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Original Research Article

Multi Criteria Decision Making Approach for Football Team Selection

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Abstract: Selecting team is one of the important issues in football. The role of a coach is selecting players that are formed subjectively without regard to various criteria. Her decision can impact team performance. Thus, this paper presents a new methodology to assess and rank football team based on multi-criteria decision making (MCDM). The aim is to select the best team for each football game by taking several criteria into account. The Analytic Hierarchy Process (AHP) method is used to determine the weightings for evaluation criteria among decision makers and Case-based reasoning systems to selecting the best team. We test the efficiency of the model using Paris Saint Germain champion's league final.

Keywords: Selection team; Football Team; analytic hierarchy process; AHP; case-based reasoning.

1. INTRODUCTION

Football is one of the most complex sports in the world, where players need technical, tactical, and physical skills to achieve a successful performance, and eventually to win a game (Yi *et al*., 2018). Yet, the selection of performing teams by the football coach is a daunting task. The selection of football teams ensures that the right player is in places who are capable leaders. The general positions are forward, midfielder, defender, and goalkeeper (see figure 1).

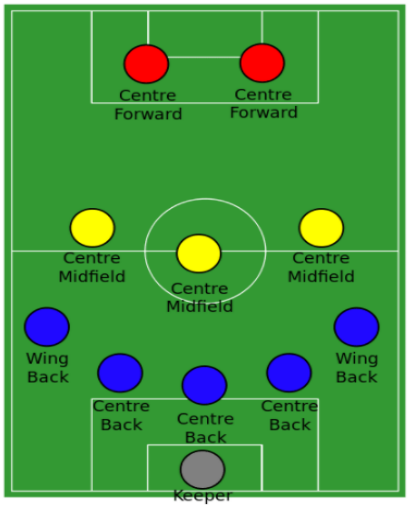

Fig-1: The position of a football player in a team

The team selection problem has become popular in various fields of football, business and hospital studies. To solve this problem, several methods have been proposed such as Artificial Neural networks (Evwiekpaefe, 2020), Fuzzy analytic hierarchy process (FAHP) (Ball, 2012), COMET (Palczewski, 2019), TOPSIS (Qader, 2017), Statistical analysis (Vlies, 2020)KMDL (Gronau *et al*., 2006), Fuzzy-genetic algorithm (Strnad and Guid, 2010), Multi-objective optimization (Ahmed *et al*., 2013) and fuzzy logic (Shipley and Johnson, 2009); etc.

The main objective of this paper is to propose a model that helps the football coach to choose the best team from a set of alternatives. The football team selection is an MCDM problem where many criteria should be considered in decision-making. Therefore, this model use AHP method to determine the importance weights of each criteria and case based reasoning (CBR) approach to obtain the best team for each game that satisfies the coach.

The use of CBR and AHP is developed in some works which belongs to different fields: healthcare (Khatrouch *et al*., 2014), environmental (Quintana 2019, Park *et al.*, 2019), manufacturing (Ghazalli *et al*., 2014), transport (Bouhana *et al*., 2011), Semantic web (Kwon and Kim, 2004), maintenance (Chou, 2008), etc. The remainder of this paper is structured as follows: in Section 2, a model for team solution is presented and the stages of the proposed approach are explained in detail. A real world example for testing the proposed model is presented in Section 3. In Section 4, experimental results and data analysis are discussed. Conclusions of this study are given in Section 5.

2. THE MODEL DESCRIPTION

For selecting football teams, the model in Figure 2 will help the football coach to find the most appropriate team; that means, the best team is adapted to the preferences and needs of each individual game under consideration.

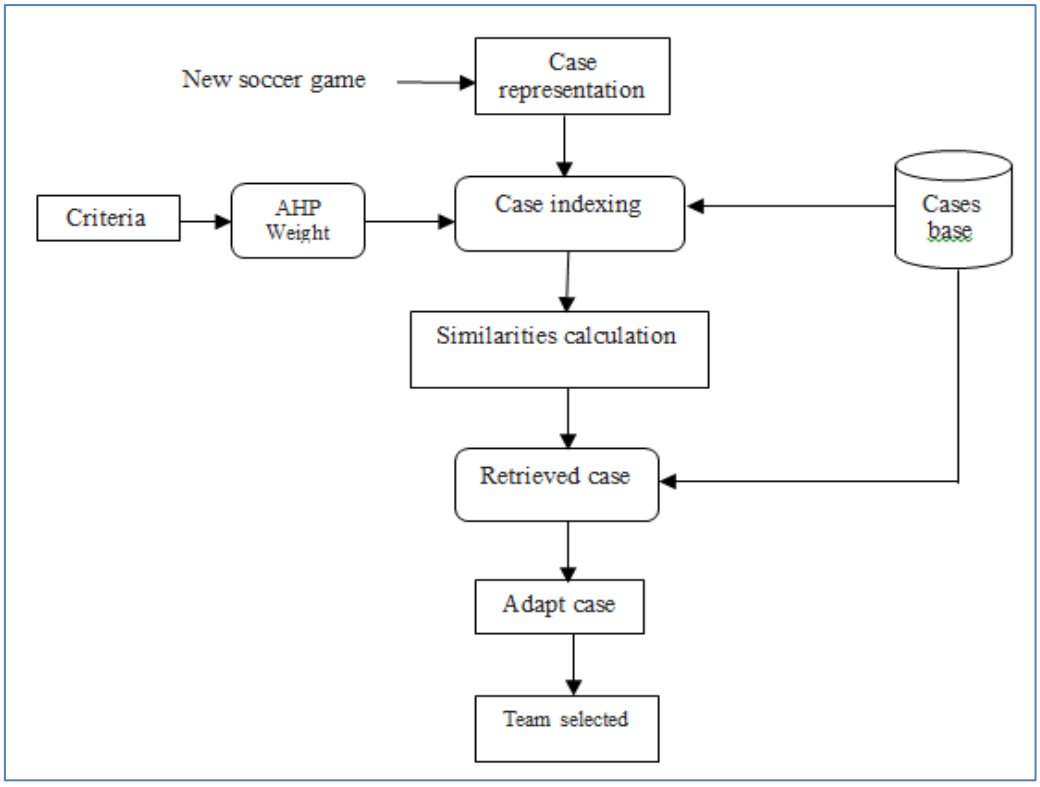

Fig-2: The structure of a football team selection model

The proposed model is presented in four main steps explained below.

2.1 Case base construction

The presentation of the base case depends on the structure and content of such cases. In our context, cases (game) contain a vector cloud of attributes that define the problem and provide any number of solutions one of which is the closest to ideal. These correspond to the best team that satisfies most closely the needs of any game under consideration and the preferences of the football coach. A case is described by their criteria which also provide, then, the basis for making decisions about the solution.

The criteria characterizing the team choice are

Criteria	Low criteria	Description
Shooting criteria	Goals scored	The total number of points in a game.
	Shots per game	The number of shots per game.
Discipline criteria	Yellow cards	The number of yellow cards shots per game.
	Red cards	The number of red cardsshots per game.
Ball control criteria	Ball possession	The percentage of the game that each team has accrued in possession of the ball.
	Dangerous attacks	Any kind of movement with the ball towards an opponent's goal.

The solution is represented by the best team that satisfies most closely the needs and the preferences of the football coach. That is defined by a set of criteria.

2.2 Calculate the weights of criteria

In this step, we use the AHP method to obtain the weights of each criterion according to its importance. Then, we use these weights to calculate the similarity among the new coming case, and each case in the case base. The first step is to compose our problem in three hierarchical levels presented by Figure 3.

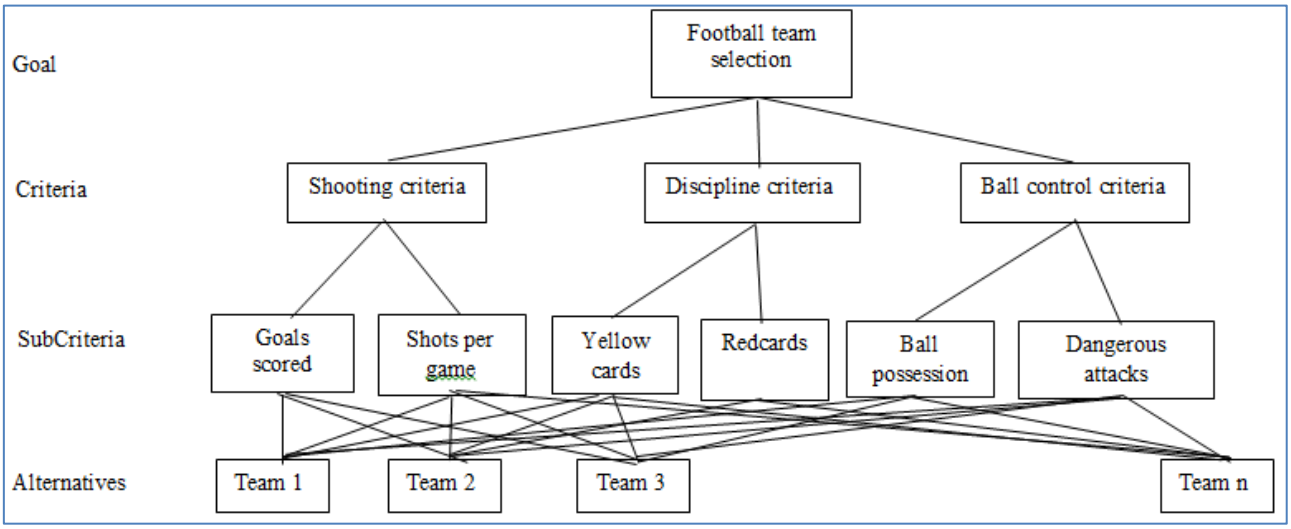

Fig-3: An AHP structure for football team selection

The next step is to conduct a questionnaire survey handed to the coach. The value assigned is based to the scale in interval of 1–9. Then, we create square pair wise comparison matrices of the selection criteria. Table 1 (Saaty, 1980) presents the scale of preference in the pair-wise comparison process.

Table-1: AHP comparison scale

Verbal judgments	*Numerical rating*
Equal importance	1
Moderate importance of one over another	3
Strong or essential importance of one over another	5
Very strong importance	7
Absolute importance	9
Intermediate values between two adjacent judgments	2, 4, 6, 8

The consistency of results obtained is found by calculating the consistency index. As the consistency index becomes bigger the judgments of the users are coherent and vice versa.

2.3 Retrieving phase

The goal of this step is to phase is to find the most similar previous cases that can support reasoning that comes in the next steps. The case that have the potential to make relevant predictions about the new case. Retrieval is done by using features of the new case as indexes into the case base.

The similar cases retrieved depend on their indexing in the case base. The objective is to measure the similarity between the new case (soccer game) and the previous cases in the case-base. In order to evaluate the similarity, the similar attribute collection $S = \{sT_1, \ldots, sT_n\}$ should be determined. We also denote by Sim, the similarity degree between the new game case and the game case stored. In the first step, we calculate the local similarity sT_i between attributes as the following:

$$sT_i = \left(1 - \frac{|T_i - T_i'|}{\text{Rank}}\right) \quad (1)$$

Where
T_i : the i^{th} attribute of the case in memory
T_i' : the i^{th} attribute of the current case

Rank: the absolute value of the difference between the upper bound and the terminal all lower values of attribute.

The second step, we calculate overall similarity by using the weights associated with each attribute. Thus, we introduce the importance of the attributes as a new variable. It measures the importance of the i^{th} attribute, which we express as T_i. In our model the weights $W_i$were calculated using the AHP method. We calculate the global similarity based on k-nearest-neighbours (kNN) approach defined by:

$$\text{Sim}(T,T') = \frac{\sum_{i=1}^{n} sT_i * W_i}{\sum_{i=1}^{n} W_i} \quad (2)$$

Where T is the case in memory, T' is the target case, and n is the number of attributes of each case. Finally, the case having the biggest global similarity with the new case will be selected.

2.4 Step 4: adapting phase

The objective of this phase is to evaluate the retrieved solution. Thus, the decision-maker must judge if the selected case is well or no. If yes, this case solution will be adapted to the new case. Otherwise, he passes to the second more similar case, to the third, etc. Finally, the new case and its validated solution are integrated into the case base. It is than necessary to know which information can be important to retain, how to index the case for a future retrieve, and how to integrate the new case in the case base.

3. COMPUTATIONAL STUDY

To assess the efficiency of the developed model, we tested our proposed model on a real dataset from 2017 to 2020of a team selection's decisions for club Paris Saint Germain final champion's league. We report the results obtained. We have 32 football players with three disciplines (defenders, midfielders, forwards) and we have to select teams for each football game. The framework proposed can help to choose the best team that satisfies the preferences of decision maker and game need. The main objective is to search the best team of a new game arising to the case base. This new case is described by the same attributes that those of the others cases in base, described in Table 2.

Table-2: Case base construction for the football team selection problems

Case	Criteria						Team
	GS	SG	YC	RC	BP	DA	
RB Leipzig	3	10	1	0	55	36	Team RB
Atlanta	2	14	3	0	59	43	Team At
Borussia Dortmund	2	5	4	0	51	37	Team Bo
Club Bruges	1	10	2	0	58	37	Team Cl
Club Bruges	5	7	3	0	46	25	Team Cl

Case	Criteria						Team
	GS	SG	YC	RC	BP	DA	
Galatasaray	1	14	3	0	53	47	Team Ga
Real Madrid	3	6	2	0	54	44	Team Re
Manchester United	2	10	4	0	55	29	Team Ma
Etoile rouge de Belgrade	4	10	2	0	67	69	Team Et
Liverpool	2	9	2	0	41	32	Team Li
Etoile rouge de Belgrade	6	28	0	0	74	52	Team Et
Celtic Glasgow FC	7	14	0	0	65	55	Team Ce
Anderlecht	5	16	0	0	55	59	Team An1
Anderlecht	4	11	2	0	45	35	Team An2
Bayern Munich	3	8	1	0	39	44	Team Ba
New Case	3	20	1	0	55	60	?

4. EXPERIMENTAL RESULTS AND DISCUSSION

The objective of the similarities measures is to look for the nearest case that satisfies the most the preferences of the new football game in the case base. We calculate all local similarities between attributes by applying equation (1) (Table 3).

Table-3: Similarities local calculation

Case	Criteria					
	GS	SG	YC	RC	BP	DA
RB Leipzig	1	0,5652	1	1	1	0,4545
Atlanta	0,8333	0,7391	0,5	1	0,8857	0,6136
Borussia Dortmund	0,8333	0,3478	0,25	1	0,8857	0,4772
Club Bruges	0,6666	0,5652	0,75	1	0,9142	0,4772
Club Bruges	0,6666	0,4347	0,5	1	0,7428	0,2045
Galatasaray	0,6666	0,7391	0,5	1	0,9428	0,7045
Real Madrid	1	0,3913	0,75	1	0,9714	0,6363
Manchester United	0,8333	0,5652	0,25	1	1	0,2954
Etoile rouge de Belgrade	0,8333	0,6521	0,75	1	0,4571	0,7954
Liverpool	0,8333	0,7391	0,75	1	0,6	0,3636
Etoile rouge de Belgrade	0,5	0,6521	0,75	1	0,4571	0,8181
Celtic Glasgow FC	0,3333	0,7391	0,75	1	0,7142	0,8863
Anderlecht	0,6666	0,8260	0,75	1	1	0,9772
Anderlecht	0,8333	0,6086	0,75	1	0,7142	0,4318
Bayern Munich	1	0,4782	1	1	0,5428	0,6363

The relative importance weighting attributes obtained by AHP method, W_i, as listed in (Table 4).

Table-4: Criteria weight

Attributes	GS	SG	YC	RC	BP	DA	WeightWi
GS	0,4778	0,4449	0,1935	0,2089	0,4523	0,6136	0,3985
SG	0,096	0,0889	0,2580	0,269	0,057	0,068	0,1393
YC	0,080	0,01	0,0322	0,015	0,023	0,023	0,0305
RC	0,068	0,0098	0,0645	0,0298	0,016	0,023	0,0352
BP	0,119	0,1779	0,1612	0,2089	0,1130	0,068	0,1414
DA	0,159	0,2669	0,2903	0,2686	0,3392	0,2045	0,2548

The attributes weights are employed in equation (2) to measure the similarity between the cases in memory and the new case. Next, we obtain Table 5.

Table-5: Global similarities calculation

Case	Team	Global similarities	Rank
RB Leipzig	Team RB	0,7981	3
Atlanta	Team At	0,7654	5
Borussia Dortmund	Team Bo	0,6685	11
Club Bruges	Team Cl	0,6520	12

Case	Team	Global similarities	Rank
Club Bruges	Team Cl	0,5325	15
Galatasaray	Team Ga	0,7305	7
Real Madrid	Team Re	0,8085	2
Manchester United	Team Ma	0,6686	10
Etoile rouge de Belgrade	Team Et	0,7466	6
Liverpool	Team Li	0,6689	9
Etoile rouge de Belgrade	Team Et	0,6202	13
Celtic Glasgow FC	Team Ce	0,620047991	14
Anderlecht	Team An1	0,827891337	1
Anderlecht	Team An2	0,684310244	8
Bayern Munich	Team Ba	0,767727194	4

The computational study seeks to analyse if the model improves the effectiveness of a team in the football game and how good is its contribution. For this study, team performance is identified by 15 case (RB Leipzig, Atanta….). The final preferences for the top fifteen considered a football game for PSG are presented in Table 5. The last column, present the ranking obtained from the CBR method.

Palczewski *et al*. (2019) proposed an approach based on the COMET method. Seven criteria were taken into consideration and a simplified structure was used in order to greatly decrease the pairwise comparisons required in the method, reduce the complexity of the problem. Hence, at first, the three sub-models are evaluated independently, namely shooting assessment, discipline assessment, and ball control assessment. Then, the final model is obtained and the Spearman's rank correlation coefficient is used to verify and compare the results of the COMET method with the benchmark ranking of twenty alternatives (top 20 football teams). For this study, it would be valuable to extend this model with additional criteria and sub-models, creating even more detailed ranking of football teams and use the data base of games.

In order to overcome the limitations in the previous approach, we proposed a new approach of a football team selection. Our method is based on a multi-criteria decision model and uses the CBR method. The combination of the two techniques seems to be more appropriate in our problem. Football team selection problem can be assimilated to a decision-making problem. This is due to the fact that team selection problems usually associate several criteria. These criteria can be qualitative or quantitative. For this reason the AHP method provide a framework to cope with multiple criteria problems. Then, the CBR technique allows us to reuse base contain teams to generate new solution that respect the new preference decider. This two phase evaluation of the system can provide high quality football teams.

5. CONCLUSIONS

In this paper, we presented a football team selection method based on a Multi-criteria aid model using CBR technique. The proposed approach was tested on the real datasets collected from club Paris Saint Germain finale champion's league. By comparing the results obtained through the model with those resulting, it was found that the developed model is highly representative of reality because it used last experience with a set of attributes that satisfied most decision maker preferences. The next step in our work will be the use of our approach in other areas. We are also planning to imbed this model in a general project management system under developing. The model can be improved by adding others attribute (experience, leadership…) which can be studied in the future.

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