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REVIEW ARTICLE

The Role of Machine Learning in Modern Football Analytics: A Systematic Review of Approaches and Their Implications

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ABSTRACTS

Purpose Football has increasingly become a multidisciplinary field that integrates not only physical and tactical elements but also technological advancements to enhance decision-making. One of the prominent developments in this domain is the application of machine learning (ML) techniques to analyze match-related data, assess player performance, and optimize team strategies. This study aims to conduct a systematic literature review of contemporary research that employs machine learning algorithms within the context of football.

Materials and Methods A total of 50 scientific articles were initially retrieved from various reputable databases. Following a rigorous screening and eligibility assessment, 30 articles were selected for detailed analysis.

Result These studies employ diverse machine learning approaches, including Support Vector Machines (SVMs), Random Forests, XGBoost, Deep Learning, and clustering methods, for a wide range of purposes, such as match outcome prediction, player performance evaluation, injury detection, and playing position classification. The findings of this review underscore the potential of machine learning to contribute significantly to data-driven decision-making in football, providing valuable insights for coaches, performance analysts, and club management.

Conclusion Furthermore, this study identifies key challenges that remain, including data quality, data availability, and the interpretability of complex models. This review will serve as a critical reference for researchers and practitioners advancing intelligent technologies in sports, with particular emphasis on football.

Keywords Football; Machine learning; Prediction; Performance evaluation; Systematic review.

INTRODUCTION

Football, the most popular sport worldwide, has developed into a highly data-driven industry that integrates technology, strategy, and analytics to enhance competitive performance. As teams seek a tactical and operational advantage, data-driven decision-making has become central to player assessment, match preparation, and performance evaluation. This evolution marks a significant

shift from traditional observational methods toward digital analytics powered by artificial intelligence (Rodrigues & Pinto, 2022). Among the emerging technologies, machine learning (ML) has shown exceptional potential for modeling the complexity of football dynamics and supporting evidence-based decision-making.

Machine learning has been applied across multiple aspects of football, including match outcome prediction (Hu & Fu, 2022), player movement and positioning analysis (Hewitt & Karakuş, 2023), performance evaluation (Chandra B et al., 2024), injury risk identification (Prys et al., 2023), and team recruitment or formation strategies (Ati et al., 2024). Rather than relying on a single algorithm, studies have progressively integrated techniques such as Support Vector Machines, Random Forests, XGBoost, and deep learning architectures to analyze diverse data sources, including match statistics, video footage, and biometric data. These methods are valued for their ability to uncover hidden relationships within high-dimensional data and to produce accurate predictive models (Anam et al., 2025; Saputra et al., 2024; Ulfah & Anam, 2020). However, persistent challenges remain in ensuring data accessibility, addressing data imbalance and bias, and enhancing model interpretability for practical applications (Theodore Armand et al., 2024).

The rapid increase in academic publications demonstrates growing interest in integrating machine learning into football analytics. However, there remains a lack of systematic synthesis that summarizes existing approaches, compares methodologies, and evaluates their effectiveness. Many studies focus on specific models or datasets, leaving a limited understanding of overarching trends or the comparative strengths of algorithms. This gap underscores the need for a structured and comprehensive review that consolidates the current research landscape.

Therefore, this study conducts a Systematic Literature Review (SLR) to identify, categorize, and evaluate scholarly works related to the application of machine learning in football. The review adopts the PICO framework (Population, Intervention, Comparison, Outcome) to define its scope and applies the PRISMA 2020 guidelines to ensure a transparent and reproducible selection process (Frandsen et al., 2020). The main objective is to provide a comprehensive overview of the machine learning techniques applied in football, their domains of use, performance outcomes, and methodological limitations. The findings are expected to guide future research directions and assist researchers, analysts, and practitioners in developing more effective AI-driven solutions for football analytics.

METHODS

Figure 1 illustrates the step-by-step process of identifying, screening, and selecting research articles included in this systematic review on the application of machine learning in football analytics.

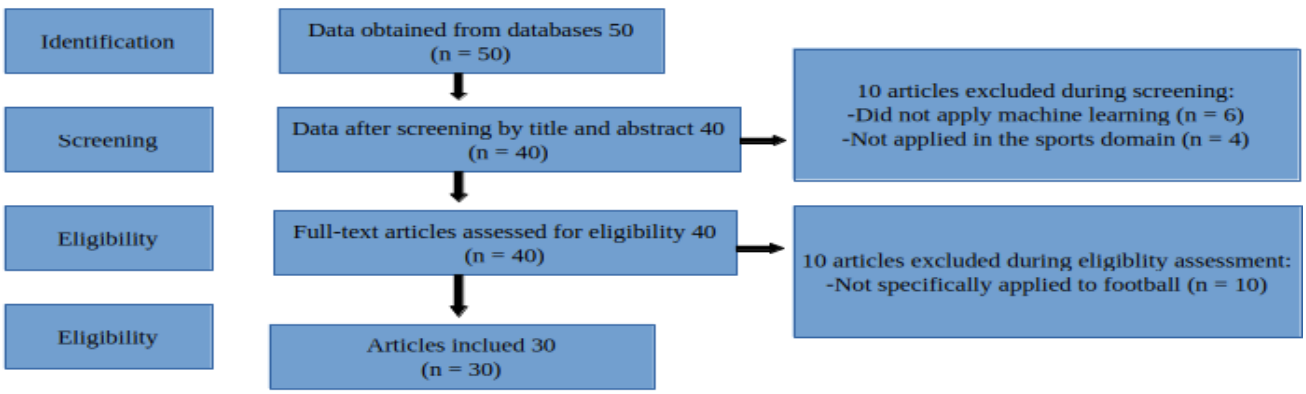

Figure 1. PRISMA flow

Figure 1 presents the systematic process for identifying and selecting relevant research articles for the review of machine learning applications in football analytics. The selection process followed the PRISMA 2020 framework to ensure the inclusion of studies with strong methodological quality and direct relevance. A total of 50 articles were initially identified from several academic databases during the identification stage. In the screening stage, each article was examined based on its title and abstract, and only those that applied machine learning and were related to the sports domain were retained. After this stage, 40 articles were considered suitable for further review.

During the eligibility assessment, the full texts of the remaining articles were evaluated to confirm their focus on football analytics. Ten studies were excluded at this stage because they discussed sports in general rather than specifically football. As a result, 30 articles met all inclusion criteria and were selected for comprehensive analysis. This process ensured that the final dataset consisted only of studies that directly explored the implementation of machine learning techniques in football contexts.

RESULT

To provide a comprehensive overview of the focus and findings of each analyzed study, Table 1 summarizes the 30 articles that met the inclusion criteria in this review. The table includes information on the authors and year of publication, the machine learning algorithms employed, the research focus or object of study, and the key findings or contributions of each work. This compilation is intended to highlight the diversity of approaches and the emerging methodological trends in research concerning the application of machine learning in football.

Table 1. Previous Studies on the Application of Machine Learning in Football

No	Authors	Algorithm / Models	Research	Results
1	(Wisdom & Javed, 2023)	CRISP-DM	Recruitment evaluation	More efficient in recruitment
2	(Freitas et al., 2025)	SVM, FNN, AdaBoost	Injury prediction	Accuracy of SVM 74,22 %
3	(Wen, 2024)	SVM, PCA, TOPSIS	Team performance evaluation	Performance metric relationships revealed
4	(W. Yu, 2022)	SVM, Logistic Regression	Match prediction results	High F1-score
5	(Beato et al., 2025)	SWOT	ML readiness assessment	ML is helpful in team strategy
6	(Wang et al., 2024)	PCA, KNN, RF, SVM	Match prediction	RF demonstrated the highest accuracy
7	(Şahinler et al., 2023)	Linear Regression	Shot accuracy analysis	Angle and speed were statistically significant factors
8	(Zareba et al., 2024)	XGBoost, DNN	Defensive evaluation	Individual player contributions were measurable
9	(Boudouda et al., 2023)	SVR, XGBRegressor	Player performance prediction	SVR achieved 97% prediction accuracy
10	(Singh & Suguna, 2023)	Machine Learning (general)	Player recruitment	Critical recruitment features identified
11	(Rebbouj & Lotfi, 2023)	Regression	League standing prediction	R^2 value approached 1
12	(Yuris et al., 2025)	K-Means	FIFA player segmentation	Players grouped based on field roles

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No	Authors	Algorithm / Models	Research	Results
13	(Moya et al., 2025)	Decision Tree, Random Forest, SVM, KNN, XGBoost, ANN, CNN, RNN, Reinforcement Learning	Application of ML in professional football for player performance and match prediction	Among 172 studies (2019–2024), supervised and deep learning models, especially CNNs, ANNs, and XGBoost, showed the highest accuracy. The study emphasizes data limitations and the potential of reinforcement learning for tactical analysis.
14	(Gadipudi et al., 2023)	RF, SVM, KNN, NB	Player position classification	RF performed best in multi-label tasks
15	(Rajagopalan & Sridhar, 2023)	Expected Goals Model	xG (Expected Goals) prediction	Accurate forecasting of player performance
16	(Melloni et al., 2022)	Clustering, Movement Model	Player movement patterns	35 distinct movement patterns identified
17	(Yang, 2023)	AHP + Binary Classification	Team success factors	Team strength emerged as a dominant factor
18	(Aliyarov et al., 2023)	Deep Learning, CV	Match outcome & player position prediction	High accuracy with automatic detection
19	(Raudonius & Seidl, 2023)	Statistic + xG	League shooting efficiency	The Bundesliga is less efficient
20	(Barbosa et al., 2022)	Passing Network + Similarity	Playing style & roles	Strategic roles were successfully identified
21	(Dauxais & Gautrais, 2019)	RF	Pass receiver prediction	Top-1: 84.1%, Top-3: 91.5% accuracy
22	(Li & Zhang, 2019)	LightGBM	Pass prediction	Top-5 accuracy reached 94%
23	(Muszaidi et al., 2022)	MLP, DNN	EPL match prediction	MLP outperformed DNN
24	(Sattari et al., 2022)	NMF	Player role representation	Multiple flexible roles captured
25	(Jadon et al., 2023)	Linear Regression	Match result prediction	Accuracy reached 70%
26	(Razali & Mustapha, 2024)	LR, RF + ELO	Malaysian league prediction	Results were stable and accurate
27	(Fournier-Viger et al., 2019)	FPP Model	Pass direction prediction	FPP outperformed baseline methods
28	(Cortez et al., 2021)	CRISP-DM, DTC, XGBoost	Victory prediction	Consistent player activity influenced outcomes
29	(G. Yu et al., 2022)	SVM, LSTM	CSL match prediction	SVM outperformed in live-match forecasting
30	(Wong et al., 2025)	Logistic Regression, KNN, SVM, Naive Bayes, Random Forest, ANN, LSTM, Ensemble Learning	Review of AI and ML models for football match outcome prediction	LSTM and ensemble methods achieved the best predictive performance. The study highlights the importance of feature selection, hyperparameter tuning, and multi-season data for improving model accuracy and generalization.

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Table 1 provides an overview of 30 research papers that explore how Artificial Intelligence (AI) and Machine Learning (ML) have been applied in football analytics across various domains. These studies, published between 2019 and 2025, collectively demonstrate the evolution of computational techniques from traditional statistical models toward advanced deep learning and hybrid ensemble systems. Early work primarily relied on classical algorithms such as Support Vector Machines (SVMs), Logistic Regression, Linear Regression, and Random Forests for tasks such as match prediction, recruitment evaluation, and player performance analysis. For instance, Wisdom and Javed (2023) applied the CRISP-DM framework to improve recruitment efficiency, while Freitas et al. (2025) achieved a 74.22% accuracy rate using SVM for injury prediction. Similarly, Wen (2024) employed SVM and PCA to reveal relationships among team performance metrics, and Yu (2022) demonstrated a high F1-score in match result prediction using SVM and Logistic Regression.

Subsequent studies expanded the analytical scope by integrating ensemble and deep learning models, such as XGBoost, DNN, and CNN, which consistently delivered higher accuracy and stronger generalization. Zareba et al. (2024) and Boudouda et al. (2023) applied these methods to evaluate player defense and predict performance, achieving accuracies of up to 97%. Hybrid frameworks combining PCA, KNN, RF, and SVM (Wang et al., 2024) further enhanced predictive performance for match outcomes. Meanwhile, studies such as Beato et al. (2025) and Şahinler et al. (2023) demonstrate that ML-based analytical approaches are beneficial for strategic planning and for identifying statistically significant gameplay factors, such as shot angle and speed.

In addition to supervised methods, unsupervised learning also played a vital role. Yuris et al. (2025) used K-means clustering to segment FIFA players by field role, while Melloni et al. (2022) analyzed movement data to identify 35 distinct player patterns. Research employing hybrid and decision-based approaches, such as Yang (2023) using AHP and binary classification or Rajagopalan and Sridhar (2023) using Expected Goals models, identified key success factors, such as team strength and goal efficiency. Other studies, such as Aliyarov et al. (2023), used computer vision and deep learning to automatically detect player positions and match outcomes, achieving high precision and demonstrating the strength of multimodal data integration.

Comprehensive reviews by Moya et al. (2025) and Wong et al. (2025) synthesized findings from over 170 studies, concluding that supervised and deep learning techniques—especially CNN, ANN, XGBoost, and LSTM—dominate modern football analytics due to their superior predictive power. These works also highlighted crucial elements like feature selection, hyperparameter optimization, and the use of multi-season datasets to enhance accuracy and robustness. Overall, the literature reveals a progressive trend toward intelligent, data-driven models that improve the understanding of tactical dynamics, player performance, and strategic decision-making in football.

DISCUSSION

The findings from this systematic review reveal a significant advancement in how machine learning (ML) has been applied in football analytics over the past several years. The 30 selected studies collectively demonstrate a transition from traditional statistical approaches toward more complex and intelligent computational models. Early works, such as those by Wisdom and Javed (2023) and Wen (2024), primarily used conventional algorithms, including CRISP-DM, SVM, and Logistic Regression, for basic prediction and performance evaluation. These studies emphasized model interpretability and ease of deployment, laying the foundation for integrating ML into sports analytics.

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As research evolved, ensemble and deep learning models began to dominate. Studies employing XGBoost, Random Forests, and Deep Neural Networks achieved higher predictive performance across diverse applications, including injury prediction, defensive evaluation, and match outcome forecasting. Notably, Zareba et al. (2024) and Boudouda et al. (2023) demonstrated that ensemble methods and regression-based models can achieve accuracy rates near or exceeding 95%, demonstrating their ability to handle complex, high-dimensional datasets typical of sports environments. The inclusion of feature selection techniques, such as PCA and Chi-Square, also contributed to improved model efficiency and interpretability, as demonstrated by Wang et al. (2024) and Yang (2023).

Unsupervised learning techniques, such as K-Means clustering and Non-Negative Matrix Factorization (NMF), were also utilized to identify hidden patterns in player behavior, positioning, and movement. These methods, as shown in the studies by Melloni et al. (2022) and Yuris et al. (2025), highlight the value of exploratory data analysis for segmenting players and understanding team dynamics. Deep learning, combined with computer vision techniques, further enabled automatic recognition of player actions and match events with high precision, as shown by Aliyarov et al. (2023).

Furthermore, meta-analytical work by Moya et al. (2025) and Wong et al. (2025) emphasized that supervised and deep learning remain dominant in football analytics, particularly through models such as CNNs, ANNs, and LSTMs. These models not only offer superior accuracy but also demonstrate strong generalization when trained on multi-season datasets. Both reviews highlighted the critical role of hyperparameter tuning, data quality, and temporal data continuity in ensuring robust predictions.

Overall, the review identifies three primary research directions. The first involves performance evaluation and player analytics, where ML helps assess skills, fitness, and tactical roles. The second focuses on predictive modeling for match outcomes, injuries, and team success factors. The third explores strategy optimization and tactical analysis, where reinforcement learning and hybrid systems are emerging as promising approaches. Despite these advancements, data heterogeneity and limited access to comprehensive player tracking datasets remain significant challenges. Future studies are encouraged to combine multimodal data, integrate explainable AI frameworks, and develop adaptive models capable of real-time decision support for coaches and analysts.

CONCLUSION

This systematic review concludes that machine learning is a key driver of football analytics, enabling intelligent performance prediction, tactical optimization, and data-driven decision-making. Across 30 analyzed studies, machine learning has been effectively applied to predict outcomes, assess player performance, prevent injuries, and conduct tactical analysis. Traditional algorithms such as SVM, Logistic Regression, and Random Forests provided a strong foundation, while advanced methods such as CNN, LSTM, and XGBoost achieved higher accuracy. Combining algorithms and using feature selection also improved model efficiency and interpretability. Despite these advances, challenges persist, including data imbalance, limited standardized multimodal datasets, and low model transparency, with many systems still operating as black boxes. Future research should prioritize multimodal real-time data integration, the development of explainable AI, and the use of reinforcement learning or hybrid adaptive systems for tactical and training applications. Overall, machine learning holds strong potential to transform football

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analytics into an intelligent, transparent, and practical tool for improving real-world sports performance.

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CONFLICT OF INTEREST

The authors affirm that there are no conflicts of interest related to the conduct of the research, the authorship process, or the publication of this article.

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