, opponent’s strategy, and pitch conditions. This way, teams can adapt to changing situations quickly and make tactical decisions based on data analysis.

4.1.3. Making training programs
Data analytics has redefined training programs by providing valuable insights to boost performance of players. By analyzing player data like skills proficiency, fitness levels, and injury data, coaches can refine their sessions to address certain areas of improvements. With data-based approach, teams can get personalized training plans for the players to target any weakness and improve their strengths. In addition, data analytics enables coaches to track players’ progress over time to measure efficiency of training programs and make changes when needed. By monitoring important metrics and analyzing performance insights, coaches can identify patterns, trends, and improvement areas to ensure constant evolution of training programs.

4.1.4. Field Placements and Bowling Strategies
They have always been the important factors affecting the outcome of the match. With data analytics, teams can now make informed choices related to fielders’ placements and setting up their bowlers. As historical data is analyzed on various players, teams can identify trends and patterns to optimize ground positions as per specific weaknesses and strengths of batsmen. Big data helps teams to dig deeper and analyze bowling patterns. Teams can customize strategies to improve effectiveness by analyzing data on weather, pitch conditions, and bowlers past performance. With this data-based approach, teams can choose bowlers for specific situations, like pace or spin, and setting fields in a way that opposing team makes mistakes.

4.1.5. Injury Prevention
In modern cricket, analyzing data to predict and prevent injuries is very important. Teams can monitor physical fitness, players’ workloads, and past injuries to manage players’ health with advanced technology and analytics. With this data-based approach, medical staff and coaches can adjust playing schedules and programs to optimize performance and reduce injury risk. In addition, in-depth data analysis can also help detect potential issues early on for timely interventions to avoid serious injuries. By tracking movements, biomechanics, and performance metrics, it is possible for teams to detect any deviations and take right measures before going towards more serious problems. This proactive measure improves player safety and plays a vital role in improving overall performance.

4.2. Effective Framework for Sports Performance Analysis
Sports data visualization and analytics enables managers, selectors, and players to get a broader insight to improve field performance. Analytics and policymakers can use statistical models and tools to get data. Data visualization is among the most vital discoveries in sports analytics. It is easier to grasp virtual data than words and number. The principles of big data analytics consist of gaming analytics, learning analytics, data viewing, and productive analysis to evaluate significant game analytics data generated by the user. Real-world and artificial datasets consist of various visualization techniques like data collections, uncertainty visualization, and multivariate/multidimensional data viewing.

Differences in ensemble data are most vital elements in game analysis. In charts and graphs, the data are the most important part of predictive analytics and visualization. Data collected are shown for the captain, selectors, and executives of upcoming auction to have clear and better knowledge of all teams, seasons, batsmen, and all-rounders. Figure 1 illustrates the proposed “video-based effective visualization framework (VEVF) model (Liu et al, 2023). The video correlates with semantical content among the consecutive frames. Hence, the classification system has a great outcome when it comes to monitor temporal relationships in the frames.

Hence, there is a need to select specific number of frames to determine video data. Input video selects specific number of RGB frame. Then, the raw frames are carried out for matching the added processing like rescaling, resizing, normalization, and multiplying. These steps are pre-processing to transform raw frames into processed ones for analyzing neural network. It is vital to gather representative data from the rules before processing them to come up with logically arranged and well-structured data structures which show the dependencies among rules. Each incoming frame is compared over the data structure to evaluate the least expensive rule. Then, the spatial feature is fathered from the video images through a “convolutional neural network (CNN)”. The CNN consists of convolutional layers followed by
activation function and max-pooling to gather features from the frames processed. The features collected go through the classification layer for collecting temporal features with CNN. At the end, sport class is categorized with output layers based on Softmax function led by well-connected layers.

**Figure 1 – Proposed Video-based Effective Visualization Framework**

Source – Liu et al. (2023)

Figure 2 illustrates the “sports data visualization management” model with subsequent functions – (1) real-time monitoring of athletes’ motion through wearables and organizing the data collected into server databases; (2) data are read by “motion visualization management” systems from servers to move visual personality in real-time; (3) CNN predicts future motions aligned with previous workout data of athletes; (4) human-computer interaction and managing multi-virtual role. The practitioners can use different analytical techniques and approaches for monitoring athletes. Several variables should be considered when collecting that information, evaluating various ways to present data and relevant changes. Athletic performance is improved when practitioners can transfer essential data and provide important data to the coaches for successful athlete monitoring (Liu et al, 2023).

**Figure 2 – Sports Data Visualization system**

Source – Liu et al. (2023)
Temporal encoding consists of simple pooling operation like max or avg and proper data calculations. Temporal encoding characteristic is more refined with “rank-pool operators”. Unlike max or avg pooling, which is in closed form, rank-pool should identify the optimization issue. Before processing rules, representative data should be extracted from the rules for creating logically arranged and well-structured data which shows dependencies among rules. Each packet that is incoming is compared over this structure to evaluate the least expensive rule.

Figure 3 illustrates the proposed “Convolutional Neural Network” model which contains convolutional layers to systematically adopt learned filters for input picture for creating a feature map to cover the features in inputs. The convolutional layer has added a new pooling layer which is applied after other layers. These layers are added to the feature map outputs after non-linearity. The output of feature map is limited by gathering accurate path of input features. This way, even small changes in features in input images can make another feature map. It may be possible when image is rotated, re-cropped, moved, and changed (Liu et al, 2023).

Figure 4 illustrates sports visualization model based on big data, such as, data source layer, data collection, exchange layer, repository layer, data analysis layer and application layer. Data source layer majorly includes behavioral trajectories and historical data of sportspersons, video information, and online data sources. The layer of data sources is the foundation for predictive use and analysis of big data for various sports. Data gathering layer collects and processes big data from the previous layer and data storage, collecting, manual imports, data interchange, and web server. Next, data collected are cleaned and required processing is conducted after different application needs. Finally, the data is saved and classified. The processed data is saved in the key storage layer, such as, file storage, structured, and unstructured data. The layer of data analysis is based on applications and performs relationship analysis, functional selection, social network analysis, and statistical analysis of social network to evaluate potential law, knowledge, and patterns” as per the demands of certain applications (Liu et al., 2023).
It is observed that big data analytics and machine learning are the technologies that can boost sports data analytics. Big data and machine learning can improve every aspect of training in sports. Recruiting of players, ticket sales, and performance of sports organization may be improved through predictive analytics. A team should understand how to evaluate players to increase their value. Big data plays a vital role in evaluating sports data. It is important to look at athletes’ performance in various environments. Trainers and management can track player performance during the session. Sports data can improve competitive level of teams and individual players and fitness level. Hence, prediction is a vital issue for applying big data in sports. In sports, the success of a career relies on skills of a player and is related to athletes’ team and country. An exceptional athlete should be selected for a team and a country. The rising sports star should be excellent in their team. Choosing the best sports star also improves national funding and builds sportsmanship spirit for better results. The proposed model improves the recall, accuracy, F1 score, precision, performance, and efficiency and reduces error rate (Liu et al, 2023).

4.3. Synergy Between Fan Engagement and Performance Optimization

In the ever-growing domain of sports, there is a dynamic relationship between fan engagement and performance enhancement that redefines the true essence of athletic performance. This section delves into interconnectivity between fan interest and performance of athletes by elucidating how data-based insights fill the gap between fan experience and on-field excellence and how technology plays a vital role in providing smooth integration among these important aspects of sports environment. The very essence of sports is based on thrill and drama which unfolds in the field and it is entwined with athletes’ performance (Tamminen et al, 2022).

Along with affecting match results, the excellence and success of players also build interest among fans. The extraordinary moments and the highs and lows play a vital role in emotional investment of fans in their favorite players.
and teams. Hence, player performance becomes a core axis which has the narrative of sports season. As players want excellence, fans are absorbed in the drama and emotionally attached to the achievements and success of players (Miah et al., 2020). The interconnectedness is clear in the combined celebration of achievements as well as shared distresses as their favorite teams are defeated (Liu, 2021).

Data science fills the gap between fan experiences and on-field excellence, offering insights to improve the narrative and build deeper connection among fans and players. Analyzing player performance is not just helpful to teams and coaches to build strategies, but also provides better understanding to fans (Wang & Song, 2023). Data-based insights provide more nuanced knowledge to fans and their contributions. Advanced statistics like “Expected Goals (xG)” in soccer or “Player Efficiency Rating (PER)” in basketball provide a deep insight to fans to appreciate and evaluate the effect of players. This deeper understanding builds the feeling of engagement as fans are not just viewers, they become experts by discussing and interpreting the game (Coles, 2024).

Integrating data science helps in providing tailored fan experiences to meet individual choices. Fans can get real-time statistics, personalized content, and highlights of specific players in interactive platforms. For example, if a fan loves specific part of performance of a player, they may get tailored content and updates on contributions and achievements of that player. As a conduit, the technology converges the synergy between fan engagement and performance enhancement smoothly (Alliou & Mouri, 2023). From innovative viewing to “augmented reality (AR)”, the connection between fan interactions and on-field experiences is amplified by the technology. Technological advancements have redefined the way sports is watched by fans. AR and VR technologies provide immersive experience, enabling fans to feel the part of the game (Miah et al, 2020).

These technologies add a new dimension to engage fans, offering an unexpected level of depth with players and their matches. Innovative platforms like social media and mobile apps have been the core for fan engagement. Data insights are used by these platforms for curating relevant content. Polls, live chats, and innovative features enable fans to have active participation in the narrative that unfolds, playing a vital role in shared experiences and sense of community. Technology builds direct connectivity among players and fans. Social media sites act as conduits to share insights, experiences, and BTS moments of players with their fans (Dvergedal, 2021). This direct interaction builds the feeling of intimacy, breaks down age-old barriers between fans and athletes.

All in all, there is an intricate synergy between fan engagement and performance optimization which weaves on-field ability of athletes having emotional tapestry of fan experiences. Data-driven insights provide in-depth knowledge of contributions of players and build engagement. From immersive viewing to innovative platforms, technology builds the connection and forms a smooth integration which exceeds physical boundaries. As sports landscape is evolving, fan engagement and experience is redefined by this symbiotic relationship (Bale, 2002).

5. Results

As data science keeps on redefining sports analytics, the field observes several ethical concerns and ramifications. Meanwhile, there is a transformative future signaled in emerging trends to redefine the way data is used for sports performance, overall innovation, and fan engagement (Stavros et al, 2022). The standardization and quality of data present various issues in sports analytics. From wearables to game statistics, several data sources often vary in granularity and formats. Combining such datasets have a huge hurdle that may affect reliability and accuracy of analyses. Though powerful, modern ML models usually don’t have interoperability. It may be challenging for analysts and coaches to know the causes behind some predictions and recommendations created by complex models. This gap of interpretability can affect adoption of smart models in decision-making related to sports (Lai et al, 2021).

Traditional coaching methods and sports cultures may resist data-based methods. Players, organizations, and coaches might be unwilling to completely adopt data analytics. It may be challenging to integrate data science in current workflows. The collection of personal data and biometric data from athletes is known to increase privacy issues. Players may not want to share their performance and health data. So, robust privacy measures should be adopted to ensure consent and data security. Using data science may unintentionally cause some consequences in sports analytics (Clegg et al, 2023). For example, overemphasis on some metrics might play a role in biased decision-making or neglect of important aspects that are not covered by data like intangible qualities. Data bias may seep into models used by analytics and training data may contain historical biases. It raises concerns, especially when team selections, evaluations of players, or other important decisions are affected by these biases. In analytics, mitigating bias and improving fairness are important (Tursunbayeva et al., 2022).
Real-time analytics is known to be the future of data science and it can be achieved with edge computing. Teams can get quick insights by processing data nearby the source – whether with wearables or on field – to make decision-making on the game. There is a rise in AI models to address the challenge of interoperability. These models clearly explain their process of decision-making so that analysts and coaches can easily integrate and trust analytics for their strategies. In sports analytics, the next frontier includes in-depth integration of cognitive analytics and biomechanics. Along with physical, understanding mental aspects of performance opens new ways to personalize training and optimize it (Sajjadi et al, 2022).

In future, fan engagement is based on a fan-oriented approach for data science. Experiences may be tailored as per preferences of fans, adopting AR for immersive experience, and personalized content to refine the interaction of fans to consume sports data. In sports, the future of data science consists of commitment to ethical practices to deal with ethical considerations (Tanisawa et al, 2020). It consists of giving priorities to consent of athletes, transparent policies towards data usage, and working actively to avoid biases in analytics (Jones, 2019).

This study has also proposed VEVF framework for sports data visualization which is designed with big data analytics and based on CNN model. Adopting deep learning with analysts and coaches may result in more interactive outputs and vital knowledge. Instead of features shown in static images, video sequences having temporal features are more important to be extended in future studies. Although this proposed model can be best suited for competitive sports training with bilevel optimization and CNN, this framework needs to design significant strategies to secure communication and optimize energy use (Liu et al, 2023).

6. Conclusion
The ethical issues and implications in full implementation of data science in sports are huge. There are transformative effects and promising advancements awaiting in future of sports. Integrating real-time analytics, fan-based approaches, and AI models will address existing challenges and make data science an indispensable tool to boost player performance, drive innovation and foster fan engagement in sports. Data science is known to have a transformative and undeniable impact in sports analytics, ushering in new age of personalization, precision, and fan connectivity. Given the insights from this study, stakeholders and sports clubs should adopt a holistic approach to make the most of data science for both fan engagement and performance improvement.

There is a need to invest in analytics platforms to improve player performance, real-time insights, and fan engagement. These platforms build synergy between fan experience and on-field excellence by providing a holistic view. With the expansion of role of data science in sports, ethical practices should be adopted by giving priority to data privacy, athletes’ consent, and avoiding biases. It will ensure sustainable and responsible use of data science in the field of sports. Sports organizations must focus on fan-based technologies like AR, VR, and other interactive platforms. Personalized experience will deepen connections with fans and build a sense of community.

Performance optimization is no longer limited to strategic game planning and physical training. It consists of a data driven-approach which redefines training programs, fine-tunes game tactics, and avoids injuries. Fan engagement has evolved rapidly into a personalized, dynamic experience promoted by big data, interactive technologies, and predictive modeling. There are profound implications for sports analytics.

References


