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Fuzzy comprehensive evaluation (FEC) of basketball player's competence system

Batu Liu*, Lan Gui

Institute of Physical Education, Inner Mongolia University For The Nationalities, Tongliao 028000, Inner Mongolia Autonomous Region, (CHINA)

ABSTRACT

With different duties on the field, the systems to evaluate a forward and a guard are also different. In this paper, fuzzy comprehensive evaluation (FEC) is applied and followed by the second rank factors, the first rank factors will be decided in advance. Thus, technique, competition consciousness, physical quality, and psychological quality are included in the first rank. According to the prioritization of these four factors, we can get a fuzzy set of the weighting factors. And then we can set up a fuzzy matrix and find out the evaluation interval of the players.

KEYWORDS

FIBA world championship;
Fuzzy evaluation;
Athletes' competence;
Fuzzy mathematics.

INTRODUCTION

With a history of 100 years, much attention has been paid to basketball. Till now, a set of strict and formal rules has taken shape. And it has been a high-ending game with time limit, space limit, speed control, and control of the ball. FIBA Asia Championship began in 1960. China took apart for the first time in 1975 and has won the championship for 14 times, including two five-match winning streaks and a four-match winning streak. With the development of economy, basketball in China has entered a high growth path.

TABLE 1 shows the frequency of which each continent has been in the top eight of the Olympic basketball tournament and the FIBA World Championship between the year of 1936 and 2010:

Figure 1 comes from TABLE 1 by Excel:

In TABLE 1 and Figure 1, it's obvious that Europe and America have got most medals in all the major games. And compared with some developed countries, Asia and Africa have relatively lagged behind. Though having a share in the field of Asia basketball, china basketball has to keep trying, gather more experience, and learn from other countries'.

TABLE 1 : The Frequency of each continent being in the top eight of the Olympic basketball tournament and the FIBA World Championship between1936 and 2010

Event	Asia	America	Europe	Africa
Olympics	5	57	44	0
FIBA	6	59	42	1
Total	11	106	86	1

THE ESTABLISHMENT OF THE MODEL

Fuzzy mathematics has a history of 40 years. Although it's a new discipline, it has a rich content of natural

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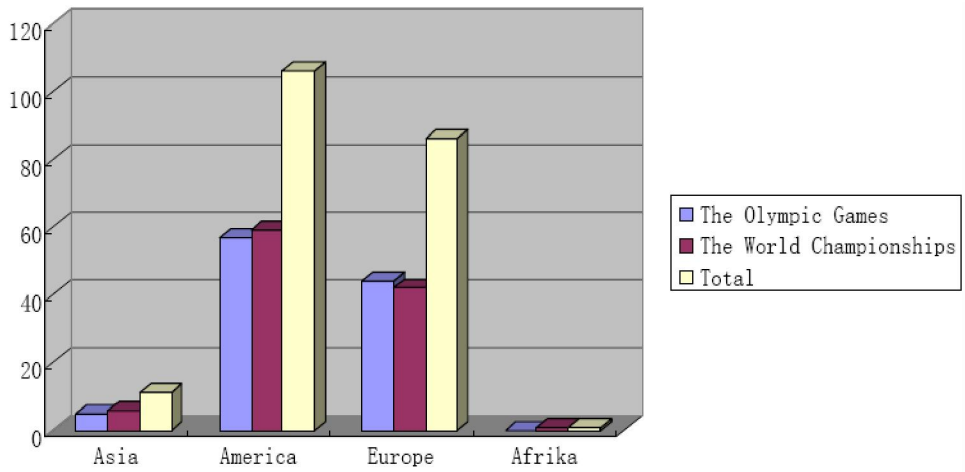

Figure 1: The Frequency of each continent being in the top eight of the Olympic basketball tournament and the FIBA World Championship between1936 and 2010

sciences and social sciences. And evaluation is a process of human's thinking, which doesn't present linearly.

As a kind of important evaluation method, fuzzy evaluation matrix has three steps——weights confirmation, establishment of the matrix, and the choice of operators.

The overview of the mode of fuzzy evaluation matrix

The steps are as following:

To make certain the factor set U,

$$U = \begin{pmatrix} U_1 & U_2 & \cdots & U_k \end{pmatrix}$$

To make certain the evaluation set V

To make certain the evaluation matrix of the fuzzy mapping from U to V:

$$R = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \vdots & \vdots & & \vdots \\ r_{m1} & r_{m2} & \cdots & r_{mn} \end{bmatrix}$$

To make certain the weight set, $A = (a_1, a_2, \cdots, a_n)$,meeting the condition:

$$\sum_{i=1}^{n} a_i = 1 \quad a_i \geq 0$$

Each line in the fuzzy mapping R can reflect the judgment of the factors to the targets. On the other hand, each column in R can reflect the judgment of the factors to the targets.

$$\sum_{i=1}^{n} r_{ij} \quad j = 1, 2, 3, \cdots, m$$

$$B = A \cdot R$$

$$= (a_1, a_2, a_3, \cdots, a_n) \cdot \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1n} \\ r_{21} & r_{22} & \cdots & r_{2n} \\ \vdots & \vdots & & \vdots \\ r_{m1} & r_{m2} & \cdots & r_{mn} \end{bmatrix}$$

$$= (b_1, b_2, b_3, \cdots, b_n)$$

The fuzzy hybrid in V is equal to evaluation set B. in conclusion, the changing model is as following:

As Figure 2 shows, we can establish the transformation function of the rank evaluation of all the relevant factors after establishing the changing modal. The membership function of evaluation factors u1, u2, u3, u4, u5 is showed below:

$$u_{v1}(u_1) = \begin{cases} 0.5(1 + \dfrac{u_i - k_1}{u_i - k_2}), & u_i \geq k_1 \\ 0.5(1 - \dfrac{k_1 - u_i}{k_1 - k_2}), & k_2 \leq u_i < k_1 \\ 0 \quad , & u_i < k_2 \end{cases}$$

$$u_{v2}(u_1) = \begin{cases} 0.5(1 - \dfrac{u_i - k_1}{u_i - k_2}), & u_i \geq k_1 \\ 0.5(1 + \dfrac{k_1 - u_i}{k_1 - k_2}), & k_2 \leq u_i < k_1 \\ 0.5(1 - \dfrac{u_i - k_3}{k_2 - k_3}), & k_3 \leq u_i < k_2 \\ 0.5(1 - \dfrac{k_3 - u_i}{k_2 - u_i}), & u_i < k_3 \end{cases}$$

$$u_{v1}(u_1) = \begin{cases} 0, & u_i \geq k_2 \\ 0.5(1 - \dfrac{k_1 - u_i}{k_2 - k_3}), & k_3 \leq u_i < k_2 \\ 0.5(1 + \dfrac{k_3 - u_i}{k_2 - u_i}), & u_i < k_3 \end{cases}$$

The evaluation of basketball players based on the

fuzzy evaluation model

According to Figure 3, considering the competition consciousness, athletes need good competition consciousness to be in total control. Now we establish factor set U, $U=(U_1 \quad U_2 \quad U_3 \quad U_4)$., in which U_1 represents technique, U_2 competition consciousness, U_3 physical fitness, and U_4 psychological quality. We can get TABLE 2.

From the factors of TABLE 2, we can gain evaluation set:

$U_1=\{u_{11},u_{12},u_{13},u_{14}\}$

$U_2=\{u_{21},u_{22},u_{23},u_{24},u_{25}\}$

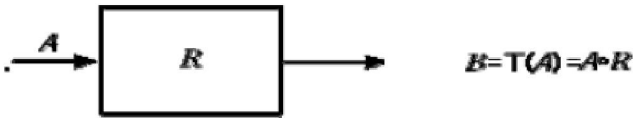

Figure 2 : Changing model

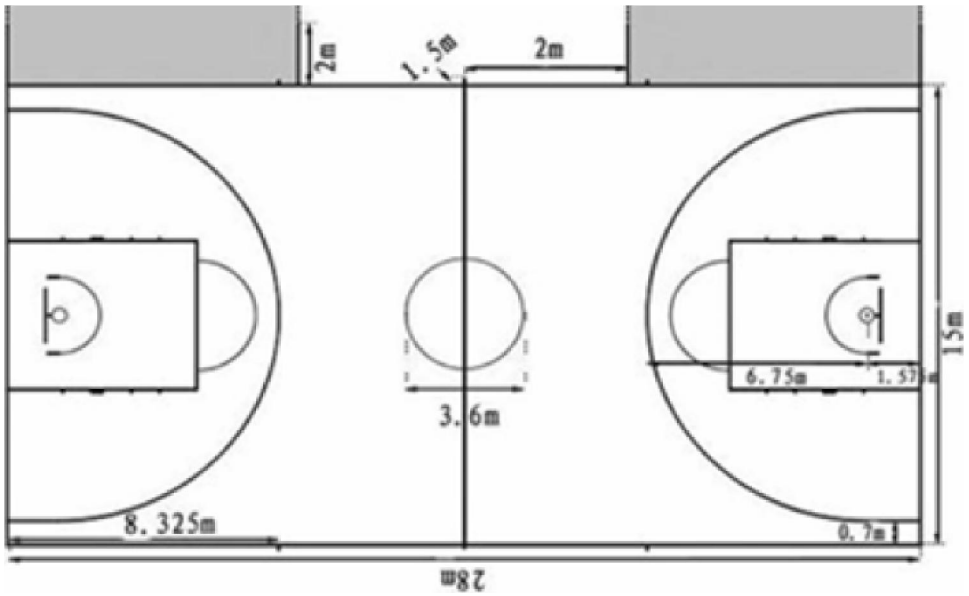

Figure 3 : Field distribution

TABLE 2 : Basketball player evaluation index system

Technique U_1	Competition consciousness U_2	Physical fitness U_3	Psychological quality U_4
Stroke u_{11}	Tactics u_{21}	Endurance u_{31}	Concentrated Force u_{41}
Receive u_{12}	Judgment u_{22}	Speed u_{32}	Self-confident Degree u_{42}
Serve u_{13}	Reaction u_{23}	Strength u_{33}	Personal quality u_{43}
Volley u_{14}	Experience u_{24}	Sensitivity u_{34}	
Basic Foot Movements u_{15}			

$U_3=\{u_{31},u_{32},u_{33}\}$

$U_4=\{u_{41},u_{42},u_{43},u_{44}\}$

After data collection and analysis, the statistics of the rank of the importance of the four factors is presented as TABLE 3:

From TABLE 3 we can get the rank matrix of the four factors, U1, U2, U3, U4:

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TABLE 3 : Statistics of the rank of importance of the four factors

Sort	Number 1	Number 2	Number 3	Number 4
Competition Consciousness U_1	23	7	4	0
Skill U_2	7	18	8	0
Psychological Quality U_3	0	9	13	12
Physical Fitness U_4	3	0	9	21

$U_2 = \{23,7,4,0\}$

$U_2 = \{7,18,8\ 0\}$

$U_3 = \{0,9,13,12\}$

$U_4 = \{3,0,9,21\}$

From number 1 to number 2 we can get the weighted vector:

$\beta = \{\beta_1, \beta_2, \beta_3, \beta_4\} = \{0.4, 0.3, 0.2, 0.1\}$

$U_i^* = U_i \cdot \beta^T$

$U_1^* = 12$, $U_2^* = 9.7$, $U_3^* = 6$, $U_4^* = 5$

In this paper, we apply the process of normalization:

$U_1^* = 0.35$, $U_2^* = 0.3$, $U_3^* = 0.2$, $U_4^* = 0.15$

and:

$\bar{A} = (0.35 \quad 0.3 \quad 0.2 \quad 0.15)$

Based on basketball performance, we can get the membership degree of evaluation. TABLE 4 shows it:

We get the conclusion of TABLE 5, according to the evaluation of one of the basketball players' indexes:

Based on the model above, we get the monolayer index of weight factor fuzzy set:

$U_1^* = \{U_{11}, U_{12}, U_{13}, U_{14}, U_{15}\} = \{0.25\ 0.25\ 0.2\ 0.15\ 0.15\}$

$U_2^* = \{U_{21}, U_{22}, U_{23}, U_{24}\} = \{0.54\ 0.1\ 0.24\ 0.14\}$

$U_1^* = \{U_{31}, U_{32}, U_{33}, U_{34}\} = \{0.4\ 0.3\ 0.1\ 0.2\}$

$U_1^* = \{U_{41}, U_{42}, U_{43}\} = \{0.3\ 0.4\ 0.3\}$

TABLE 4: Membership degree of evaluation

evaluation method	Score enactment interval 0-60	60-80	80-90	90-100
perfect	0	0	0.05	0.95
good	0	0.05	0.9	0.05
general	0.05	0.9	0.05	0
poor	0.95	0.05	0	0

According to the combination of TABLE 5 and TABLE 4, we get the evaluation set including: technique, competition consciousness, physical quality, psychological diathesis:

Technique $U_1 = \begin{pmatrix} 0 & 0 & 0.05 & 0.95 \\ 0 & 0 & 0.05 & 0.95 \\ 0 & 0.05 & 0.95 & 0.05 \\ 0 & 0.05 & 0.95 & 0.05 \\ 0 & 0.05 & 0.95 & 0.05 \end{pmatrix}$

Competition consciousness $U_2 = \begin{pmatrix} 0 & 0 & 0.05 & 0.95 \\ 0 & 0 & 0.05 & 0.95 \\ 0 & 0 & 0.05 & 0.95 \\ 0 & 0.05 & 0.9 & 0.05 \end{pmatrix}$

Physical quality $U_3 = \begin{pmatrix} 0 & 0 & 0.05 & 0.95 \\ 0 & 0.05 & 0.9 & 0.05 \\ 0 & 0.05 & 0.9 & 0.05 \\ 0.05 & 0.9 & 0.05 & 0 \end{pmatrix}$

Psychological diathesis $U_4 = \begin{pmatrix} 0 & 0 & 0.05 & 0.95 \\ 0 & 0.05 & 0.9 & 0.05 \\ 0 & 0.05 & 0.9 & 0.05 \end{pmatrix}$

$B_i = A_i \cdot R_i$

After normalizing B_i, we get fuzzy set matrix:

$\bar{B} = \begin{pmatrix} B_1 \\ B_2 \\ B_3 \\ B_4 \end{pmatrix} = \begin{pmatrix} 0.07 & 0.27 & 0.13 & 0.53 \\ 0 & 0.1 & 0.4 & 0.5 \\ 0.08 & 0.46 & 0.38 & 0.08 \\ 0.14 & 0.2 & 0.3 & 0.36 \end{pmatrix}$

And the comprehensive evaluation value: $Z = U^* \cdot B = (0.15 \quad 0.26 \quad 0.29 \quad 0.36)$

On the basis of the logic $0.36 > 0.29 > 0.26 > 0.15$, that basketball player gains the excellent score, and accord-

TABLE 5: The evaluation of every basketball players' indexes

Every index	Evaluation	Every index	Evaluation
Stroke u_{11}	Perfect	Endurance u_{31}	Perfect
Receive u_{12}	Perfect	Speed u_{32}	Good
Serve u_{13}	General	Strength u_{33}	Good
Volley u_{14}	General	Sensitivity u_{34}	General
Basic Foot Movement u_{15}	General	Concentrated Force u_{41}	Good
Tactics u_{21}	Perfect	Self-confident Degree u_{42}	Perfect
Judgment u_{22}	Perfect	Personal quality u_{43}	General
Reaction u_{23}	Perfect		
Experience u_{24}	Good		

ing to fuzzy set, the score is between 90 and 100.

CONCLUSION

With fuzzy comprehensive evaluation, first we must make certain of the rank 1 of every of effective factors. And then the rank 2 on the base of it. In this paper, the rank 1 of every of effective factors are technique, competition consciousness, physical quality, psychological diathesis.

On the different importance of the four factors, we can get the fuzzy set of the weight factors, build up the fuzzy set matrix, and get the players' evaluation interval. And what's more, we can get the players' integrated assessment value about technique, competition consciousness, physical quality, psychological diathesis according to the analysis by the coach. Finally, we can know that the score of that player is between 90 and 100.

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