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Based on TOPSIS CBA basketball team strength statistical analysis

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ABSTRACT

The shooting averages, 3-point field goal percentage, free throw percentage, averaging offensive rebounds, averaging defensive rebounds, averaging assists, averaging turnovers, averaging steals, averaging blocks, averaging foul and averaging scoring, all 11 indexes of all the 17 CBA teams in 2011-2012 season are comprehensively evaluated based on TOPSIS method and the comprehensive strength of the 17 teams are ranked. The research results are consistent with the actual situation, reflecting the ranking of each team's strength authentically. It demonstrates that the research of basketball teams' comprehensive strength based on TOPSIS method has high reliability and significance.

KEYWORDS

TOPSIS method;
Comprehensive strength;
Comprehensive evaluation;
Statistical analysis.

INTRODUCTION

After nearly 20 years of development, Chinese Basketball Association league (CBA) has become China's best and most normative professional league from the perspective of scale, management, operation and the degree of concern, and is the top level basketball league in Asia too. Currently the CBA consists of 17 teams, which is the highest scale in history. With the implementation of a series of policies, the strength of the teams in the league are becoming increasing average, an evolution from two teams' (Bayi and Guangdong) control of the game to the contending of all the teams now. As a group sport, the team's technical statistics reflect the team's offensive and defensive capabilities (the team's strength), which is closely linked to the team's record. Comprehensive analysis of the strength of the CBA teams has a realistically practical significance when basketball has become an industry nowadays. In previous studies, scholars have conducted the research of teams' strength on a lot of methods, such as the cluster analysis, rank and ratio analysis and multiple linear regression analysis. In this study, conduct comprehensive evaluation of the 17 CBA teams' strength in the 2011-2012 seasons in TOPSIS method and then reveal the comprehensive strength of the teams in the men's professional basketball league in China, providing a basis for the training of coaches and players.

BRIEF INTRODUCTION OF TOPSIS METHOD

TOPSIS (technique for order preference by similarity to ideal solution), is an optimum technique of arranging according to the similarity of ideal solutions, also known as good-bad resolution distance method, com-

monly used in multi-objective decision analysis.

Basic idea of TOPSIS method

The basic idea is the normalization process of the raw data matrix. The positive ideal solution (the optimal scheme, each property value of the scheme is the best compared with other schemes) and the negative ideal solution (the worst scheme, each property value of the scheme is the worst compared with other schemes) forms a special space and the scheme to be evaluated can be regarded as one point in the space. Then calculate the distance D_i^+ from the point to the positive solution and the distance D_i^- from the point to the negative solution, as expressed as Euclidean distance. Via these two distances D_i^+ and D_i^-, the degree of relative closeness C_i of this scheme to the positive solution can be calculated. Judge and evaluate the scheme according to the value of C_i.

Basic steps of TOPSIS method

Collect original data: Supposing that the number of objects to be evaluated is n and the number of evaluation index to be used is m, then these data forms an n×m matrix, shown in TABLE 1.

TABLE 1 : The original data matrix

Evaluation object	Index1	Index2	…	Index m
Object1	x_{11}	x_{12}	…	x_{1m}
Object2	x_{21}	x_{22}	…	x_{2m}
…	…	…	…	…
Object n	x_{n1}	x_{n2}	…	x_{nm}

The same tendency processing of all the indexes: Among all the comprehensive evaluation indexes, some indexes, indicting a better result with a higher index value, are called high optimal indexes, such as exam results; other indexes, indicating a better result with a lower index value, are called low optimal indexes, such as disease mortality. All of the evaluation indexes should change in the same direction, meaning the same tendency in comprehensive evaluation. In other words, the evaluation indexes should all either be high optimal indexes or low optimal indexes. Therefore, there is a need to conduct conversion of indexes. Conversion of all indexes to high optimal indexes is most frequently used in research and the conversion methods commonly used include the reciprocal method and the difference method. For example, to convert the low optimal indexes $x_{ij}(i=1,2;\cdots,n;\ j=1,2;\cdots,m)$ from the original data all to high optimal indexes $x_{ij}^{'}$ in reciprocal method, the formula of conversion can be expressed as:

$$x_{ij}^{'} = \frac{1}{x_{ij}} \quad (1)$$

By means of conversion in reciprocal method, all of the low optimal indexes are converted to high optimal indexes and the change direction of all the evaluation indexes is the same.

Standardize the original data matrix after the same tendency processing and establish a standardized matrix Z.

When the original data are high optimal indexes, the standardization formula is:

$$Z_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{n} x_{ij}^2}} \quad (2)$$

When the original data are low optimal indexes, the standardization formula is:

$$Z_{ij} = \frac{x_{ij}^{'}}{\sqrt{\sum_{i=1}^{n} (x_{ij}^{'})^2}} \quad (3)$$

The standardized matrix Z can be expressed as:

$$Z = \begin{bmatrix} z_{11} & z_{12} & \cdots & z_{1m} \\ z_{21} & z_{22} & \cdots & z_{2m} \\ \vdots & \vdots & \vdots & \vdots \\ z_{n1} & z_{n2} & \cdots & z_{nm} \end{bmatrix} \quad (4)$$

Find the positive ideal solution (optimal vector) and the negative ideal solution (the worst vector) according to the standardized matrix Z

Positive ideal solution $Z^+ = (z_{i1}^+, z_{i2}^+, \cdots, z_{im}^+)$ (5)

Negative ideal solution $Z^- = (z_{i1}^-, z_{i2}^-, \cdots, z_{im}^-)$ (6)

In formula (5) and (6), i=1,2,…n; j=1,2,…m. z_{ij}^+ means the maximum value of the evaluation object in index j, z_{ij}^- means the minimum value of the evaluation object in index j.

Calculate the distance from each index value to the positive solution D_i^+ and the distance from each index value to the negative solution D_i^-

FULL PAPER

$$D_i^+ = \sqrt{\sum_{j=1}^{m}[\omega_j(z_{ij} - z_j^+)]^2} \quad (7)$$

$$D_i^- = \sqrt{\sum_{j=1}^{m}[\omega_j(z_{ij} - z_j^-)]^2} \quad (8)$$

In formula (7) and (8), ω_j stands for the weight coefficient of evaluation index j. if the weight of each index is the same with one another, then ω_j=1.

Calculate the degree value of relative closeness for each evaluation object' evaluation index to the positive ideal solution and the negative ideal solution, C_i

$$C_i = \frac{D_i^-}{D_i^+ + D_i^-} \quad (9)$$

Sort and sequence all the evaluation objects according to the degree value of relative closeness. Judging from formula (9), the value of C_i ranges from [0, 1]. A higher value of C_i indicates that the evaluation object is closer to the positive ideal solution; a lower value of C_i indicates that the evaluation object is closer to the negative ideal solution and farer away from the positive ideal solution.

EVALUATION OF ALL CBA TEAMS' STRENGTH IN 2011-2012 SEASON BASED ON TOPSIS METHOD

To conduct an effective evaluation of each team's overall strength, this study integrates the evaluation indexes used in relative research after consulting basketball experts and chooses the following 11 stroke analysis indexes as the evaluation indexes: shooting averages, 3-point field goal percentage, free throw percentage, averaging offensive rebounds, averaging defensive rebounds, averaging assists, averaging turnovers, averaging steals, averaging blocks, averaging foul and averaging scoring.

Collect original data

All of CBA teams' data in 2011-2012 seasons is obtained from the data center (DC) in the CBA official website.

The same tendency processing of the indexes

Among the above indexes, averaging turnovers (x7)

TABLE 2 : Index data for stroke analysis of all CBA teams

Team	shooting averages (x_1)	3-point field goal percentage (x_2)	free throw percentage (x_3)	averaging offensive rebounds (x_4)	averaging defensive rebounds (x_5)	averaging assists (x_6)	averaging turnovers (x_7)	averaging steals (x_8)	averaging blocks (x_9)	averaging foul (x_{10})	averaging scoring (x_{11})
Beijing	0.461	0.341	0.753	13	29.6	15	11.7	10.2	3.3	25.7	106.1
Guang dong	0.487	0.362	0.716	15.3	29.9	16	16.2	10.4	3.4	25.6	109.5
Zhejiang	0.46	0.317	0.736	14.3	34.5	14.8	17	8.1	2.7	20.3	99.4
Chou zhou	0.468	0.337	0.645	15.6	30.3	13.6	16.3	10.8	2.9	24.2	100.2
Shang hai	0.434	0.323	0.738	15.7	32.4	12.4	14.4	8.5	3.9	23.3	91.9
Xin jiang	0.472	0.362	0.738	13.5	29.2	15.4	15.6	8.8	2.9	23.9	99.5
Dong guan	0.459	0.355	0.75	13.6	26.7	14.3	13.7	8.6	3.2	23.9	103.5
Liaoning	0.458	0.318	0.742	16.4	29.6	17.3	14.6	7.9	5	23.5	102.4
Fujian	0.468	0.346	0.689	14.1	31.5	15.3	15.7	7.9	2.2	24.1	103.3
Shanxi	0.514	0.364	0.739	13.3	29.9	14.5	14.3	10	3.5	26.3	110.4
Jilin	0.464	0.321	0.699	13.4	28.1	15.2	16.6	10.4	2.7	22.7	97.7
Qingdao	0.457	0.33	0.71	13.7	27.2	16.4	15	9.4	2.2	23.8	101.4
Shan dong	0.453	0.331	0.725	14.3	29.7	13.8	16.4	10.7	2.2	24.2	96
Bayi	0.453	0.357	0.694	9.8	26.8	13.8	17.4	10.2	4.2	25.4	96.4
Tian jin	0.463	0.336	0.734	14.3	30.9	14	17	7.8	3	24.4	99.9
Fo shan	0.493	0.362	0.734	12.1	29.1	13.7	16.7	6.9	3.4	23	100.8
Jiangsu	0.437	0.329	0.702	13.6	28.4	14.7	16.4	11.3	3.5	22.3	98.5

and averaging foul (x10) are the only two low optimal indexes and are converted to high optimal indexes in reciprocal method.

$$x_7' = \frac{1}{x_7} \qquad x_{10}' = \frac{1}{x_{10}}$$

After the same tendency processing, the matrix of averaging turnovers and averaging foul are respectively:

$x_7' = (0.085\ 0.062\ 0.059\ 0.061\ 0.069\ 0.064\ 0.073\ 0.068\ 0.064\ 0.070\ 0.060\ 0.067\ 0.061\ 0.057\ 0.059\ 0.060\ 0.061)^{-1}$

$x_{10}' = (0.039\ 0.039\ 0.049\ 0.041\ 0.043\ 0.042\ 0.042\ 0.043\ 0.041\ 0.038\ 0.044\ 0.042\ 0.041\ 0.039\ 0.041\ 0.043\ 0.045)^{-1}$

Standardize the original data matrix after the same tendency processing and establish a standardized matrix Z

Standardize each team's data after the same tendency processing and the standardized matrix is shown in TABLE 3.

Find the positive ideal solution and the negative ideal solution according to the standardized matrix Z

According to formula (5) and (6), the positive ideal solution and the negative ideal solution are respectively as follows:

$$Z^+ = (0.268, 0.259, 0.253, 0.285, 0.282, 0.284, 0.318, 0.292, 0.371, 0.284, 0.265)$$

$$Z^- = (0.226, 0.225, 0.217, 0.170, 0.218, 0.204, 0.214, 0.179, 0.163, 0.219, 0.220)$$

Calculate the distance from each index value to the positive solution D_i^+ and the distance from each index value to the negative solution D_i^-, then determine the degree value of relative closeness C_i and sequence

As each evaluation index has basically the same impact on the team's comprehensive strength, the weight of all indexes can be regarded as the same, ω_j=1. According to formula (7) and (8), calculate the distance from each index value to the positive solution D_i^+ and the distance from each index value to the negative solution D_i^-. Then determine the degree value of relative closeness C_i based on formula (9).

TABLE 3 : Standardized stroke analysis index value of CBA teams

Team	shooting averages (x_1)	3-point field goal percentage (x_2)	free throw percentage (x_3)	averaging offensive rebounds (x_4)	averaging defensive rebounds (x_5)	averaging assists (x_6)	averaging turnovers (x_7)	averaging steals (x_8)	averaging blocks (x_9)	averaging foul (x_{10})	averaging scoring (x_{11})
Beijing	0.240	0.243	0.253	0.226	0.242	0.246	0.318	0.264	0.245	0.224	0.255
Guang dong	0.254	0.257	0.241	0.266	0.244	0.263	0.230	0.269	0.252	0.225	0.263
Zhejiang	0.240	0.225	0.248	0.248	0.282	0.243	0.219	0.210	0.200	0.284	0.238
Chouzhou bank	0.244	0.240	0.217	0.271	0.247	0.223	0.228	0.279	0.215	0.238	0.240
Shanghai	0.226	0.230	0.248	0.273	0.265	0.204	0.259	0.220	0.289	0.248	0.220
Xinjiang	0.246	0.257	0.248	0.235	0.238	0.253	0.239	0.228	0.215	0.241	0.239
Dong guan	0.239	0.252	0.252	0.236	0.218	0.235	0.272	0.222	0.238	0.241	0.248
Liaoning	0.239	0.226	0.250	0.285	0.242	0.284	0.255	0.204	0.371	0.246	0.246
Fujian	0.244	0.246	0.232	0.245	0.257	0.251	0.237	0.204	0.163	0.239	0.248
Shanxi	0.268	0.259	0.249	0.231	0.244	0.238	0.260	0.259	0.260	0.219	0.265
Jilin	0.242	0.228	0.235	0.233	0.229	0.250	0.224	0.269	0.200	0.254	0.234
Qingdao	0.238	0.235	0.239	0.238	0.222	0.269	0.248	0.243	0.163	0.242	0.243
Shan dong	0.236	0.235	0.244	0.248	0.243	0.227	0.227	0.277	0.163	0.238	0.230
Bayi	0.236	0.254	0.234	0.170	0.219	0.227	0.214	0.264	0.312	0.227	0.231
Tianjin	0.241	0.239	0.247	0.248	0.252	0.230	0.219	0.202	0.223	0.236	0.240
Foshan	0.257	0.257	0.247	0.210	0.238	0.225	0.223	0.179	0.252	0.251	0.242
Jiangsu	0.228	0.234	0.236	0.236	0.232	0.242	0.227	0.292	0.260	0.259	0.236

As can be seen from TABLE 4, after comprehensive strength analysis of CBA teams in 2011-2012 seasons in TOPSIS method, the teams' comprehensive strength order is slightly different from the actual ranking. The reason may be that the weights of all indexes are regarded as the same when calculating the distance from each index value to the positive solution D_i^+ and the distance from each index value to the negative solu-

FULL PAPER

tion D_i^-. As a matter of fact, the weight of the evaluation indexes may be not exactly the same and certain indexes chosen as evaluation indexes may not greatly relate to the team's comprehensive strength.

TABLE 4 : The degree of closeness for each CBA team to the positive ideal solution and the sequencing

Team	D_i^+	D_i^-	C_i	order	Actual ranking
Beijing	0.168	0.185	0.524	2	1
Guangdong	0.131	0.261	0.666	1	2
Zhejiang	0.169	0.184	0.521	3	3
Chouzhou bank	0.177	0.175	0.497	6	4
Shanghai	0.166	0.171	0.507	5	5
Xinjiang	0.167	0.182	0.521	3	6
Dongguan	0.206	0.161	0.439	8	7
Liaoning	0.204	0.177	0.465	7	8
Fujian	0.208	0.126	0.377	11	9
Shanxi	0.221	0.134	0.377	11	10
Jilin	0.192	0.140	0.422	9	11
Qingdao	0.227	0.141	0.383	10	12
Shandong	0.221	0.122	0.356	13	13
Bayi	0.251	0.136	0.351	14	14
Tianjin	0.222	0.118	0.347	15	15
Foshan	0.254	0.113	0.308	17	16
Jiangsu	0.246	0.127	0.340	16	17

CONCLUSIONS

TOPSIS is a commonly used scientific method during multi-objective decision analysis. There is no special requirement for data distribution patterns and sample content. Besides, TOPSIS method can make full use of all the information of the original data and the evaluation results are intuitive. This study conducts the comprehensive strength analysis of CBA teams in 2011-2012 seasons based on TOPSIS method and obtains a ranking list according to the teams' comprehensive strength. The research result is fundamentally in accordance with the actual situation and TOPSIS can be a useful way for comprehensive strength evaluation of CBA teams. In further research, simplifying of the evaluation indexes and determining the weight of evaluation indexes based on correlation studies is needed to get a more reasonable evaluation result.

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