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MCDM and Soccer: A Systematic Review of Key Aspects, Trends, and Future Perspectives

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Abstract: As the most widely played and commercially influential sport worldwide, football (soccer) demands increasingly data-driven and methodologically sound decision-making across tactical, operational, and financial domains. In recent years, Multi-Criteria Decision-Making (MCDM) methods have been increasingly adopted to address the complex, multi-dimensional challenges faced by stakeholders in the sport. To comprehensively examine the current state of research, a systematic literature review (SLR) was conducted focusing on the application of MCDM techniques in football-related decision contexts. The analysis was performed using articles indexed in the Scopus and Web of Science databases, with the Novelty, Impact, Relevance, and Prestige (NIRP) method employed to filter and prioritize the most impactful publications. A final portfolio of 27 articles published between 2000 and 2024 was identified and examined. The selected works were analyzed to identify prevailing MCDM techniques, thematic concentrations, and methodological trends within the domain, providing a comprehensive overview of developments in this field. This review is expected to serve as a foundational reference for academics and practitioners seeking to leverage decision-making frameworks in the evolving landscape of football analytics.

Keywords: Multi-criteria decision-making (MCDM); Multi-criteria decision analysis (MCDA); Systematic literature review (SLR); Football management; Decision-making techniques; Sports analytics

1 Introduction

Globally, football stands out as the most popular sport [1, 2], played by millions and generating billions in revenue annually, making it one of the most profitable sports disciplines. Beyond its massive global participation, football is also the most extensively studied sport. It has remained one of the most influential sports in the world for over a century [3], and professional football industry now plays a key role in the global economic and business environment [4]. Football spans multiple fields of study, including player injuries and club sustainability. Given the complexity of the sport, numerous challenges and decision criteria emerge.

With the growing number of studies on football, literature reviews are essential for identifying key aspects within specific research areas. According to the study by Kirkendall [5], there are 14,000 citations related to football in PubMed, a database focused on health sciences, representing approximately 60% more publications than the second most researched sport. A search on Google Scholar in June 2024 revealed approximately 91,500 publications with "football" in the title. Between 2000 and 2023, the number of such publications increased from 635 to 2,540, reflecting a growing academic interest in the sport.

Several studies have been conducted on football and its various aspects. It is worth noting that different dimensions of the sport have been examined in the literature, highlighting the growing importance of sports analytics in academic publications. As a result, literature reviews focusing on football have become essential.

A literature review by the study [6] examined the validity and reliability of football speed tests, identifying 90 publications in the process. It was found that most of the tests involved male players and that the large number of tests conducted emphasizes the importance of speed and agility in football.

Goes et al. [7] investigated publications on the use of big data to support tactical performance analysis in professional football, focusing on areas such as physiology, behavioral sciences, and psychology. A total of 73 articles were selected, which pointed to promising opportunities for joint efforts between sports science and computer science in football tactics research.

Kunrath et al. [8] analyzed publications related to mental fatigue and football, selecting a total of 89 articles. The findings showed that mental fatigue negatively affects players' technical, physical, tactical, and cognitive performance. Furthermore, methodological advances in research on mental fatigue in football starting from 2015 were observed.

In such scenarios, MCDM serves as a key strategy to manage complexity and support sound decisions. MCDM methods have emerged from the growing need to analyze and make decisions involving multiple alternatives and criteria. As a rapidly expanding sport in recent decades, football involves a multitude of alternatives and criteria that must be regularly analyzed. MCDM techniques are applied across various areas of football, including the analysis of football club performance [9–11] and player selection [4, 12].

However, few SLRs have explored the intersection between sports and MCDM. In fact, only one literature review specifically addressing football and MCDM was found. Nisel and Özdemir [13] conducted a review focusing on the Analytic Hierarchy Process (AHP) and Analytic Network Process (ANP) in sports, identifying 62 relevant articles, 13 of which were related to football. The findings highlighted a broad range of applications and decision criteria, with AHP and the Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) being the most frequently used methods.

Regarding football and MCDM specifically, only one SLR was identified. Ati et al. [3] provided a review of the integration of MCDM and machine learning for player selection and performance prediction, analyzing 66 publications – including research articles, reviews, conference papers, and book chapters – published between 2018 and 2023. These studies covered diverse topics such as player classification, sports management, and team design. AHP and TOPSIS emerged as the most commonly employed methods.

This study aims to systematically review the literature on MCDM applications in football, identifying key trends and methodologies. Additionally, it seeks to highlight gaps in the existing research, providing insights that may guide future studies in this field.

There are several methods available for conducting SLRs. Liberati et al. [14] developed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) method, aimed at conducting systematic reviews and meta-analyses. This method was proposed by a group of researchers who came together to evaluate the earlier Quality of Reporting of Meta-analyses (QUOROM) method [15]. In the context of generating ranked lists of publications in SLRs, Pagani et al. [16] proposed a method for ranking studies based on journal impact factors, citation counts, and publication year.

This work follows the SLR process suggested by Steffen et al. [17], chosen for its ability to generate a ranking of relevant articles and highlight key publications in the field. The ranking was based on specific indicators that pertain to the articles and their respective journals. The collected indicator data underwent a normalization process, followed by the assignment of weights to criteria, which were computed using the Criteria Importance Through Intercriteria Correlation (CRITIC) method. The CRITIC method, proposed by Diakoulaki et al. [18], was used to calculate the weights of the criteria based on the data themselves. This method relies on the correlation coefficients between criteria to determine their relative importance. According to Peng et al. [19], the CRITIC method is useful because it takes into account the intensity of contrast and the conflicting relationships inherent to each decision criterion.

Despite the widespread application of MCDM methods in various studies, no comprehensive systematic review has been conducted in this research area. This article aims to bridge this gap. The study is structured into four sections. Section 1 introduces the research topic and contextualizes the key aspects. Section 2 details the SLR methodology, including the approach used to calculate scaling constants. Section 3 presents the results of the bibliometric and systematic review. Section 4 concludes the study by discussing the findings and offering suggestions for future research.

2 Methodology

This work follows the SLR process suggested by Steffen et al. [17], which comprises 14 steps. A detailed description of the procedures followed in each step is provided below.

Step 1: Establishing research objectives

The first step involves defining the foundational premises of the study. The objectives to be achieved through SLR were outlined. The main goal of this research is to identify the key aspects of MCDM methods in football and highlight potential gaps in the existing literature.

Steps 2-4: Defining databases, keywords, and initial search

These three steps focus on selecting the databases for the search and creating the initial portfolio, which is directly linked to the choice of keywords. Initial searches were conducted across various databases relevant to the study's

themes, testing different keyword combinations. Based on the results, the databases and, consequently, the keywords to be used in the search were finalized.

For the purpose of this study, the Web of Science and Scopus databases were chosen, and keywords related to MCDM, Multi-criteria decision analysis (MCDA), multicriteria, multi-criteria, football and soccer were defined, resulting in eight keyword combinations. It is important to note that searches using other databases and keywords outside those included in this analysis did not yield additional relevant results.

Step 5: Final search in selected databases

In this step, the final search was conducted within the selected databases, forming the initial portfolio (prior to filtering procedures). The search was restricted to titles, keywords, and abstracts, as these fields are more directly aligned with the researchers' area of interest.

Step 6: Filtering procedures

This step involves filtering the articles based on various criteria. In this study, the primary focus is on removing duplicates, off-topic articles, and publications lacking relevant indicators (e.g., conference proceedings, book chapters, etc.).

During the searches across different databases and with various keyword combinations, articles may be duplicated in the initial portfolio. Once the references were downloaded, bibliographic management tools (such as JabRef, Mendeley, and others) were employed to identify and remove any duplicate entries.

Additionally, for the purpose of creating a ranking of the articles, certain indicators were used. Therefore, publications without these indicators must be excluded from the portfolio.

Step 7: Definition of indicators

Step 7 involves defining the indicators used to rank the articles. In this study, three indicators were selected: Source Normalized Impact per Paper (SNIP) of the journal, the number of citations of each paper, and self-citations (selfcit/100) of the journal.

Step 8: Search for indicator values for portfolio articles

In this step, after defining the indicators, the next task is to retrieve the values for these indicators for all the articles in the portfolio, following the filtering procedures. Additionally, the number of citations for each article was also collected. Since both the SNIP and self-citation indicators were derived from citation data indexed by journal articles, citation counts were gathered from the databases used in this analysis (Scopus and Web of Science).

Step 9: Elimination of articles without indicators

Step 9 involves the possibility of removing articles from journals that lack indicator data. Given the study's aim to consider all relevant articles, the ranking serves solely to highlight the most significant ones, as indicated by the indicator and its associated values. For journals without a SNIP value, a score of 0 was assigned, reflecting the concept that "the higher the SNIP, the better."

Since both the SNIP and self-citation indicators are based on the same source, i.e., the Center for Science and Technology Studies (CWTS) at Leiden University, articles from journals without a SNIP value automatically lack a self-citation score. The self-citation indicator ranges from 0 to 100, representing a percentage. For journals without this indicator, a self-citation value of 100 was assigned, reflecting the concept of "the higher the self-citations, the worse." Waltman et al. [20] explained that SNIP's source-normalized method aims to correct for citation differences between scientific fields, without needing an explicit classification system to define these boundaries. By using SNIP in combination with citation counts where all indicators were normalized (Step 10), the analysis provided a more robust ranking of publications, minimizing distortions caused by significant differences between fields of knowledge. This is particularly important given that football-related studies are published across a wide range of disciplinary journals.

Step 10: Data normalization

Since the selected indicators have different ranges, data normalization is necessary to ensure they are all on the same scale (0 to 1). Additionally, the analysis includes both cost and benefit indicators, and it is important to align them in the same direction (the higher the better). Therefore, the normalization process proposed by Chakraborty and Yeh [21], as indicated in Eqs. (1) and (2) for benefit and cost indicators, respectively, was applied.

$$\mathrm{I}_{ij}^{\mathrm{norm}} = \frac{\mathrm{I}_{ij} - \mathrm{I}_{\mathrm{min}}}{\mathrm{I}_{\mathrm{max}} - \mathrm{I}_{\mathrm{min}}} \quad \text{for benefit indicators} \tag{1}$$

$$\mathrm{I}_{ij}^{\mathrm{norm}} = \frac{\mathrm{I}_{\mathrm{max}} - \mathrm{I}_{ij}}{\mathrm{I}_{\mathrm{max}} - \mathrm{I}_{\mathrm{min}}} \quad \text{for cost indicators} \tag{2}$$

where, I_{min} and I_{max} denote the minimum and maximum values of an indicator from the final portfolio articles, and $\mathrm{I}_{ij}^{\mathrm{norm}}$ is the normalized value of the indicator.

Step 11: Ranking of articles

In Step 11, the ranking of articles in the final portfolio was generated, following the filtering procedures and, if necessary, the exclusion of articles from journals without indicators. The initial calculations were based on the weighting of the number of citations. To achieve this, both the total number of citations and the age of the article were considered, with the age being calculated using the average number of citations per year, as described in Eq. (3).

$$\mathrm{ACI}_i = \frac{CI_i}{Y_i + 1} \tag{3}$$

where, ACI_i represents the average number of citations for article i; CI_i is the total number of citations for article i; and Y_i is the publication year of article i, calculated as the difference between the study year and the publication year of the article. The value +1 was added to the denominator to avoid indeterminacy when the publication and study years were the same, which would otherwise result in a value of 0 in the denominator.

Then the data was normalized, and the article ranking was generated based on the I index, proposed by Chakraborty and Yeh [21] as described in Eq. (4).

$$\mathrm{I}_i = \left[\alpha \mathrm{JC}_{jk}^{\mathrm{norm}} + \beta \mathrm{AC}_i^{\mathrm{norm}}\right] \left(\gamma + \mathrm{JS}_j^{\mathrm{norm}}\right) \tag{4}$$

where, $\mathrm{JC}_{j,k}^{\mathrm{norm}}$ is the normalized value of $\mathrm{JC}_{j,k}$; $\mathrm{JS}_j^{\mathrm{norm}}$ is the normalized value of JS_j; $\mathrm{AC}_i^{\mathrm{norm}}$ is the normalized value of AC_i; and the parameters α, β, and γ are positive constants (scaling factors), which can be either chosen by the researcher or calculated through MCDM. Given that many aspects of the analysis are subjective (such as selecting indicators and searching for citation data), the scaling constants were calculated using the CRITIC method.

Step 12: Download articles

In this step, the articles in the portfolio were downloaded. If the portfolio is not truncated, the download may take place before the classification procedure.

Step 13: Filtering by reading full articles

After defining the final portfolio and generating the ranking, Step 13 involves reading the full text of the articles. According to Steffen et al. [17], in some cases, the abstract may not accurately represent the content of the full article, or the researcher may be unsure whether an article should be eliminated based solely on the abstract. Therefore, reading the complete article may lead to further deletions from the portfolio.

Step 14: Bibliometric and systematic analysis of articles

Following the download of the full articles and the formation of the final version of the portfolio, which is aligned with the research area of interest, a bibliometric and systematic analysis was conducted. This analysis can highlight relevant aspects found within these studies.

2.1 CRITIC method

To compute the weights of the criteria from the data, the CRITIC method, as proposed by Diakoulaki et al. [18], was employed and described in the steps below.

a) **Normalization of the data:** The data was normalized using the formulas in Eqs. (1) and (2).

b) **Calculation of the standard deviation for each criterion:** The second phase involves the computation of the standard deviation s_j for all criteria based on Eq. (5).

$$\mathrm{s}_j = \sqrt{\frac{\sum_{j=1}^{n} \left(I_{ij}^{\mathrm{norm}} - I_{ij}^{\mathrm{norm}}\right)^2}{m-1}} \tag{5}$$

where I_{ij}^{norm} represents the normalized value of the i-th indicator, $I_{ij}^{\bar{n}orm}$ is the average of the normalized values for the i-th indicator, and m is the number of variables considered.

c) **Calculation of the correlation coefficient:** In Step 3, the Pearson linear correlation coefficient was calculated between pairs of different indicators.

d) **Calculate the values of q_j and the weights α, β and γ of the criteria:** Finally, the values of q_j and the weights w_k for each criterion are computed:

$$\mathrm{q}_j = s_j \sum_{j=1}^{n} (1 - |c_{jk}|) \tag{6}$$

$$\mathrm{EM}_j = \frac{s_j}{\sum_{j=1}^{n} q_j} \tag{7}$$

3 Results and Discussion

Based on the defined keywords and selected databases for this analysis, the final search for articles was conducted, resulting in the construction of the final portfolio, which is presented in Table 1.

The preliminary results produced 104 articles: 54 from the Scopus database and 45 from Web of Science. Although other databases were initially considered, their inclusion did not alter the total number of articles after eliminating duplicates (the first filtering procedure). As a result, these databases were excluded. Table 2 and Figure 1 outlines the eliminations according to the filtering procedures, leading to the final portfolio.

Table 1. Key parameters of our model

Keywords/Database			Scopus	Web of Science
Football	AND	MCDM	4	6
		MCDA	5	3
		Multicriteria	8	6
		Multi-criteria	17	14
Soccer	AND	MCDM	3	3
		MCDA	4	2
		Multicriteria	8	2
		Multi-criteria	10	9
Total per database			59	45
Total			104	

Table 2. Filtering workflow

Steps	Papers
Initial number of papers	104
Find duplicates	62
Out of scope	15
Final number of papers	27

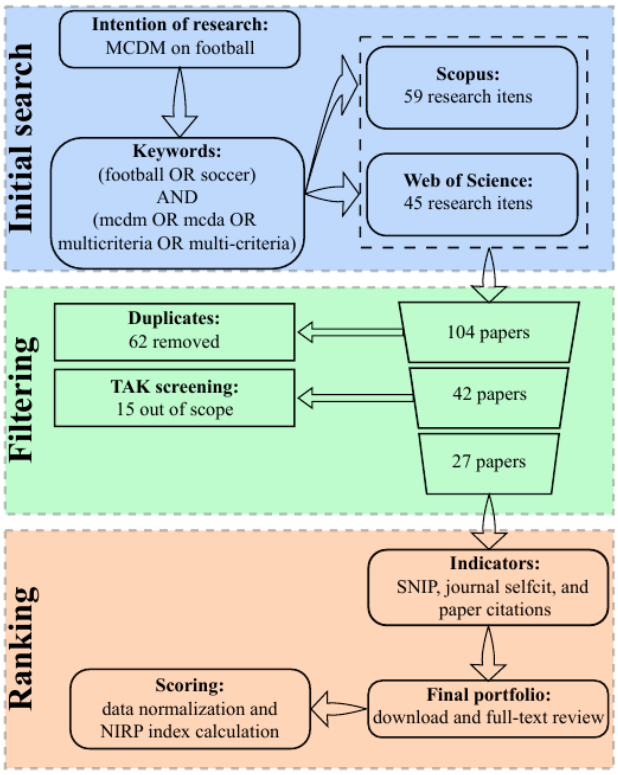

Figure 1. Overview of the study selection steps in the systematic review

After building the initial portfolio, filtering procedures were applied to eliminate possible duplicates, off-topic articles, and publications without relevant indicators (such as book chapters and conference papers). To eliminate duplicates, bibliographic management tools like Mendeley and JabRef were used, which have been employed in similar studies [16, 17, 22–25]. In addition to these tools, a manual check was conducted, as recommended by Chacón-Luna et al. [26]. As a result, 62 duplicate articles were removed. The elimination of off-topic publications was carried out manually [27], based on the reading of titles and abstracts [28]. This process ensured that the selected articles were aligned with the research topic, removing those that were not relevant to the study [29]. As a result, 15 publications that did not match the scope of this study were excluded, leaving a final portfolio of 27 articles, representing nearly 30% of the original collection.

With the final portfolio in hand, searches were conducted using the chosen indicators (SNIP, average number of citations, and self-citations). The raw data was normalized using the method proposed by Chakraborty and Yeh [21], a process also employed by Steffen et al. [17]. Normalization is crucial in multi-criteria data analysis [30] and ranking generation, as indicators often have different ranges, which can influence the results [31].

The next steps in this analysis involve defining the weights (scale constants) and generating the ranking of the articles in the final portfolio. Since the choice of indicators is subjective, the weights were calculated using the CRITIC method to reduce the subjectivity of the process. The scale constants were determined by applying the chosen MCDM method and based on the values of the alternatives (articles) and criteria (indicators). Table 3 presents the weight of the criteria, while the final ranking and decision matrix are shown in Table 4.

Table 3. Weight indicators

Indicator	SNIP	Self-citation	Average Citation
α, β and γ	0,26	0,39	0,35

Table 4. Final portfolio ranking based on defined indicators

Authors	Title	SNIP	Self-citation (Normalized)	Average* Citation ⁻ (Normalized)	AI	Ranking
Qader et al. [4]	*A methodology for football players selection problem based on multi-measurements criteria analysis*	0,70	0,91	1,00	0,73	1
Tavana et al. [32]	*A fuzzy inference system with application to player selection and team formation in multi-player sports*	0,97	0,92	0,72	0,66	2
Salabun et al. [12]	*A fuzzy inference system for players evaluation in multi-player sports: The football study case*	0,40	0,91	0,79	0,52	3
Galariotis et al. [9]	*A combined methodology for the concurrent evaluation of the business, financial and sports performance of football clubs: the case of France*	0,60	0,85	0,61	0,47	4
Arsu [11]	*Investigation into the efficiencies of European football clubs with bi-objective multi-criteria data envelopment analysis*	1,00	0,97	0,25	0,38	5
Gokgoz and Yalcin [33]	*A comparative multi criteria decision analysis of football teams: Evidence on FIFA world cup*	0,41	0,94	0,27	0,30	6
Gokgoz and Yalcin [34]	*Analyzing the champions league teams via decision models*	0,41	0,94	0,27	0,30	6
Ozceylan [35]	*A mathematical model using ahp priorities for soccer player selection: A case study*	0,16	0,95	0,29	0,27	8
Chelmis et al. [10]	*Multiciteria evaluation of football clubs: The Greek Superleague*	0,43	0,95	0,18	0,26	9

Nasiri et al. [36]	*A novel hybrid method for selecting soccer players during the transfer season*	0,43	0,95	0,16	0,25	10
Pehlivan et al. [37]	*Player selection for a national football team using fuzzy AHP and fuzzy TOPSIS*	0,26	0,93	0,22	0,25	11
Scarelli and Narula [38]	*A multicriteria assignment problem*	0,32	0,96	0,13	0,22	12
Chang [39]	*Developing a multicriteria decision-making model based on a Three-Layer virtual Internet of Things algorithm model to rank players' value*	0,39	0,88	0,11	0,20	13
Kolbowicz et al. [40]	*A multi-criteria system for performance assessment and support decision-making based on the example of Premier League top football strikers*	0,27	0,81	0,11	0,18	14
Mu [41]	*Who really won the FIFA 2014 Golden Ball Award? What sports can learn from multi-criteria decision analysis*	0,24	0,88	0,09	0,18	15
Omer Faruk Gorcun [42]	*A novel performance evaluation technique based on integrated weighting approach: A case study in the field of sport management*	0,35	0,95	0,03	0,17	16
Añon et al. [43]	*Analysis of the technical-tactical profile of la liga teams 2017-2018: A multivariate approach*	0,07	1,00	0,04	0,16	17
Principe et al. [44]	*Multicriteria analysis of football match performances: Composition of probabilistic preferences applied to the English premier league 2015/2016*	0,18	0,80	0,08	0,15	18
Gholamian et al. [45]	*Farsjum, a fuzzy system for ranking sparse judgment matrices: A case study in soccer tournaments*	0,21	0,93	0,01	0,15	19
Li et al. [46]	*A new similarity function for Pythagorean fuzzy sets with application in football analysis*	0,37	0,86	0,00	0,15	20
Górecka [47]	*Selecting the right football club to sponsor: Multi-criteria analysis*	0,25	0,60	0,13	0,14	21
de Lima et al. [48]	*Optimizing Police Locations around Football Stadiums Based on a Multicriteria Unsupervised Clustering Analysis*	0,15	0,93	0,00	0,14	22
Salles et al. [49]	*Multiple Choice Method with Genetic Algorithm for the formation of soccer teams*	0,18	0,80	0,00	0,12	23
Górecka [50]	*Applying multi-criteria decision aiding methods to the process of selecting a host city for sporting event*	0,25	0,60	0,04	0,12	24
Da Silva and Mello [51]	*Applying grey relational analysis to Brazilian soccer clubs: A measurement of the financial and sports performance*	0,12	0,64	0,00	0,10	25
Saeed et al. [52]	*Application of generalized fuzzy topsis in decision making for neutrosophic soft set to predict the champion of FIFA 2018: A mathematical analysis*	0,00	0,00	0,09	0,00	26
Schaefer et al. [53]	*Application of multicriterial methods for management and comparison of the financial efficiency of the football clubs of the brazilian football championship series A*	0,00	0,00	0,04	0,00	26

The CRITIC method revealed that self-citation and average citation were the indicators with the highest weights. The final ranking indicated that the top-rated article is titled "*A methodology for football players selection problem based on multi-measurements criteria analysis*", authored by Qader et al. [4], published in *Measurement*. This article ranks second in terms of total citations but holds the first position for average citations. This highlights the importance of considering the article's age when constructing a ranking, as older publications tend to have more citations. This factor has also been emphasized in other studies [17, 22, 23, 54, 55].

3.1 Analysis of the final portfolio through bibliometric and systematic approaches

The articles in the final portfolio can be analyzed in greater detail through bibliometric and systematic analyses, which are presented in this subsection. These analyses are crucial as they reveal the key aspects of the publications in the constructed portfolio.

The first part of this subsection focuses on a bibliometric analysis of the 27 selected articles. According to the study [56], bibliometric analysis is a robust method for exploring large volumes of scientific data, helping to uncover the evolutionary trends within a specific field. Chaves et al. [57] defined bibliometric analysis as the quantitative examination of data from a set of scientific articles, aimed at managing information in a particular area of knowledge. de Carvalho et al. [29] added that bibliometric reviews can highlight common limitations and assumptions in selecting and analyzing relevant articles. Based on these definitions, the primary bibliometric results from the portfolio construction process were presented in this study, focusing on MCDM and football. Figure 2 illustrates the temporal evolution of the cited articles.

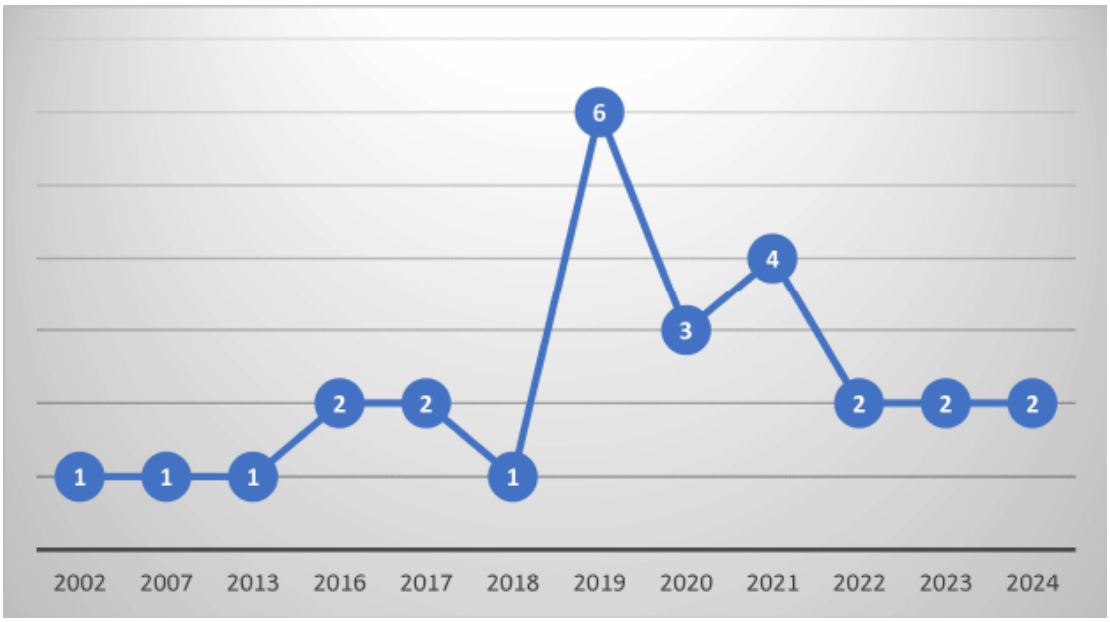

Figure 2. Number of papers by year

The first study within the scope of this SLR was published in 2002, indicating a growing interest in the topic over the past decades. According to Pagani et al. [16], both the mechanisms for scientific publishing and the methods for searching theoretical articles have improved in quantity and quality. A notable increase in publications has been observed in recent years, with 2019 standing out as the most prolific year (six publications). Additionally, approximately 89% of the portfolio consists of articles published from 2016 onward, demonstrating a consistent trend, with at least one publication per year since then. Similar publication growth has been observed in other studies [58–62]. The geographic spread of the articles in the final portfolio is represented in Figure 3.

Turkey leads the portfolio with six publications, followed by Brazil (five) and Poland (four). The United States and Iran each contribute two publications, while the remaining countries – China, France, Greece, Italy, Malaysia, Pakistan, Portugal, and Taiwan – are represented by a single publication each. Turkey has shown strong representation in other literature reviews related to MCDM across different fields [23, 63, 64], suggesting a widespread adoption of these methods in the country. Analyzing publications by country, more than 50% originate from European nations.

Beyond identifying contributing countries, geographic distribution also provides insights into the institutions conducting research on this topic. Based on an analysis of the primary authors' affiliations, only two institutions – Ankara University and Nicolaus Copernicus University in Torun – appear more than once.

For ranking purposes, one of the key indicators considered was the average number of citations, as defined in

Eq. (3). Building on this concept, Figure 4 presents the distribution of average citations by country. This was determined by summing the average citations of each article and dividing by the total number of publications per country, according to Eq. (8).

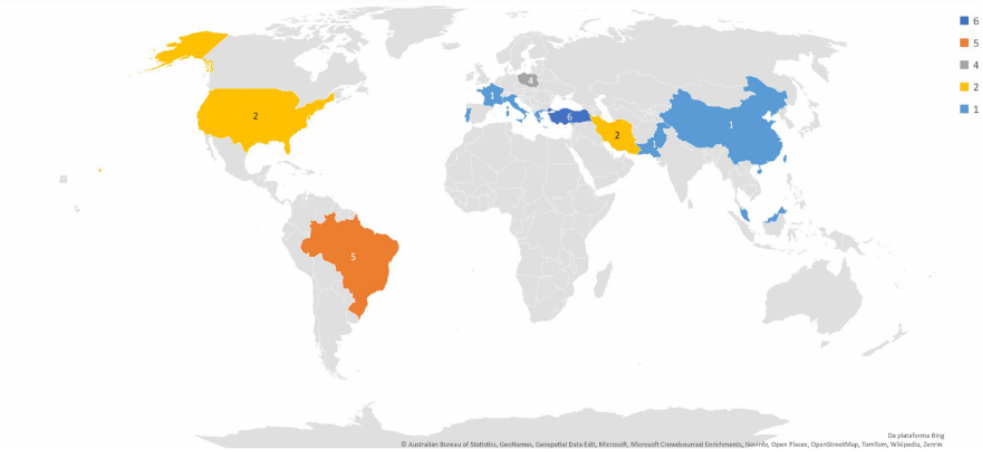

Figure 3. Number of papers by country

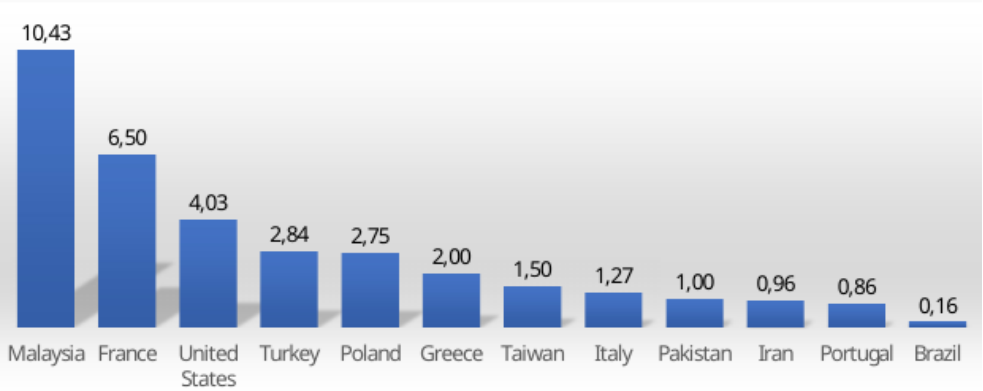

Figure 4. Average citations by country

$$\text{CIC} = \frac{\sum_{j=1}^{n} ACI}{NPC} \tag{8}$$

where CI stands for the average number of citations per country, ACI is the average citation count for country j, and NPC refers to the total number of publications from that country.

While Malaysia achieved the highest citation average with a single article, Brazil, ranking second in publication volume, showed the lowest. The language of publication may explain this difference. Figure 5 illustrates the distribution of articles by journal.

In this case, it is evident that the publications are distributed across multiple journals, with only three journals containing two publications each (*Journal of Physical Education and Sport, Operational Research (Brazil), and Team Performance Management*), while the remaining 21 journals are represented by a single publication. This diversity across 24 journals can be attributed to the broad scope of the review, which examines both MCDM methods and their applications in football. As a result, the selected articles cover a range of perspectives, from the development of new methodologies to the physiological analysis of players, highlighting the potential for publication in journals spanning different fields of knowledge Figure 6.

Figure 7 presents the main keywords found in the articles included in the portfolio. These keywords help identify research trends and key applications explored in the selected studies. The keyword map was generated using VOSviewer, a widely adopted tool for literature review analyses [17, 23, 65]. This software identifies relationships between keywords, clustering them into groups and establishing connections that reveal thematic patterns within the field.

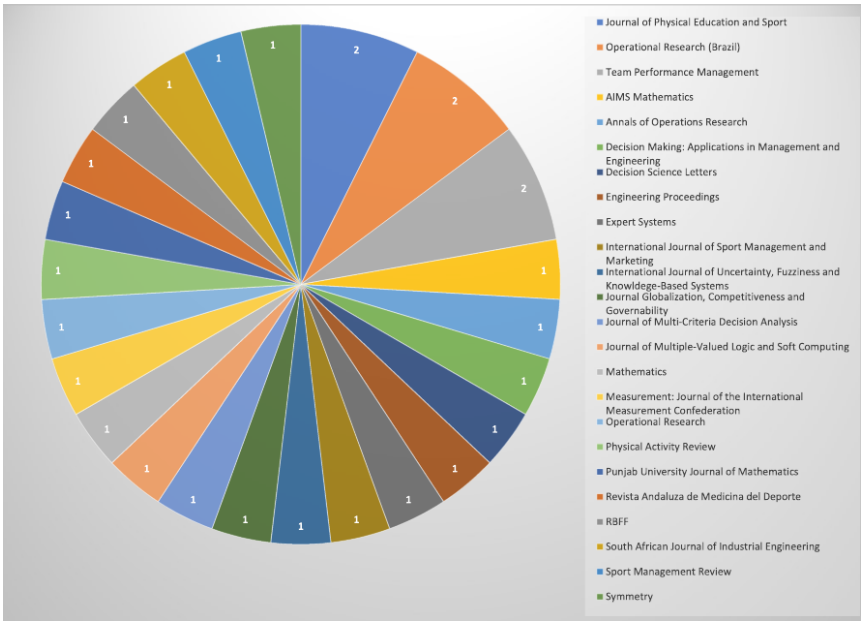

Figure 5. Number of papers by journals

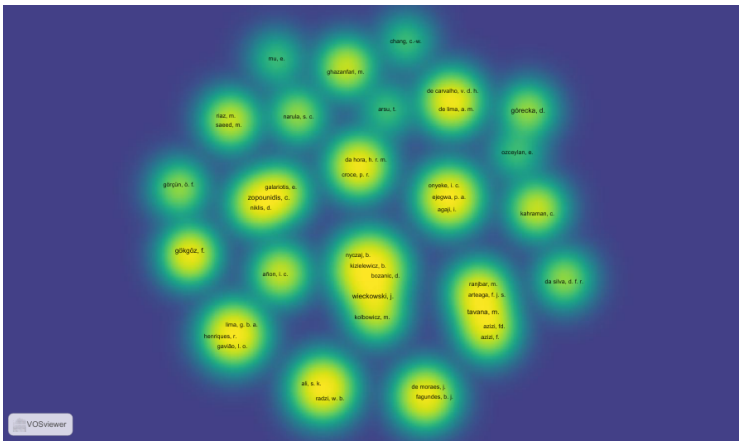

Figure 6. Main authors

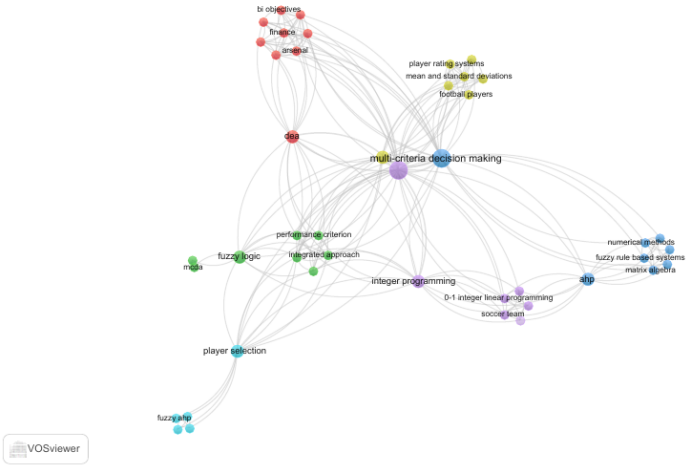

Figure 7. Keywords map

"MCDM" was the most frequently occurring keyword, serving as the central element in the generated cluster. Additionally, "football" and "soccer" were prominently highlighted, as they were among the keywords used for database searches. To deepen the understanding of the selected articles, the final stage of SLR involved a systematic review of their content. This analysis focused on identifying the main topics discussed, which are outlined in Table 5.

Table 5. Main themes covered in the portfolio

Theme	Occurrences	Percentage
Performance of football clubs	11 [9–11, 34, 42–44, 47, 49, 51, 53]	40.74%
Football player selection	6 [4, 12, 32, 35–37]	22.22%
World cup	3 [33, 50, 52]	11.11%
Assignment of referees	1 [38]	3.70%
Evaluate the efficiency of football players (defense) in the Champions League	1 [39]	3.70%
FIFA Golden Ball selection	1 [41]	3.70%
Football tournaments	1 [45]	3.70%
Optimizing police-locations around football stadiums	1 [48]	3.70%
Players from the football clubs of the Brazilian football	1 [46]	3.70%
Sporting performance of Premier League strikers	1 [40]	3.70%

Table 6. Main methods covered in the portfolio

Method	Occurrences	Percentage
PROMETHEE	6 [9, 10, 33, 34, 36, 47]	11.11%
TOPSIS	5 [4, 12, 33, 40, 47]	9.26%
ELECTRE	4 [38, 47, 50, 53]	7.41%
AHP	3 [35, 39, 41]	5.56%
DEA	3 [34, 36, 53]	5.56%
Fuzzy	3 [12, 32, 44]	5.56%
Entropy	2 [33, 34]	3.70%
EXPROM-II	2 [47, 50]	3.70%
FTOPSIS	2 [37, 52]	3.70%
GRA	2 [39, 51]	3.70%
WASPAS	2 [33, 42]	3.70%

Table 7. Relations between themes and methods

Theme	Method	Occurrences
Performance of football clubs	PROMETHEE	3 [9, 10, 47]
Football player selection	TOPSIS	2 [4, 12]
Football player selection	Fuzzy	2 [12, 32]
Performance of football clubs	DEA	2 [34, 53]
Performance of football clubs	ELECTRE	2 [47, 53]

A more detailed analysis, based on a systematic reading of the articles, revealed that the predominant themes related to football and the application of MCDM methods include performance evaluation in football clubs (11 occurrences), followed by player selection (six occurrences) and topics related to the World Cup (three occurrences). Additionally, seven other themes appeared with a single occurrence each.

Football clubs are increasingly striving for excellence in their sporting results. Therefore, applying multi-criteria methods proves useful in supporting decisions where a wide range of variables must be considered performance analysis in football clubs can be linked not only to sporting achievements but also to economic and financial aspects, concerns that have gained prominence in recent years [66]. Moreover, sports performance is often associated with physical conditioning, as the study [67] highlights that training management plays a crucial role in ensuring that players maintain optimal physical performance throughout the season.

Regarding player selection, the second most common theme, the vast number of available athletes makes this process highly complex. Various techniques, including MCDM methods, can assist in identifying and selecting players. Ati et al. [3] argue that effective recruitment should be grounded in a more advanced human resource management methodology. In this context, decision-makers must continually seek efficient techniques to identify talent and build elite teams [68]. Player selection can also be relevant when determining a team's starting lineup for a given match. However, this process is often based on intuition and experience rather than a structured analytical approach [69].

Finally, regarding the last theme with multiple occurrences in the portfolio, some studies have applied MCDM methods to analyze World Cups. These studies have addressed various aspects, including predicting potential winners of the 2018 World Cup. Table 6 presents the most frequently used methods in the analyzed publications, considering only those with two or more occurrences. For this analysis, methods were examined individually within each publication. Additionally, a comparison of method combinations revealed that no two studies in the portfolio applied the exact same combination of methods.

The Preference Ranking Organization Method for Enrichment Evaluations (PROMETHEE) family of methods was the most frequently used in the final portfolio publications, appearing in six studies. Following this, the TOPSIS method was applied in five publications, while the Electre family of methods appeared in four, and the AHP method in three. These findings align with other studies that also report a high occurrence of these methods in similar contexts [23, 70]. Table 7 shows the relations between themes and methods.

4 Conclusions, Directions for Future Studies and Limitations

Football has undergone significant evolution over time, leading to increased competitiveness among clubs. In this context, the use of techniques to support decision-making has become crucial, especially given the numerous criteria that can influence the analysis. Multi-criteria decision analysis methods offer a valuable approach to addressing these complex challenges.

This study, through a systematic literature review, provided an overview of the key aspects present in publications related to MCDM and football. Additionally, the ranking of publications highlighted those with the most substantial impact in the field, based on the selected indicators.

The findings revealed that a variety of MCDM methods have been applied to tackle football-related issues, with many studies exploring the integration of multiple methods to enhance decision-making processes. This highlights the growing importance and versatility of MCDM in addressing the diverse and evolving challenges in football.

The analysis demonstrated that Multi-Criteria Decision-Making (MCDM) methods are being applied in practice to help solve problems related to football. Player selection and performance analysis are already incorporating these methods to support decision-making, effectively connecting MCDM techniques with various fields of knowledge.

Despite the numerous findings discussed in this analysis, there are some limitations that should be acknowledged and explored in future studies. Many articles use keywords specific to the individual methods, which makes it challenging to identify all potentially relevant publications. This is particularly relevant given the wide variety of MCDM methods available and the continual emergence of new techniques. Other areas of football (such as performance evaluation, player scouting and selection, game strategies, and more) also involve multiple alternatives and criteria, and could benefit from the application of MCDM methods.

Therefore, building upon the insights presented in this article and considering the results obtained, future research could focus on identifying publications that explore football in combination with specific MCDM methods or with techniques from other domains. Artificial intelligence is another promising avenue, especially when combined with MCDM approaches. The integration of AI and MCDM has the potential to further optimize processes in football [71].

Data Availability

The data used to support the research findings are available from the corresponding author upon request.

Conflicts of Interest

The authors declare no conflict of interest.

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