SCIENTIFIC OASIS

Journal of Soft Computing and Decision Analytics

Journal homepage: www.jscda-journal.org
ISSN: 3009-3481

A novel multiple criteria ranking approach for determining the Most Valuable Player (MVP) of a sport season: A numerical study from NBA league

Vildan Özkir[1], Ali Değirmenci[1,*]

[1] Department of Industrial Engineering, Faculty of Mechanical Engineering, Yıldız Technical University, Istanbul, Turkey

ARTICLE INFO

Article history:
Received 14 August 2023
Received in revised form 21 September 2023
Accepted 23 September 2023
Available online 1 October 2023

Keywords: Sport management, multiple criteria, uncertainty, decision analytics, ranking, axiomatic design, FUCOM.

ABSTRACT

Team sports have gained a significant place in society, generating debates about team strengths, player merits, and ultimately, determining champions. The National Basketball Association (NBA) offers various individual awards, with the MVP award holding paramount importance. Selecting the MVP necessitates a comprehensive approach considering both statistical performance and team success throughout the season. This study presents a fuzzy decision-making approach to compare the performance of players and identify the MVP of the League. A case study for the 2022-2023 NBA season is presented in this study, wherein 535 players' regular season statistics are analyzed. Correlation analysis is employed to eliminate the criteria which are dependent on each other. Therefore, the number of criteria has been decreased from twenty to seven which are defined as key metrics: (i) matches won, (ii) points scored per game, (iii) shooting percentage, (iv) rebounds per game, (v) assists per game, (vi) steals per game, and (vii) blocks per game. After correlation analysis, Full Consistency Method (FUCOM) is employed to determine the importance weights of the criteria. We have employed a specific normalization procedure and employed information axiomatic design (IAD) to rank players based on their total information contents. The case study proves the feasibility and applicability of the proposed methodology for multiple criteria ranking problem. Future research may focus on position-specific rankings, providing more accurate assessments, and extending analysis to youth leagues for draft day decisions.

1. Introduction

Today, team sports have undeniably carved out a significant place in people's lives. In every major urban center, there exist professional sports teams, and the local community shows remarkable support for these hometown athletes, often regarding them as their heroes or inspirational figures [1]. The competitive spirit inherent in these sports has always fueled heated debates, ranging from which team has the superior strength to the merits of various players. The champion team at the end

* *Corresponding author.*
E-mail address: ali.degirmenci@yildiz.edu.tr

https://doi.org/10.31181/jscda11202323

of the season proves its superiority over the others for the season. The players of the champion team receive various kinds of rewards and incentives at the end of the season. There are also various kinds of awards for individual team members from the same league at the end of the basketball season, and so does the NBA. NBA is one of the best professional leagues in basketball played in America-Canada [2]. The most important NBA award is undoubtedly the MVP, although there are various individual awards in the NBA organization. The consensus on this subject is that the method used to choose the MVP award winner must take into account a comprehensive context that takes into account both statistical performance and the bigger picture of team success throughout the season. Coleman et al. [3] examines the voting of NBA award whether it is fair or not.

Sport scientists may be able to identify critical factors for player analysis and assist coaches in developing data-driven performance indicators for basketball by developing decision analysis models to evaluate the performance of the players [4]. Basketball is a sport that requires a full set of parameters to understand the game in depth and analyze strategies and decisions while minimizing unpredictability. Hence, critical analysis of these metrics is essential for domain experts and decision makers to understand the strengths and weaknesses in the game, to better evaluate competing teams, to see how to optimize performance indicators [5]. Sarlis & Tjorjis [5] examines the background and advanced basketball metrics used in National Basketball Association (NBA) and Euro league games. The authors provide a detailed review of performance analysis methods utilized in the literature in order to assess teams and players. Mertz et al. [4] have presented a statistical model to rank the top NBA players of all-time and employed a linear regression model to create the reliable list of top 150 player in NBA history. However, constructing this type of model is a formidable challenge due to the abundance of individual player statistics and accomplishments that must be taken into account, as well as the influence of changes in the game's dynamics over the years on the analysis of individual player performance.

In sports management, there are several studies with different methods. Chen [1] has built a statistical model to predict who will win 2017 NBA MVP Award and used Data Mining Discriminant analysis to rank players into clusters. Hubáček et al. [6] have proposed a new forecasting system designed to profit from sports-betting market using machine learning. Watanabe et al. [7] have modelled the generation process of sets and their outputs from low-dimensional latent variables using a manifold network model by using visual analytics. Authors have used basket team data from the National Basketball Association. Ballı et al. [8] have used artificial neural networks for choosing the best team player in Basketball. Çetin and Eren [9] have utilized Analytic Hierarchy Process, TOPSIS and ELECTRE methods for choosing guard for a Basketball team. Ciğerci [10] has employed one-way variance analysis for investigating the performance of players in EuroLeague. In order to evaluate the performance of teams, some researchers have employed Data Envelopment Analysis [11,12,13].

In this study, we propose a decision-making approach to compare the performance of players in order to choose MVP of the Basketball League. The main objective of this study is to present multiple criteria ranking approach tailored to the ranking problems with more than one single criterion and subjective judgments of decision makers on the criteria' importance. The paper is structured as follows. In section 2, we introduce the proposed methodology and provide the context for multiple criteria ranking procedure. Section 3 presents the case study for the recent NBA season and summarizes the results of our findings. The consequences of the case study demonstrate how effectively the proposed approach handles challenges with high levels of uncertainty and variability. Finally, we present a comprehensive discussion and provide a conclusion that encapsulates the key insights drawn from our research. Furthermore, we outline and summarize the opportunities for future research in Section 4.

2. Methodology

Researchers have long been drawn to problems involving multiple criteria, because ranking a number of alternatives is a common challenge that frequently arises in real life situations. Many practices such as determining candidates to be interviewed, determining priority projects, and ranking the best performing alternatives are encountered in our daily lives. Although using a system that evaluates numerous factors simultaneously enables a more thorough and multidimensional review, it also has significant drawbacks, such as scaling and aggregation. The literature on multi-criteria decision making emerges to determine the most accurate ranking by evaluating multiple dimensions together.

This study proposes a multiple criteria decision-making approach for ranking alternatives under uncertainty. The uncertainty is incorporated with the determination of importance weights of criteria. The importance weights of the criteria are determined by Fuzzy Full Consistency Method, which is introduced by Pamucar et al. [14]. FUCOM algorithm provides an efficient subjective method in order to determine the importance weights of criteria by decreasing the required number of pairwise judgements to a minimum level. Then, we present a new normalization procedure in order to deal with possible scaling problems. Lastly, we utilize Axiomatic design to obtain the final ranking of alternatives. Axiomatic design is chosen because the aim of axiomatic design is to make decision makers more creative, reduce uncertainty and the experimental errors it brings, and choose the best of the available option [15]. If the probability of the design meeting the system's needs is certain, the information content is 0; if it is impossible, the information content is infinite [16]. The proposed approach is illustrated in Figure 1.

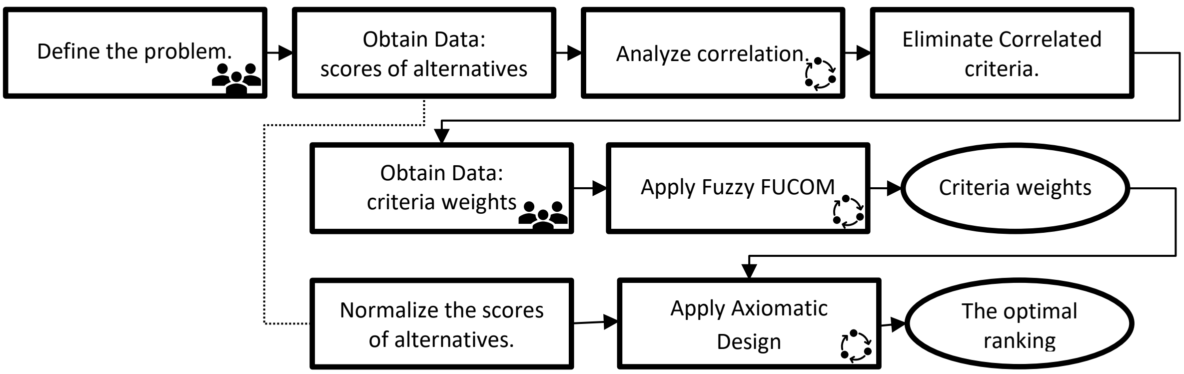

Fig. 1. The proposed multiple criteria ranking approach.

In the following, we explain the steps of the proposed approach for solving multiple criteria ranking problems.

Step 1. The set of evaluation criteria and the set of feasible alternatives are determined in the problem definition step.

Step 2. The scores of alternatives in respect to criteria are collected from the relevant data sources.

Step 3. Correlation analysis is performed to uncover potential interdependencies among criteria. When such interdependence is identified, one of the correlated criteria is removed from the evaluation process.

Step 4. FUCOM Algorithm

Step 4.1 This stage uses the FUCOM data collection approach. Starting with the criterion that is anticipated to have the highest weight coefficient and moving down to the criterion with the least importance, the criteria are rated according to their significance.

Step 4.2 The ranked criteria are compared by using a numerical scale. The comparative (significance) priority of a criterion, say $\tilde{\varphi}_{k/(k+1)}$, is defined as an advantage of the criterion of the $C_{j(k)}$ rank compared to the criterion of the $C_{j(k+1)}$ rank.

Step 4.3 The final importance weights of criteria $(\tilde{w}_1, \tilde{w}_2, \dots, \tilde{w}_n)^T$ are calculated by using the mathematical model to achieve minimum inconsistency. We refer Pamucar et al. [14] and Ilieva [17] for the application procedures of FUCOM and Fuzzy FUCOM, respectively.

Step 5. For calculating the normalized scores of alternatives, we have employed a different normalization procedure. In order to compare alternatives, scores are normalized to be between 0 and 1. Separately for each criterion, we have determined the minimum, average and maximum scores of alternatives. The minimum value is set to 0, the average value of the scores is set to 0.5 and the maximum value is set to 1. Therefore, we have obtained better diversified normalized values within (0,1) range. Therefore, if the score of an alternative is below the average value, we normalized it within the range (0.0, 0.5), and if the score of an alternative is above the average value, then we normalized it within the range (0.5, 1.0) by simply defining a piecewise linear function. Let x_{ij} be the performance score of alternatives i in respect to criterion j and $\overline{x_j}$ be the average of scores for the criterion j $\left(\overline{x_j} = \frac{\sum_{i=1}^{n} x_{ij}}{n}\right)$, then the normalized score y_{ij} is calculates as given in Equation 1.

$$y_{ij} = \begin{cases} 0.5 \times \dfrac{x_{ij} - \min\limits_i(x_{ij})}{\overline{x_j} - x_{ij}}, & if\ x_{ij} \le \overline{x_j} \\ 0.5 + 0.5 \times \dfrac{x_{ij} - \overline{x_j}}{\max\limits_i(x_{ij}) - \overline{x_j}}, & otherwise \end{cases} \quad (1)$$

Step 6. After the normalized scores are calculated and the importance of weights of criteria are obtained, an information axiomatic design approach has been employed for multiple criteria ranking problems. The existence of the design axioms (independence axioms and information axioms) is the most crucial point in axiomatic design. The independence axiom states that the independence of functional requirements must always be maintained, where information axiom states that the design with the smallest information content is the best design among the designs satisfying the independence axiom [18]. For a detailed literature review, we refer Kulak et al. [19] and we refer Fan et al. [20] for future notes and guidelines for applications.

Step 6.1 In order to apply the Axiomatic Design, the normalized scores y_{ij} are assumed to be equal to the success probability of each alternative, say p_{ij}, in respect to criterion j and these probability values are employed in the axiomatic design approach.

Step 6.2 The information content (I_{ij}) for each entry in the decision matrix is calculated by using probabilities as given in Equation 2 [18].

$$I_{ij} = \log_2(1/p_{ij}) \quad (2)$$

Step 6.3 The total information content of each alternative is then calculated by using criteria weights, as shown in Equation 3.

$$I_i = \sum_{j} (I_{ij} \times w_j) \quad (3)$$

Step 7. The alternatives are ranked from the least total information content to the highest information content. The alternative with the lowest total information content is said to be the best option in the multiple criteria ranking problem.

3. Case Study and Results

3.1 Problem Definition and Data

In this study, the regular season statistics of 535 players were taken from the NBA official page to determine the MVP of the 2022-2023 NBA regular season. These statistics are: number of games played by the player, number of matches won, minutes played per match, points scored per match, number of shots on target per match, number of shots attempted per match, shooting percentage, number of three points made per match, number of three points attempted per game, three-point percentage, number of free throws made per game, number of free throws attempted per game, free throw percentage, offensive rebounds taken per game, defensive rebounds taken per game, rebounds taken per game, assists made per game, turnover made per game, steals per game, blocks per game.

Since the number of criteria is high and there is a possibility of repetition, the correlation coefficient of all criteria was calculated with each other. Number of games played by the player, minutes played per match, number of shots on target per match, number of shots attempted per match, number of free throws made per game, number of free throws attempted per game, turnover made per game, number of three points attempted per game, offensive rebounds taken per game, defensive rebounds taken per game were removed because of having 0.75 or above correlation coefficient with a candidate criterion as shown in Table 1. In addition, the number of three points made per match (3PM), three-point percentage (3P%) and free throw percentage (FT%) were removed because they are not effective enough in ranking players. At the end, we have 7 criteria to rank the players that are number of matches won (W), points scored per match (P), shooting percentage (FG%), rebounds taken per game (R), assists made per game (A), steals per game (S), blocks per game(B).

To use information axiomatic design to compare players, information contents must be calculated. As mentioned in the methodology, normalized numbers are assumed as probabilities which are needed to calculate the information contents. After the information contents are obtained for each criterion and player, the information contents are summed up by multiplying with criteria weights and total information contents for each player are calculated. Finally, MVP is the player who has the least information content. Ranking is also determined by arraying players from the least information content to the highest information content.

Journal of Soft Computing and Decision Analytics
Volume 1, Issue 1 (2023) 265-272

Table 1.
Correlation Coefficient of Criteria

	GP	W	MIN	PTS	FGM	FGA	FG%	3PM	3PA	3P%	FTM	FTA	FT%	OREB	DREB	REB	AST	TOV	STL	BLK
GP		0.89	0.65	0.51	0.51	0.51	0.23	0.41	0.41	0.17	0.39	0.39	0.37	0.33	0.51	0.49	0.34	0.40	0.41	0.31
W			0.59	0.48	0.48	0.46	0.22	0.40	0.39	0.17	0.37	0.36	0.33	0.27	0.48	0.45	0.34	0.36	0.38	0.29
MIN				0.87	0.88	0.88	0.19	0.68	0.70	0.21	0.71	0.71	0.35	0.39	0.75	0.69	0.73	0.79	0.72	0.38
PTS					0.99	0.98	0.20	0.70	0.72	0.22	0.90	0.89	0.33	0.30	0.71	0.64	0.72	0.85	0.58	0.33
FGM						0.98	0.25	0.66	0.67	0.19	0.86	0.86	0.30	0.36	0.75	0.68	0.71	0.85	0.58	0.36
FGA							0.10	0.75	0.78	0.22	0.84	0.83	0.33	0.24	0.67	0.58	0.74	0.85	0.60	0.27
FG%								-0.11	-0.18	0.04	0.17	0.21	0.05	0.48	0.35	0.42	0.03	0.15	0.05	0.37
3PM									0.98	0.43	0.47	0.42	0.35	-0.13	0.31	0.19	0.53	0.53	0.46	-0.03
3PA										0.37	0.50	0.45	0.36	-0.14	0.33	0.20	0.55	0.56	0.47	-0.03
3P%											0.12	0.07	0.25	-0.23	0.02	-0.06	0.18	0.14	0.17	-0.12
FTM												0.99	0.31	0.28	0.63	0.57	0.65	0.79	0.48	0.31
FTA													0.25	0.36	0.67	0.62	0.63	0.79	0.47	0.36
FT%														-0.02	0.18	0.13	0.25	0.24	0.21	0.06
OREB															0.68	0.83	0.09	0.29	0.20	0.64
DREB																0.97	0.50	0.68	0.46	0.59
REB																	0.41	0.61	0.41	0.65
AST																		0.83	0.65	0.09
TOV																			0.57	0.28
STL																				0.20
BLK																				

3.2 Results

Firstly, weights of chosen criteria are calculated by using FUCOM Algorithm as mentioned in Step 4 in the methodology. The obtained weights from FUCOM Algorithm are written in Table 2.

Table 2.
The importance weights of the criteria

P	A	R	W	FG%	B	S
0.1751	0.1402	0.1358	0.0989	0.0898	0.0898	0.0883

Then, the total information contents for each player are calculated by using the weights and the information contents. According to total information contents, TOP 50 players are obtained as shown in Table 3***.*** Joel Embiid is chosen MVP according to the list. Nikola Jokic, Giannis Antetokounmpo, Luka Doncic and Jason Tatum are the following players in top 5 of the list.

If the information contents were collected without including weights, Nikola Jokic would be first, and Joel Embiid would be second. For this reason, we can say that the two players are ahead of the others, but they are close to each other, in this list and in fact, Joel Embiid's win is better in the criteria with high weights.

Table 3.
Top 50 players

Rank	Player	Total Information Content	Rank	Player	Total Information Content
1	Joel Embiid	0.3373	**26**	Paul George	0.5947
2	Nikola Jokic	0.3558	**27**	De'Aaron Fox	0.5961
3	Giannis Antetokounmpo	0.3601	**28**	Evan Mobley	0.5984
4	Luka Doncic	0.4047	**29**	Jimmy Butler	0.6012
5	Jayson Tatum	0.4234	**30**	Devin Booker	0.6047
6	Anthony Davis	0.4428	**31**	Zion Williamson	0.6061
7	Shai Gilgeous-Alexander	0.4606	**32**	Lauri Markkanen	0.6138
8	Kevin Durant	0.46545	**33**	Tyrese Haliburton	0.6195
9	LeBron James	0.4863	**34**	Nikola Vucevic	0.6228
10	Domantas Sabonis	0.4924	**35**	Nic Claxton	0.6263
11	Donovan Mitchell	0.5290	**36**	Desmond Bane	0.6450
12	Stephen Curry	0.5298	**37**	Brandon Ingram	0.6466
13	Jaylen Brown	0.5309	**38**	Dejounte Murray	0.6566
14	Kyrie Irving	0.5437	**39**	Bradley Beal	0.6589
15	Anthony Edwards	0.5499	**40**	CJ McCollum	0.6591
16	Ja Morant	0.5559	**41**	Fred VanVleet	0.6609
17	Pascal Siakam	0.5569	**42**	Mikal Bridges	0.6615
18	James Harden	0.5593	**43**	Aaron Gordon	0.6629
19	Bam Adebayo	0.5668	**44**	Jarrett Allen	0.6672
20	Damian Lillard	0.5679	**45**	Deandre Ayton	0.6726
21	Julius Randle	0.5827	**46**	Josh Giddey	0.6755
22	Kawhi Leonard	0.5831	**47**	Kyle Kuzma	0.6840
23	Kristaps Porzingis	0.5833	**48**	Jaren Jackson Jr.	0.6859
24	DeMar DeRozan	0.5865	**49**	Scottie Barnes	0.6922
25	Jrue Holiday	0.5947	**50**	Paolo Banchero	0.6949

In this case study, Joel Embiid is identified as the MVP for the 2022-2023 NBA season, consistent with real-life results. While the list includes some surprises, it generally aligns with expectations.

4. Conclusions

In this study, NBA players were scored and ranked for the 2022-2023 regular season using 7 different statistics. The player who came first in this ranking was Joel Embiid. Also, in real life, Joel Embiid won the MVP award and Nikola Jokic is one of the candidate players. Therefore, we can say that the ranking is consistent. According to my general NBA knowledge, there are some surprising ranks in the list but generally the list looks logical.

For future studies, players may not be evaluated as a single list but rather divided into positions and evaluated according to the importance weights of their positions. In this way, more precise results can be obtained and the best player in each position can be selected rather than determining a single MVP. Additionally, when data from youth leagues is accessed rather than well-known players, scouting studies can be carried out for the choices teams will make on draft day.

Acknowledgement
This research was not funded by any grant.

Conflicts of Interest

The authors declare no conflicts of interest.

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