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CBA team comprehensive technical indicator and scoring relational degree research based on SPSS factor analysis

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ABSTRACT

Whether one team wins or not can reference team comprehensive quality, including team competition state playing and comprehensive strength. The stronger comprehensive strength is the bigger winning possibility team would have. Similarly, in competition, one team state is better, playing better, it would easier to win the game. Through grey relational degree method, research 2012-2013 seasons CBA17 teams' front-court rebound, block shot, 3-point, shoot, foul, steal, rebound, assist, fault, total rebounds, free throw 11 technical indicators, implement correlation analysis of 11 factors, eliminate factors that has no big correlation with other each factor, utilize SPSS carrying out factor analysis of remnant influence factors, get internal dependence relationship. Use factor scores that got through calculation to calculate comprehensive scores, the higher score is, the bigger winning possibility in competition would be, it provides references for scientific designing reasonable training.

Key words: Grey relational degree, entropy method, factor analysis, CBA competition

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INTRODUCTION

Height is chief condition to improve basketball level. Physical ability is basketball basis. But basketball competition victory or failure decisive factors should include physical ability, technique, tactics, psychology, on site accommodate alteration ability and other aspects, its special quality structural model should include shape, function, psychology three aspects, from the perspective of court different roles' task, it has more concrete quality content and requests [1-3]. Shape can also be divided into figure and physique, higher height surely is more conform to basketball basic requests, while all fours are slender as well as hands and legs are larger, it mainly has more advantages in ball-control, intercepting as well as backboard recovery and other aspects [4, 5]. Physiological function parts, except possessing comprehensive basic movement ability, it need more specially highlight explosive power, coordination, instant direction changing ability, accuracy as well as time, space sense cultivation, because these special movement quality plays an important role in basketball court grabbing, passing, backboard recovering, dribble cutting in as well as accurate throwing and other activities; while in psychology aspect, because basketball is a kind of team movement, except fiercely attacking desire, destructive power, it needs more mutual cooperation, sacrifice and create opportunities for comrades. In addition, in fierce, tense competition, it should make calm judgment, stand up to outside pressure. Also due to basketball limbs has strong crashing, it should also possess high forbearance [6].

Extract CBA 17 teams in 2012-2013 seasons, through analyzing basketball competition spot technical data to determine each technical indicator and team scoring correlations, it provides references for scientific designing reasonable teaching and training plans as well as ways.

2012-2013 SEASONS' CBA TEAM TECHNIQUES INFLUENCE FACTORS MODEL ESTABLISHMENT

For 2012-2013 seasons CBA 17 teams techniques influence factors, draw out broken line chart, find out each indicator and competition performance correlations, as Figure 1 shows.

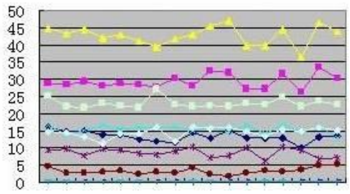

Figure 1: CBA teams each technical level broken line chart

Grey relational degree analysis technical indicators analysis

Grey relational degree analysis method actually is to make comparison on sequence curve geometrical shape approximate degree. The more similar curve is, the bigger sequence relational degree would be. If two sequences coincide together at each time, relational degree is 1 and vice versa [7].

Grey relational degree analysis method basic thoughts:

Given it has n pieces of parameters sequence: $X_0(t)=\{X_0(1),X_0(2),X_0(3),\dots,X_0(t)\},t=1,2,\dots,m$, comparison sequence: $X_i(t)=\{X_i(1),X_i(2),X_i(3),\dots,X_i(t)\},t=1,2,\dots,m$

Calculate two sequences correlation coefficients at the time $t=k$ that is formula (1):

$$\gamma(x_0(k),x_i(k))=\frac{\min_i\min_k|x_0(x)-x_i(k)|+\xi\max_i\max_k|x_0(k)-x_i(k)|}{|x_0(k)-x_i(k)|+\xi\max_i\max_k|x_0(k)-x_i(k)|} \tag{1}$$

Among them, $\xi\in(0,1),$ becomes resolution coefficient, normally value 0.1~0.5, its significance is to weaken maximum absolute difference value $\min_i\min_k|x_0(k)-x_i(k)|$ and $\max_i\max_k|x_0(k)-x_i(k)|$ excessive large generated distortion, improve correlation coefficients difference significances.

Correlation coefficient reflects reference sequence and comparison sequence closeness degree at one moment. If at the time $\min_i\min_k|x_0(k)-x_i(k)|$, $\gamma=1$; if at the time $\max_i\max_k|x_0(k)-x_i(k)|$, γ is mini mum. Due to two sequences may not completely vertical, γ may also not equal to 0.Therefore, correlation coefficient range $\gamma\in(0,1)$ each point correlation coefficient average value is relational degree formula (2):

$$\gamma(X_0,X_i)=\frac{1}{m}m\sum_{t=1}\gamma(x_0(k),x_i(k)) \tag{2}$$

From correlation technical indicators and scoring relational degree Table 1 and relational analysis Table indication, except for block shot, relative technical indicators and scoring relational degree all are in the strong level, at least find out 7 items factors quantitative proportion distribution in overall training, it has important reference significance to scientific quantitative designing training plan.

Table 1: Correlation technical indicators and scoring grey relational degree

Technical indicator	Front court rebound	Back court rebound	Total rebounds	Assists	Steal	Block shot
Relational degree	0.7682	0.7805	0.8575	0.8524	0.7491	0.5366
Technical indicator	3-point	Free throw	Shoot	Fault	Foul	
Relational degree	0.753	0.7839	0.8898	0.7516	0.8313	

Table 2: Influence factors relational degree contrasting table

Correlation intension	Weak	Medium	Strong
γ	$0<\gamma\le 0.35$	$0.35<\gamma\le 0.65$	$0.65<\gamma\le 1.0$

From above analysis solution process, it get each basketball team each indicator and final competition performance relational degree, as well as these relational degrees relative sizes, it can put forward some suggestions for referencing.

Each team comprehensive scoring evaluation model
Factor analysis is quantitative varied simply multiple variables statistics method; it can be regarded as principal component analysis extension. Factor analysis is dissolving original variable, we summarize variable and conclude into one type, different types' variables correlation is strong correlation potential "type" between lower ones, every type variable is a "common" factor internal structure (touch). Factor analysis is also a method looking for internal structural relations.

Utilize SPSS carrying out double variant correlation analysis, it get that it should eliminate front court rebound, block shot, 3-point, shoot and foul from 11 technical indicators. For other technical indicators' tackle, rebound, assists, fault, total rebound, free throw, these 6 technical indicators to implement factor analysis.
Factor analysis main model forms:

(1) Expansion formula (3):

$$\begin{cases} X_1 = a_{11}F_1 + a_{12}F_2 + \cdots + a_{1m}F_m + \varepsilon_1 \\ X_2 = a_{21}F_1 + a_{22}F_2 + \cdots + a_{2m}F_m + \varepsilon_2 \\ \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \\ X_\rho = a_{\rho 1}F_1 + a_{22}F_2 + \cdots + a_{\rho m}F_m + \varepsilon_\rho \end{cases} \tag{3}$$

(2) Matrix formula (4)

$$\begin{bmatrix} X_1 \\ X_2 \\ \vdots \\ X_\rho \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1m} \\ a_{21} & a_{22} & \cdots & a_{2m} \\ \vdots & \vdots & & \vdots \\ a_{\rho 1} & a_{\rho 2} & \cdots & a\rho m \end{bmatrix} \begin{bmatrix} F_1 \\ F_2 \\ \vdots \\ F_m \end{bmatrix} + \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \vdots \\ \varepsilon_\rho \end{bmatrix} \tag{4}$$

Simplifying as formula (5):

$$X = AF + \varepsilon (p\times 1)(p\times m)(m\times 1)(p\times 1) \tag{5}$$

And meet: $m \le p$; $Cov(F,\varepsilon) = 0$; $D(F) = \begin{bmatrix} 1 & & 0 \\ & \ddots & \\ 0 & & 1 \end{bmatrix} = I_m$.

In analysis, people normally used common factor that prefer to reflects original variable, so that it is more helpful for describing research objects features. Therefore, it tends to express common factor as variables (or samples) linear combination that is formula (6):

$$\begin{aligned} f_1 &= \beta_{11}x_1 + \beta_{12}x_2 + \cdots + \beta_{1p}x_p \\ f_2 &= \beta_{21}x_1 + \beta_{22}x_2 + \cdots + \beta_{2p}x_p \\ &\cdots\cdots \\ f_m &= \beta_{m1}x_1 + \beta_{m2}x_2 + \cdots + \beta_{mp}x_p \end{aligned} \tag{6}$$

Called above formula (6) as factor scoring function, it can be used to calculate every sample common factor score. There are many methods to estimate factor scoring. Judge whether it can make factor analysis or not.

Table 3: KMO and Bartlett test

\	Sampling sufficient degree Kaiser-Meyer-Olkin measurement	.560
Bartlett sphericity degree test	approximate to chi-square	37.786
	df	15
	Sig.	.001

Table 3 shows KMO and Bartlett test result, from which the more KMO value close to 1, the more proper factor analysis would be. From Table 3, it can get that KMO value is 0.560 that can make factor analysis. Bartlett sphericity degree test original hypothesis correlation coefficient matrix is unit matrix; sig value is 0.001 less than significance level 0.05, therefore refuse original hypothesis, which indicates variables have correlations that they are proper for factor analysis.

Table 4: Common factor variance

\	Initial	Extract
Steal	1.000	.791
Back court rebound	1.000	.817
Assists	1.000	.600
Fault	1.000	.326
Total rebounds	1.000	.831
Free throw	1.000	.720
Extract method: Principal component analysis.		

Table 4 provides each communality result. Data table left side expresses each variable explainable variance by all variances, right side is communality. From the Table 4, it is clear that factor analysis communalities are basically above 0.6, indicates most information in variables can be extracted by factors that show factor analysis result is valid.

Table 5: Explanatory total variance

Element	Initial feature value			Extract squares sum and load into	
	Total	Variance %	Accumulation %	Total	Variance %
1	2.646	44.095	44.095	2.646	44.095
2	1.439	23.987	68.081	1.439	23.987
3	.979	16.322	84.403		
4	.616	10.272	94.675		
5	.189	3.148	97.823		
6	.131	2.177	100.000		
Extract method: Principal component analysis.					

Table 5 provides factor contribution ratio result. On the above table, there is initial feature value, extracting main factor result and main factor result after rotation. "Total" refers to factor feature value, "variance%" shows the factor feature value percentage that accounts for total feature value, and "Accumulation%" means accumulation percentage. Among them, only the previous two factors feature values are above 1, and the sum of the previous two feature values accounts for 68.08% of total feature value, therefore, extract the previous two factors as main factors.

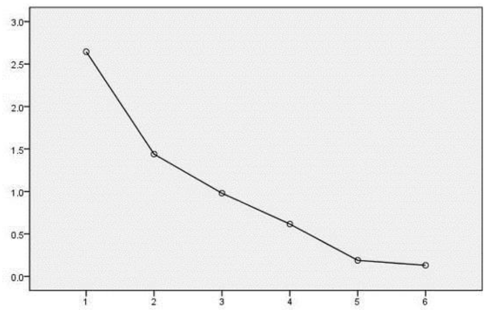

Figure 2: Screen plot

Figure 2 provides feature value screen plot, it normally indicates that large factor steep slope and surplus factor gentle end have obvious interruption. Generally, selected main factors are in the quite steep slope, while gentle slope factors have quite small explanation on variation. From Figure 2, it is clear that previous two factors are in the quite steep slope, while slope starts gentle since the third factor; therefore select the previous two factors as main factors.

Table 6: Element matrix

\	Element	
\	1	2
Steal	-.223	.861
Back court rebound	.900	-.080
Assists	.118	.766
Fault	.558	-.120
Total rebounds	.911	.001
Free throw	-.793	-.302
Extract method: Principal component analysis.		
a. Already extracted 2 elements.		

Table 6 provides factor loading without rotation. From the table, it can get two main factors loading values that extracted by principal component method. So as to convenient to explain factor definition, it needs to carry out factor rotation.

Table 7: Rotation element matrixa

\	Element	
\	1	2
Steal	-.209	.864
Back court rebound	.899	-.095
Assists	.131	.763
Fault	.556	-.129
Total rebounds	.911	-.015
Free throw	-.798	-.289

Extract method: Principal component analysis.
Rotation method: Kaiser standardized orthogonal rotation method.
a. Restrain after rotation experiencing 3 times iterations.

Table 7 provides factor loading value after rotation. Among them, rotation method adopts Kaiser standardized orthogonal rotation method. By factor rotation, each factor has relative clearly definition. Each factor only has few indicators with large factor loading; therefore classification can be done according to above table, divide 6 indicators into two types according to high loading. Factor 1 mainly explains back court rebound, total rebound and fault that can be named as rebound factor; Factor 2 mainly explains the other three indicators, steal, assists and free throw that can be named as pass factor.

Table 8: Element conversion matrix

Element	1	2
1	1.000	-.017
2	.017	1.000

Extract method: Principal component analysis.
Rotation method: Kaiser standardized orthogonal rotation method.

Factor analysis requires that final achieved factors are independent from each other without correlations. Factor conversion matrix is as Table 8, indication element figure is as Figure 3.

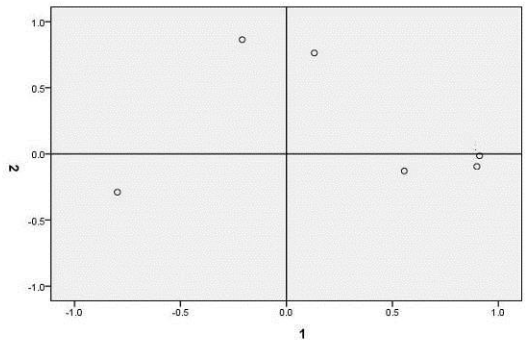

Figure 3: Rotation space element figure

Table 9: Element scoring coefficient matrix

\	Element	
\	1	2
Steal	-.074	.599
Back court rebound	.339	-.061
Assists	.054	.531
Fault	.210	-.087
Total rebounds	.344	-.005
Free throw	-.303	-.205

Extract method: Principal component analysis.
Rotation method: Kaiser standardized orthogonal rotation method.

Table 9 provides element scoring coefficient matrix, Table 10 provides factor scores that element scoring coefficient matrix calculated. Among them, element scoring coefficient matrix is factor scores calculation basis. Synthesis scores can be further got from factor scores, carry out synthesis strength ranking according to synthesis scores. Ranking reflects synthesis strength. According to 6 indicators, it excavates 2 potential synthesis factors that can give objective evaluations on 17 teams' strength.

Table 10: Synthesis scoring ranking table

Team No.	Rebound factor	Pass factor	Synthesis scoring	Ranking
14	1.22326	1.63731	0.93	1
16	1.73853	-0.39946	0.67	2
11	1.63281	-0.70774	0.55	3
10	1.222	-0.54411	0.41	4
1	0.27756	1.04518	0.37	5
9	-0.11906	0.50337	0.07	6
5	-0.08828	0.43151	0.06	7
3	0.2858	-0.31022	0.05	8
12	-0.72278	1.13741	-0.05	9
4	-0.82976	1.23566	-0.07	10
2	-0.12979	-0.19585	-0.1	11
17	0.49542	-1.80162	-0.21	12
8	-0.80023	0.35737	-0.27	13
7	-0.6161	-0.11793	-0.3	15
6	-0.67338	0.00345	-0.3	14
15	-1.42459	-0.16202	-0.67	16
13	-1.47142	-2.11231	-1.16	17

Table 11: Element covariance matrix

Element scoring covariance matrix		
Element	1	2
1	1.000	.000
2	.000	1.000

Extract method: Principal component analysis.
Rotation method: Kaiser standardized orthogonal rotation method.
Construct into scores.

Through factor analysis, it finds two synthesis evaluation indicators that are rebound factor and pass factor, refer to Table 11. From original 6 indicators, it excavates 2 potential synthesis factors that can give objective evaluations on 17 teams' synthesis strength. Synthesis score formula (7):

$$W = 0.44095x_1 + 0.23987x_2 \tag{7}$$

From which, x_1 is rebound factor, x_2 is pass factor.

Integral model

Given season competition teams win i sessions, fail j sessions, draw k sessions, integral G , as formula (8):

$$G = 2i + j \tag{8}$$

Use entropy to judge one indicator dispersion degree, the larger indicator dispersion degree is, the larger the indicator influences on comprehensive evaluation would be.

Select n years' samples, m pieces of indicators, X_{ij} Table shows the i year the j indicator value, among them $i = 1,2,3,...,n$ $j = 1,2,3,...,m$. Construct indicator value indicator matrix A as following formula (9):

$$A = \begin{bmatrix} x_{11} & x_{12} & x_{13} & \cdots & x_{1m} \\ x_{21} & x_{22} & x_{23} & \cdots & x_{2m} \\ x_{31} & x_{32} & x_{33} & \cdots & x_{3m} \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ x_{n1} & x_{n2} & x_{n3} & \cdots & x_{nm} \end{bmatrix} \tag{9}$$

Adopt $Z-score$ standardization method. The method is based on original data average value and standard deviation to carry out standardization method, use $Z-score$ standardizing A original value x into x'. Standardization formula is formula (10):

$$x'_{ij} = \frac{x_{ij} - \overline{x_j}}{\sigma^2} \tag{10}$$

Among them, $\overline{x_j}$ is the j indicator average value, σ is variance. The method is fit for maximum value and minimum value unknown situations or beyond value range dispersion data situation.

After original data standardization, it gets standardization matrix A' formula (11):

$$A' = \begin{bmatrix} x'_{11} & x'_{12} & x'_{13} & \cdots & x'_{1m} \\ x'_{21} & x'_{22} & x'_{23} & \cdots & x'_{2m} \\ x'_{31} & x'_{32} & x'_{33} & \cdots & x'_{3m} \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ x'_{n1} & x'_{n2} & x'_{n3} & \cdots & x'_{nm} \end{bmatrix} \tag{11}$$

Utilize MATLAB carrying out entropy method to determine synthesis score and integral weights, get synthesis scores weight $w_1 = 0.6828$, integral weight $w_2 = 0.3172$, it is clear that synthesis scores accounts for large when evaluates a team synthesis quality. Therefore, synthesis quality S formula (12):

$$S = 0.6828W + 0.3172G \tag{12}$$

According to synthesis quality formula (12) rank 17competition teams in 2012-2013 seasons again so as to easier to calculate weight, 100adjust synthesis scores upwards 100.Top ranking ones have big winning possibility and high synthesis quality.

Table 12: Chinese men's basketball team professional tournament total score ranking in 2012-2013

Team No.	Team name	Score	Ranking	Integral	Total score
14	Shandong Gold	100.93	1	56	86.6782
16	Tianjin Golden Lions	100.67	2	42	82.05988
11	Fujian Quanzhou	100.55	3	43	82.29514
10	Zhejiang Guangsha	100.41	4	49	84.10275
1	Shanxi Fen Wine	100.37	5	48	83.75824
9	Jiangsu Midheaven	100.07	6	45	82.6018
5	Guangdong Dongguan	100.06	7	60	87.35297
3	Foshan Youcheng	100.05	8	47	83.22254
12	Jilin Jiutai	99.95	9	42	81.56826
4	Liaoning Jiebao	99.93	10	51	84.4094
2	Zhejiang Chouzhou	99.9	11	48	83.43732
17	Shanhai Maxxis	99.79	12	42	81.45901
8	Beijing JinOu	99.73	13	53	84.90724
6	Xinjiang Guanghui	99.7	14	53	84.88676
7	Qingdao double star	99.7	15	40	80.76316
15	Bayi Rocket	99.33	16	48	83.04812
13	Dongguan Marco Polo	98.84	17	49	83.03075

CONCLUSION

For CBA 17 teams in 2012-2013 seasons, utilized grey relational degree method, researched basketball, adopting competition data to reflect each team score and technical indicators correlations, it got that defense rebound, total rebound, assists, steal, block shot, free throw, 3-point, shoot, foul, fault relational degree were respectively 0.7682、0.7805、0.8575、0.8524、0.8525、0.7491、0.5366、0.753、0.7839、0.8898、0.8313、0.7516. Then eliminated factors that had no large correlations with other factors, applied SPSS to make factor analysis of remnant influence factors, it achieved internal dependence relationships and synthesis scores, synthesis scores reflected synthesis strength. However, on site playing was a factor that related to synthesis quality. Made quantization on evaluation labeled competition playing through integral. The higher integral got, the better team performance would be. For weight synthesis scores and entirety, it utilized entropy method, it could have two weights. Total integral scores that solved represented synthesis quality quantitative evaluation criterion. The higher mass scores were, the bigger competition winning possibility would be.

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