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Decision Making in Best Player Selection: An Integrated Approach with AHP and Extended TOPSIS Methods Based on Wefa Freamwork in MAGDM Problems

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A B S T R A C T

The Problem of selecting the best player among other good ones is an important issue in the world of sport. Player selection is a big challenge in all types of clubs, involving multiple criteria that should be evaluated simultaneously. Therefore, an appropriate decision approach for player's selection is required. The goal of this research is to present a new model for clubs' head coaches and managers that consider experts' votes and making a good decision. Thus, this paper considers an approach based on WeFA framework and Multiple Criteria Decision Making (MCDM) methods in Multiple Attribute Group Decision Making (MAGDM) problems for the challenge of best player selection where, important criteria and experts' vote is received by using WeFA. Analytic Hierarchy Process method (AHP) is used for determining the Weight of each criterion. Extended TOPSIS and its application in MAGDM are applied for weighting to decision makers (DMs) and ranking of alternatives. This research can be useful as a practical and scientific framework for managers and head coaches of clubs all around the world. Finally, a numerical example is evaluated to illustrate the proposed methodology.

Keywords: *Multiple Attribute Group Decision Making, best player selection, AHP, Extended Topsis, Multiple Criteria Decision Making, Integrated Approach.*

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1. Introduction

Nowadays, it is obvious that the best players' selection for each sport team is a very important task and one of the most critical issues that managers and head coaches are often faced with. Therefore, selecting an appropriate and efficient player is essential for the success of any sport team. Also, every player has an important role in success and failure of each sport team. Thus, selecting a clever and professional player requires having criteria and

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characteristics for playing. Therefore, in current research a new approach for a good choice is presented. It is important to present and apply an appropriate decision making tool, involving a set of decision criteria and a special methodology for evaluating and ranking of alternatives [1]. Multiple attribute decision-making (MADM) is an important part of modern decision science. It always involves multiple decision attributes and multiple decision alternatives [2]. Multiple attribute group decision making (MAGDM) approach is often used to solve various decision making and selection problems. This approach often imposes on the decision makers to provide qualitative and quantitative assessments for determining the performance of each alternative with respect to each criterion and the relative importance of evaluation criteria with respect to the overall objective.Topsis and AHP are the most frequently used MAGDM techniques [3]. Many studies have focused to apply Multiple Criteria Decision Making (MCDM) methods, and it has been broadly applied to different areas such as economics, military, society, management, agricultural, environmental, etc. [4-8]. Dooley et al [7] have proposed Application of Multiple Criteria Decision Analysis (MCDA) in the New Zealand Agricultural Industry that multiple criteria decision analysis (MCDA) has the potential to be used in agricultural and environmental decision making to help trade-off the economic, environmental, and social aspects that need to be considered in making strategic decisions. Ozcan et al [9] have considered a warehouse location selection problem, and for ranking, Multi-criteria decision making methodologies such as AHP, TOPSIS, ELECTRE and Grey Theory was applied. Hashemkhani Zolfani et al [10] have considered forest roads locating problem where they applied AHP to criteria weights and COPRAS-G method for ranking. Jati [11] have presented a new mixed TOPSIS and VIKOR Method for webometrics ranking. He shows that these models efficiently help evaluators to determine with a strategic view for future developments and more aspect by using multicriteria decision analysis. Tavana et al [12] have presented a group MADM framework based on the analytic hierarchy process (AHP), entropy and the technique for order preference by similarity to the ideal solution (TOPSIS) that were developed for the Integrated Human Exploration Mission Simulation Facility (INTEGRITY) project at the Johnson Space Center (JSC) to assess the priority of a set of human spaceflight mission simulators. And the proposed structure framework has some obvious attractive features such as the models are applicable to a wide range of real-world decision making problems in MADM, useful for seeking input from multiple DMs and helps to identify inconsistencies in judgments at very early stages of the computation process.

Some of the recent applications of MADM and MAGDM method in selection are briefly reviewed in the following. Production control policy selection [13]; Supplier evaluation and selection [14]; Team Member Selecting [1]; Support Site Selection [15]; selection of a potential supplier [16, 17]; industrial robots selection [18]; selection of machine tool [19]; Contractor Selection [20]; Network Selection [21], Material selection [22]. Some of the most famous MADM tools are listed in table 1.

Table.1. Summary of MADM Methods

Method	Author(s)	year
Simple Additive Weighting (SAW)	Churchman &Ackoff [23]	1954
Elimination and Choice Translating Reality (ELECTRE)	Roy [24]	1968
Analytic Hierarchy Process (AHP)	Saaty [25]	1980
Technique For Order Preference By Similarity To Ideal Solution (TOPSIS)	Hwang, Yoon [26]	1981
Preference Ranking Organization Method for Enrichment Evaluations (PROMETHEE)	Brans et al [27]	1984
VI Sekriterijumska Optimizacija I Kompromisno Resenje (VIKOR)	Opricovic [28]	1998
Analytic Network Process (ANP)	Saaty & Vargas [29]	2001
Multicriteria Satisfaction Analysis (MUSA)	Grigoroudis & Siskos [30]	2002
Complex Proportional Assessment With Grey Relations (COPRAS-G)	Zavadskas et al [31]	2009

Although. In the literature, there are many studies of application of MADM and MAGDM methods in different areas, but there is no study that deals best player selection all over world. And this research hopes to fill these gaps. Accordingly, the goal of this research is proposing combined WeFA, AHP and Extended Topsis tools in MAGDM method for evaluation and choosing of a best player.

The rest of this paper is organized as follows. In the next section; the proposed methodologies including WeFA, AHP and Extended Topsis in MAGDM are described. In section 3, we describe selecting experts and criteria. In section 4, a numerical example is evaluated to illustrate the proposed methodology and finally the conclusion and future research directions are presented in section 5.

2. Methodology

Multiple attribute decision making (MADM) is an advanced field of operations research, provides a wide range of methodologies for decision makers and analysts. The combined model represented in Fig. 1 integrates WeFA framework, AHP method and the Extended TOPSIS method in MAGDM problems for ranking the best player.

1.1. Weighted Factors Analysis (WeFA)

Weighted Factors Analysis (WeFA) has been proposed by Hessami [32] as a new approach for elicitation, representation, and handling of knowledge about a given problem, generally at a high and strategic level. The competence assessment framework provides an integrated perspective on competence in a given context whilst additionally empowering the duty holders or the organization to benchmark each aspect, measure, assess and where necessary take actions to enhance various elements in the framework. The latter aspects of

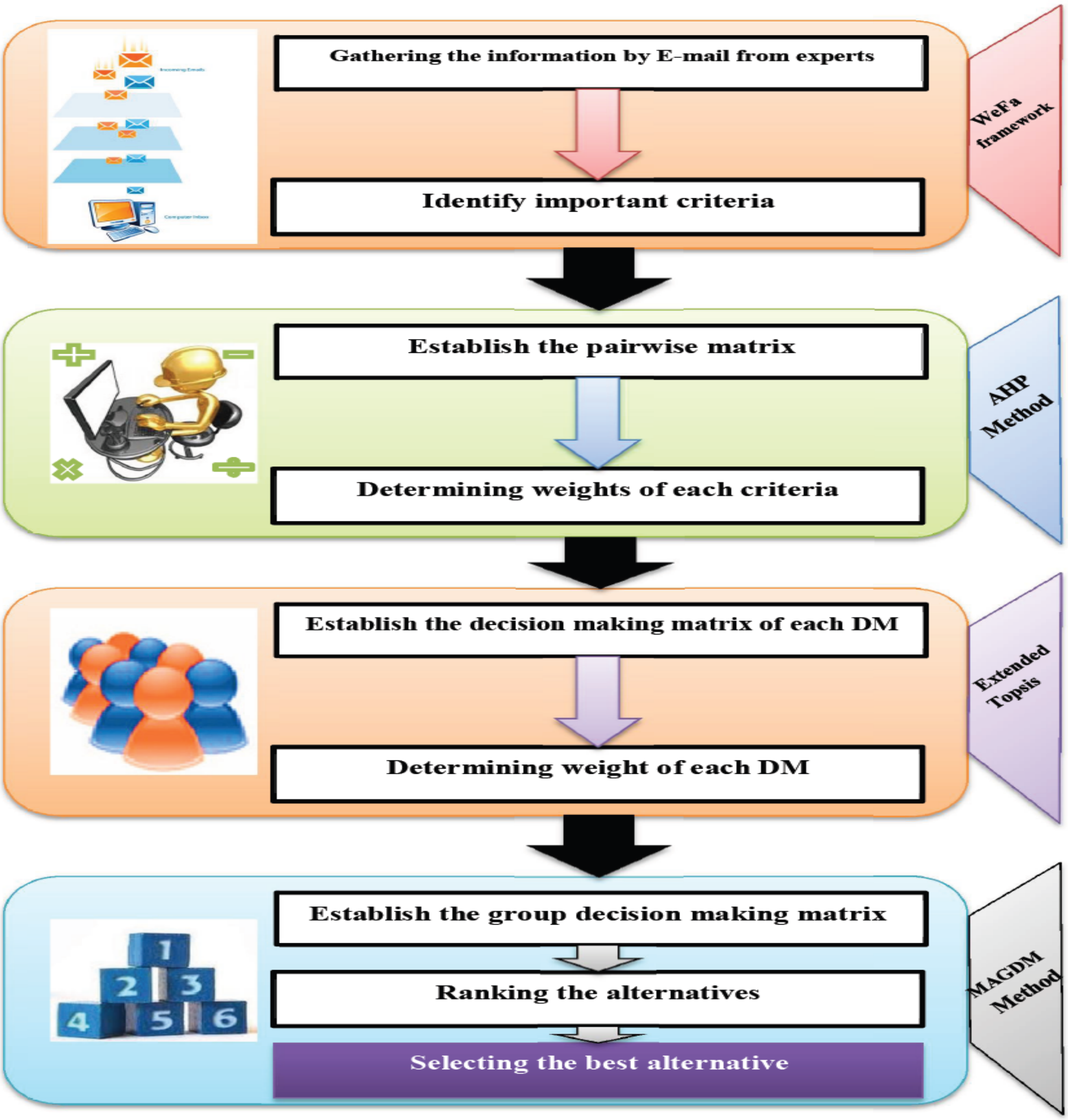

Fig.1. the proposed combined approach

benchmarking, evaluating, assessing and potentially enhancing competence are inherent in the underpinning WeFA methodology [33] and not elaborated here [34].

In this research WeFA framework applied just for gathering information of experts to identify important criteria to use for AHP and Extended Topsis method in MAGDM problems. One advantage of the process is that the assessor can provide guidance and feedback whilst carrying out the staged assessments remotely, thus reducing non-productive travelling time to meet the candidate and review the evidence. This can be a significant benefit particularly when there may be a limited number of assessors available locally [34]. WeFA methodology is based on removing papers for decreasing computational time and guides projects to attain final answers fast. Process of proposed integrated approach in this research is based on this logic of WeFA framework.

2.1. Analytic Hierarchy Process (AHP)

Analytic Hierarchy Process (AHP) has been proposed by Saaty [25] and it is one of the best and most widely used MCDM approaches that have been applied in different areas of research [29,35]. The major characteristic of the AHP method is the use of pair-wise comparisons, which are used both to compare the alternatives with respect to the various criteria and to estimate criteria weights. It has many advantages, as well as disadvantages. One of its advantages is its ease of use. Its use of pairwise comparisons can allow decision makers to weight coefficients and compare alternatives with relative easily. It is scalable, and can easily adjust in size to accommodate decision making problems due to its hierarchical structure [36]. In this research, AHP method is used for determining the Weight of each criterion.

3.1. Extended Technique For Order Preference By Similarity To Ideal Solution (Ex-TOPSIS)

Traditional TOPSIS, known as one of the most MCDM methods, was first proposed by Hwang and Yoon [26]. TOPSIS is an approach to identify an alternative which is closest to the ideal solution and farthest to the negative ideal solution in a multi-dimensional computing space. Recently, it has been widely used in various fields such as supply chain management and logistics, design, engineering and manufacturing systems, business and marketing management, environmental management, human resources management, and water resources management. Also, it has numerous advantages including simple process, ease of use and programmability [36]. The traditional TOPSIS has solved MADM problems with just one DM [26]; whereas the extended TOPSIS technique proposed by Zhongliang [2] has solved a MADM problem with multiple DMs. Since, in MAGDM problems the weight of DMs votes (λ_k) is important. Therefor, in this paper, Zhongliang's Algorithm is applied for weighting to decision makers (DMs). The steps for implementing the Extended Topsis process are illustrated as follows [2]:

Let $i = 1, \dots, m$ be alternatives; $j = 1, \dots, n$ be criteria and $k = 1, \dots, t$ be number of DMs.

Step1: Establish the decision matrix of each DM.

Let us assume a decision matrix of *kth* DM, $X_{k,}$ be defined as:

$$X_k = (x_{ij}^{(k)})_{m\times n} = \begin{pmatrix} x_{11}^k & x_{12}^k & \cdots & x_{1n}^k \\ x_{21}^k & x_{22}^k & \cdots & x_{2n}^k \\ \vdots & \vdots & \cdots & \vdots \\ x_{m1}^k & x_{m2}^k & \cdots & x_{mn}^k \end{pmatrix} \quad (1)$$

Step2: Establish the normalized decision matrix of each DM.

$$R_k = (r_{ij}^{(k)})_{m\times n} = \begin{pmatrix} r_{11}^k & r_{12}^k & \cdots & r_{1n}^k \\ r_{21}^k & r_{22}^k & \cdots & r_{2n}^k \\ \vdots & \vdots & \cdots & \vdots \\ r_{m1}^k & r_{m2}^k & \cdots & r_{mn}^k \end{pmatrix} \quad (2)$$

The normalized value of $x_{ij}^{(k)}$, $r_{ij}^{(k)}$ can be obtained by following equation:

$$r_{ij}^{(k)} = \frac{x_{ij}^{(k)}}{\sqrt{\sum_{i=1}^{m}(x_{ij}^{(k)})^2}} \quad (3)$$

Step3: Construct the weighted normalized decision matrix of each DM as:

$$Y_k = (y_{ij}^{(k)})_{m\times n} = (W_j r_{ij}^{(k)})_{m\times n} = \begin{pmatrix} y_{11}^k & y_{12}^k & \cdots & y_{1n}^k \\ y_{21}^k & y_{22}^k & \cdots & y_{2n}^k \\ \vdots & \vdots & \cdots & \vdots \\ y_{m1}^k & y_{m2}^k & \cdots & y_{mn}^k \end{pmatrix} \quad (4)$$

Remark: W_j is equal to weight of each criterion obtained by section 2.2.

Final Step: this section will present an approach to determining the weighs of DMs (λ_k) as:
Let $Y^* = \frac{1}{t}\sum_{k=1}^{t} Y_k$; $y_{ij}^* = \frac{1}{t}\sum_{k=1}^{t} y_{ij}^{(k)}$.

Sub-step1: Construct the average matrix of group decision as:

$$Y^* = (y_{ij}^*)_{m\times n} = \begin{pmatrix} y_{11}^* & y_{12}^* & \cdots & y_{1n}^* \\ y_{21}^* & y_{22}^* & \cdots & y_{2n}^* \\ \vdots & \vdots & \cdots & \vdots \\ y_{m1}^* & y_{m2}^* & \cdots & y_{mn}^* \end{pmatrix} \quad (5)$$

Sub-step2: Calculate the distance between Y_k and Y^*,S_k^+ as:

$$S_k^+ = \|Y_k - Y^*\| = \left(\sum_{i=1}^{m}\sum_{j=1}^{n}(y_{ij}^{(k)} - y_{ij}^*)^2\right)^{\frac{1}{2}} \quad (6)$$

Remark: Consider that the Euclidean distance is the most widely used tool to measure the distance of two objects in practical applications [2].

Sub-step3: Calculate left and right maximum distance from the average matrix of group decision as:
Let $y_{ij}^{l} = \min_{1\le k\le t}\{y_{ij}^{k} | y_{ij}^{k} \le y_{ij}^{*}\}$; $y_{ij}^{r} = \max_{1\le k\le t}\{y_{ij}^{k} | y_{ij}^{k} \ge y_{ij}^{*}\}$

Left negative ideal solutions:

$$Y_l^{-} = \begin{pmatrix} y_{11}^{l} & y_{12}^{l} & \cdots & y_{1n}^{l} \\ y_{21}^{l} & y_{22}^{l} & \cdots & y_{2n}^{l} \\ \vdots & \vdots & \cdots & \vdots \\ y_{m1}^{l} & y_{m2}^{l} & \cdots & y_{mn}^{l} \end{pmatrix} \tag{7}$$

And

Right negative ideal solutions:

$$Y_r^{-} = \begin{pmatrix} y_{11}^{r} & y_{12}^{r} & \cdots & y_{1n}^{r} \\ y_{21}^{r} & y_{22}^{r} & \cdots & y_{2n}^{r} \\ \vdots & \vdots & \cdots & \vdots \\ y_{m1}^{r} & y_{m2}^{r} & \cdots & y_{mn}^{r} \end{pmatrix} \tag{8}$$

Sub-step4: Calculate the separation between Y_k and $Y_l^{-}(S_k^{l-}), Y_r^{-}(S_k^{r-})$ as:

$$S_k^{l-} = \|Y_k - Y_l^{-}\| = \left(\sum_{i=1}^{m}\sum_{j=1}^{n}(y_{ij}^{(k)} - y_{ij}^{l})^2\right)^{\frac{1}{2}} \tag{9}$$

$$S_k^{r-} = \|Y_k - Y_r^{-}\| = \left(\sum_{i=1}^{m}\sum_{j=1}^{n}(y_{ij}^{(k)} - y_{ij}^{r})^2\right)^{\frac{1}{2}} \tag{10}$$

Sub-step5: Calculate the closeness coefficient of the *kth* DM that is defined as:

$$C_k = \frac{S_k^{l-} + S_k^{r-}}{S_k^{+} + S_k^{l-} + S_k^{r-}} \tag{11}$$

It is clear that $C_k \in [0,1]$, since $S_k^{+} \ge 0$; $S_k^{l-} \ge 0$; $S_k^{r-} \ge 0$.

Final Sub-step: determining the weighs of DMs (λ_k) as**:**

$$\lambda_k = \frac{C_k}{\sum_{k=1}^{t} C_k} \tag{12}$$

Remark: $\lambda_k \ge 0 , \sum_{k=1}^{t} \lambda_k = 1$.

4.1. Representation of MAGDM problem

Multi-attribute group decision making problem (MAGDM) is for selecting best solution by multiple DMs' evaluation from a given set of alternatives that are characterized by multiple attributes or to rank the alternatives. It can be described as follows:

Step1: Establish group decision matrix by using following formula:

$$Y = \sum_{k=1}^{t} \lambda_k Y_k = (y_{ij})_{m\times n} = \begin{pmatrix} y_{11} & y_{12} & \cdots & y_{1n} \\ y_{21} & y_{22} & \cdots & y_{2n} \\ \vdots & \vdots & \cdots & \vdots \\ y_{m1} & y_{m2} & \cdots & y_{mn} \end{pmatrix} \quad (13)$$

Where $y_{ij} = \sum_{k=1}^{t} \lambda_k y_{ij}^{(k)}$

Step2 (Final Step): Ranking the alternatives by sum all the elements in the *ith* row of Y as follows**:**

$$y_i = \sum_{j=1}^{n} y_{ij} \quad \text{For each alternative} \quad (14)$$

Remark: the best alternative has the maximum of y_i .

3. Experts and criteria selection

In this research, was considered the 10 expert and 3 decision makers for performing this research. Due to distance between experts and authors the information sent and received based on email (WeFA framework). Experts of this research include: head coaches, coaches and managers of sport teams. Finally, 6 criteria as best for Comparisons and decision were selected. Best criteria are shown in Table 2.

Table.2. Best criteria

indication	criterion
C_1	Technical and tactical skills
C_2	Experience of professional play
C_3	The average number of goals scored per game (due to the Post)
C_4	Ability to coordinate with the team
C_5	Moral and behavioral features
C_6	Social prestige (popularity)

4. Numerical example (case study)

In the following, a case study is provided to illustrate the proposed approach. Also, the hierarchy structure of best player selection is shown in Fig.2.

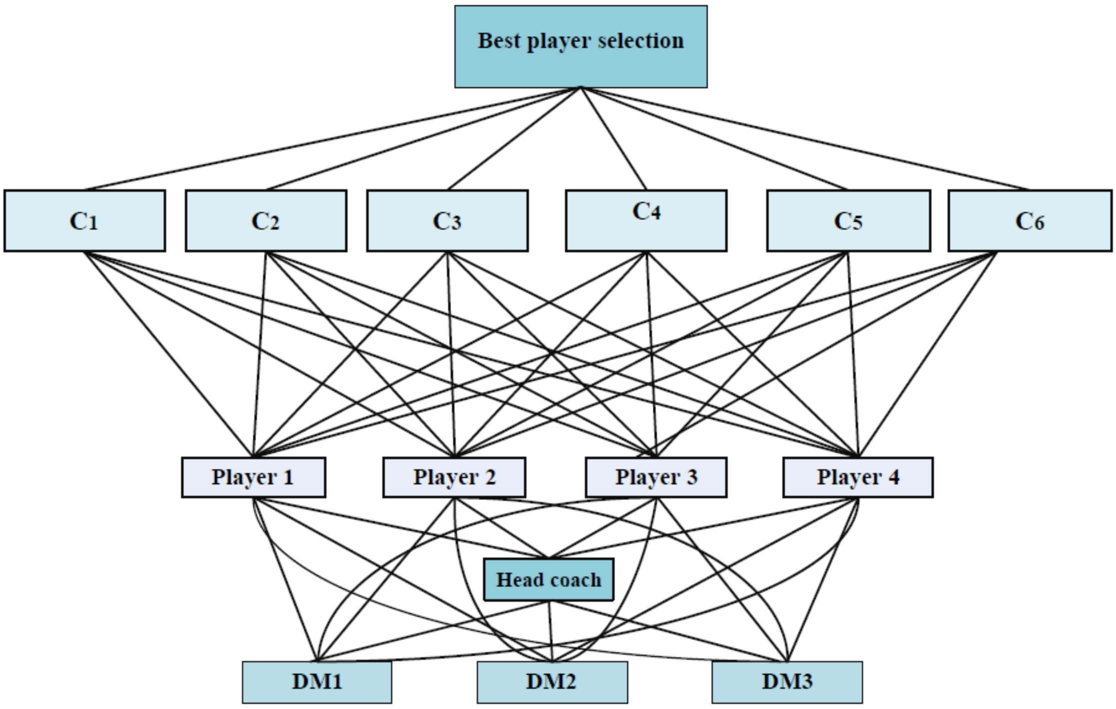

Fig.2.the hierarchy structure of best player selection

Case study: Best player selection based on head coach decision making.
A football club is going to attract the best players based on the head coach decision. As, best player is selected by using technical feedback of experts.to reach this goal, following steps are performed:
First, by WeFA framework information of experts to identify important criteria are gathered. Then, six criteria as best for Comparisons and decision were selected and in Table 2 are shown. In the second step, the weights of criteria are determined by AHP. The pair-wise comparison matrix of the Criteria and weight of each criterion is shown in Table 3. There are four qualified candidates (as alternatives marked by player1, player2… player4) on the list for the selection. Then three DMs (marked by DM_1, DM_2, and DM_3) are responsible for the selection from among them based on criteria. The decision matrixes of each DM are listed in Table 4. Following the proposed steps, each DM constructs a normalized decision matrix. Since all listed attributes are benefit attributes, by Eq. (3), we normalize Table 5 into Table 6 according to Step 2 of section2. Table 6 includes 3 normalized decision matrixes. Then by

using Eq. (4) and the obtained weight, we construct weighted normalized decision matrix that are listed in Table 7.
In the end, establish group decision matrix by Eq. (13) and finally, ranking the alternatives by summing all the elements in the *ith* row of Y by Eq. (14), are shown in table 8. We can see that the second candidate is ranked as best player.

Table.3. Pair-wise comparison matrix and weight of criteria

Main DM	criteria							weight
		C_1	C_2	C_3	C_4	C_5	C_6	
criteria	C_1	**1**	3	4	2	5	5	0.355
	C_2	1/3	**1**	3	1/2	4	6	0.191
	C_3	1/4	1/3	**1**	1/4	3	4	0.107
	C_4	1/2	2	4	**1**	5	2	0.234
	C_5	1/5	1/4	1/3	1/5	**1**	2	0.056
	C_6	1/5	1/6	1/4	1/2	1/2	**1**	0.052
	II=0.11			IR=0.08				✓

Table.4. decision matrixes of each DM

	DM1						DM2						DM3					
	C_1	C_2	C_3	C_4	C_5	C_6	C_1	C_2	C_3	C_4	C_5	C_6	C_1	C_2	C_3	C_4	C_5	C_6
Player1	7	7	5	5	6	5	6	7	5	6	7	5	5	6	7	5	9	7
Player2	9	7	6	6	5	4	7	6	7	5	5	3	7	7	7	5	5	5
Player3	5	6	5	5	7	7	7	7	5	5	7	6	7	5	7	7	6	9
Player4	6	7	3	7	4	5	5	7	4	7	3	5	5	6	5	7	5	5

Table.5. normalized decision matrixes of each DM

	DM1						DM2						DM3					
	C_1	C_2	C_3	C_4	C_5	C_6	C_1	C_2	C_3	C_4	C_5	C_6	C_1	C_2	C_3	C_4	C_5	C_6
Player1	0.5	0.51	0.51	0.43	0.53	0.46	0.47	0.51	0.46	0.51	0.6	0.51	0.41	0.49	0.53	0.41	0.69	0.52
Player2	0.65	0.51	0.61	0.51	0.44	0.37	0.55	0.44	0.65	0.43	0.43	0.3	0.57	0.57	0.53	0.41	0.38	0.37
Player3	0.36	0.44	0.51	0.43	0.62	0.65	0.55	0.51	0.46	0.43	0.6	0.6	0.57	0.41	0.53	0.57	0.46	0.67
Player4	0.43	0.51	0.3	0.6	0.35	0.46	0.39	0.51	0.37	0.6	0.26	0.51	0.41	0.49	0.38	0.57	0.38	0.37

Table.6. weighted normalized decision matrix of each DM

	DM1						DM2						DM3					
	C_1	C_2	C_3	C_4	C_5	C_6	C_1	C_2	C_3	C_4	C_5	C_6	C_1	C_2	C_3	C_4	C_5	C_6
Player1	0.17	0.09	0.05	0.1	0.02	0.02	0.16	0.09	0.04	0.11	0.03	0.02	0.14	0.09	0.05	0.09	0.03	0.02
Player2	0.23	0.09	0.06	0.11	0.02	0.01	0.19	0.08	0.06	0.1	0.02	0.01	0.2	0.1	0.05	0.09	0.02	0.01
Player3	0.12	0.08	0.05	0.1	0.03	0.03	0.19	0.09	0.04	0.1	0.03	0.03	0.2	0.07	0.05	0.13	0.02	0.03
Player4	0.15	0.09	0.03	0.14	0.01	0.02	0.13	0.09	003	0.14	0.01	0.02	0.14	0.09	0.04	0.13	0.02	0.01

Table.7. separations, closeness coefficient and weight of each DM

DMs	S_k^+	S_k^{l-}	S_k^{r-}	C_k	λ_k
DM₁	0.0636	0.05744	0.04358	0.61365	0.2818
DM₂	0.0344	0.08246	0.05744	0.80263	0.3687
DM₃	0.0474	0.09165	0.05916	0.76089	0.3495

Table.8. ranking the alternatives

Alternatives	y_i	Ranking
Player1	0.438	3
Player2	0.478	1 *
Player3	0.465	2
Player4	0.427	4
	Best player: Player 2	

5. Conclusions and Future directions

Selecting a best player for each sport team had been difficult and major problem is existence many criteria in this field. In this research, important criteria based on WeFA framework were introduced. Then, Analytic Hierarchy Process method (AHP) was used for determining the Weight of each criterion. Finally Extended TOPSIS and its application in MAGDM were applied for weighting to decision makers (DMs) and ranking of alternatives. The proposed framework is: (1) structured and systematic with step-by-step procedure; (2) facile and straightforward with a transparent computation process; (3) versatility and pliability with the ability to be applied to ranking other multi-criteria decision problems; and can be useful as a practical and scientific framework for managers and head coaches of clubs in all around the world. For future researches the methodology of the proposed integrated approach can be easily applied to different areas with similar decision problems or applied other integrated approaches of MCDM to ranking the defined problem.

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