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Study on fuzzy mathematics theory applied to comprehensive evaluation for the offense ability of basketball guard

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ABSTRACT

Basketball is a kind of flexible sports which need the interaction among teammates, Teamwork is essential, but individual basketball technique is the most important thing, especially the ability of basketball guard. In this paper, the basketball guard offensive ability is evaluated on the basis of fuzzy evaluation system; in addition, evaluation index is established based on expert interviews. By a lot of experience, factors of influencing on the basketball guard offensive ability are weighted, and the evaluation model on the basketball guard movement mobilization ability is obtained and achieved so that the weight of each index is calculated. As a result, evaluation value of a basketball guard player's comprehensive ability can be worked out currently. Thus, more accurate theoretical basis can be provided for material and the related training of basketball guard in basketball sports.

KEYWORDS

Basketball guard
Hierarchy matrix;
Fuzzy mathematics;
Comprehensive evaluation.

INTRODUCTION

In recent years, as the NBA is popular with the basketball sports lovers worldwide, the basketball skills and team strategies are rapidly developing afterwards. Defender's ability has been attracting more and more attention; guard not only plays an important role in organizing teams and coordinating games, but also had strong ability in the defense, who is usually the key scorer in a basketball team. But what kind of defender is a good player?, because there are many relevant evaluation factors, including not only technology such as dribbling the ball, passing the ball, breaking through, also observation, alertness, tactics in mentality, and even physical and psychological elements etc.. So, the establishment of a comprehensive evaluation on individual ability of a basketball guard is the new requirement for basketball guard ability in the new historical period.

FUZZY ANALYTIC HIERARCHY PROCESS (FUZZY AHP)

The mathematics analysis of study and process on fuzzy phenomenon by mathematical methods is called fuzzy analytic hierarchy process. Nowadays, Application of fuzzy analytic hierarchy process has applied in various fields of social science, which fully demonstrates its strong vitality and penetration. This model performs the comprehensive consideration and research on the premise of various factors to achieve more reasonable evaluation effects, so we use fuzzy AHP to analyze and evaluate basketball goods industry, for which the con-

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crete methods and steps are as follows:

First of all, the evaluation object should be determined, which is by the y factors influencing single variables, and its the factors set is α, which is defined as:

$$\alpha = (\alpha_i, \alpha_i, \alpha_i, \cdots, \alpha_i) \quad (1)$$

And set:

$$\alpha_i (i = 1,2,3,\cdots, y) \quad (2)$$

Because the weight of each variable is not the same, therefore, the influencing degree is not the same in terms of the determined evaluation grade. We assume that the weight distribution is a_i, and:

$$b_i = (b_1, b_2, b_3, \cdots b_y) \quad (3)$$

What's more,

$$b_i (i = 1,2,3,\cdots, y) \quad (4)$$

Is the weight value of formula 2, according to elementary knowledge, it is known that $b_i \geq 0$ and $\sum_{i=1}^{y} b_i = 1$

If each factor b_i contains n sub factors, and the factors set is

$$\alpha_i = (\alpha_{i,1}, \alpha_{i,2}, \alpha_{i,3}, \cdots, \alpha_{i,n}) \quad (5)$$

Then, the corresponding weight value is:

$$b_i = (b_{i,1}, b_{i,2}, b_{i,3}, \cdots b_{i,n}) \quad (6)$$

As for the weight value b_i of $\alpha_{i,j}$, it can be known from common since that $b_{i,j} \geq 0$ and $\sum_{j=1}^{n} b_{i,j} = 1$

Thus the evaluated index sets is:

$$g = (g_1, g_2, g_3, \cdots, g_s) \quad (7)$$

The corresponding evaluation object can be divided into s different levels, here, we let $g_1, g_2, g_3, \cdots, g_s$ be the quality evaluation degrees from high to low, such as "excellent", "good"," qualified", and" failed" etc.

By The matrix composition calculation, evaluation results of the corresponding volleyball players' performance can be obtained, that is:

$$c = b * r = (b_1, b_2, b_3, \cdots b_y) * (r_1, r_2, r_3, \cdots, r_y)^T = (c_1, c_2, c_3, \cdots, b_y) \quad (8)$$

According to fuzzy sets c, we can use Maximum rating method to get a determined evaluation ranks.

$$H_k = \{H_I\} \quad (9)$$

Then, the rank of final H_K evaluation result is k 0

COMPREHENSIVE EVALUATIONS ON THE BASKETBALL GUARD PLAYER'S ABILITY

According to the characteristics of basketball guard 's ability and comprehensive evaluation mode of fuzzy mathematics, multiple factors in this condition are considered, what's more, in order to achieve the goal level, factors set and evaluation set are established, and the evaluation index system is built, which includes the 5 levels such as" excellent", "good", "qualified"," failed", therefore, the corresponding set is

$$v = \begin{cases} \text{excellent, good, medium, qulified, failed} \\ = \{v_1, v_2, v_3, v_4, v_5\} \end{cases} \quad (10)$$

We let r_{ij} be the possible degree of comment among the j factor

First, analyze the application hierarchy for the basketball guard's ability, and build hierarchy of goals, build hierarchy of criterion, whose relations is shown in following TABLE 1:

Based on this programmed, we built a analytic hierarchy structure figure to analyze further the whole process of hierarchical structure for offense ability of basketball guard, which is shown as Figure 1:

CONSISTENCY CHECKING

Consistency checking algorithm design

Due to the complexity of the objective world and the diversity of people's congniition, the $a_{ij} \bullet a_{jk} = a_{ik}$ is not rigorously achieved during the process of constructing the judgment matrix, so, when weight vector is calculated under single criteria, Consistency checking must be performed again, taking the matrix R_1 for example, algorithm design is as shown below:

Step-1: obtain the vector $\vec{a} = (a_1, a_2, a_3, a_4)$ and the vector $\vec{w} = (w_1, w_2, w_3, w_4)$;

Step-2: the largest eigenvalue of matrix R_1 is obtained as λ_{max}, whose calculation method is as shown in the following formula:

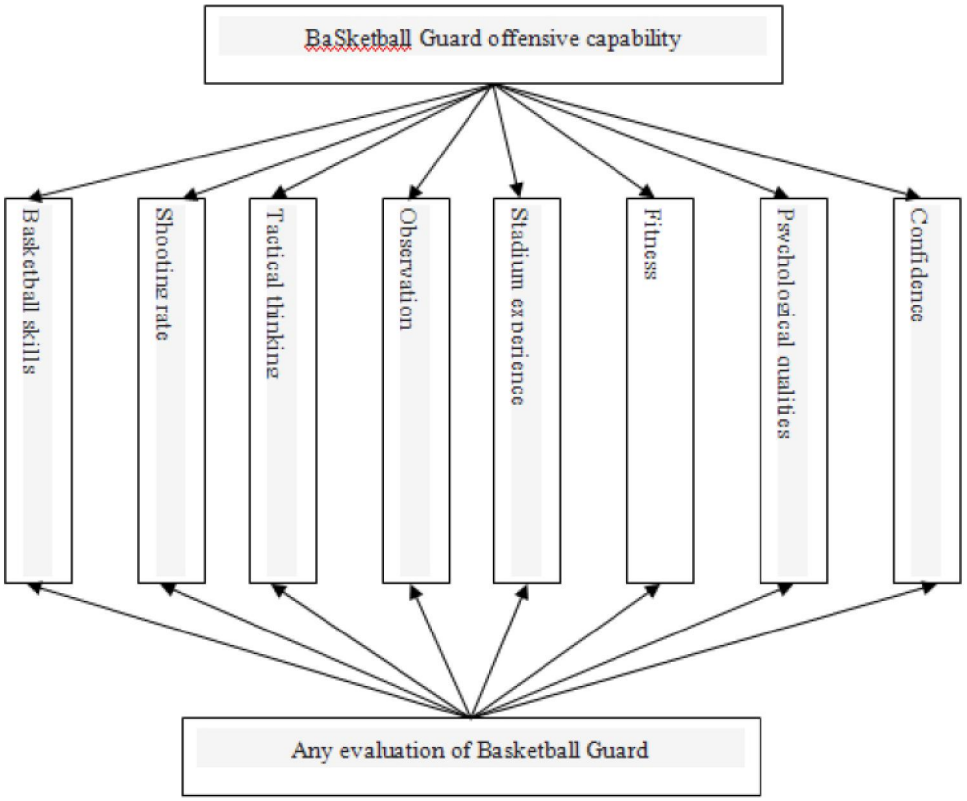

Figure 1 : Analytic hierarchy structure chart

TABLE 1: Low hierarchical structure table

hierarchy of goal	hierarchy of rule	hierarchy of measure
offense ability of basketball guard A	Basketball skill B_{11} the Percentage of Basket Hits B_{12} tactical awareness B_{13} observation ability B_{14} Competing experience B_{15} physical fitness B_{16} psychological quality B_{17} Self-confidence B_{18}	offense ability of a certain basketball guard

$$\lambda_{max} = \vec{a} \bullet \vec{w} = \begin{pmatrix} a_1 & a_2 & a_3 & a_4 \end{pmatrix} \begin{pmatrix} w_1 \\ w_2 \\ w_3 \\ w_4 \end{pmatrix}.$$

Step-3: Calculation of consistency index CI , such as the calculation method $CI = \frac{\lambda_{max} - n}{n-1} = \frac{\lambda_{max}}{7} - \frac{8}{7}$

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In it, n represents the number of criteria, namely, the number of factors, so, as for the matrix R_1, $n = 8$ is reasonable

Step-4: calculate the consistency ratio CR, and its calculating methods is $CR = \frac{CI}{RI}$.

In view of the judgment matrix A, $\lambda^{(0)}_{\max} = 4.073, RI = 0.9$

$$DI = \frac{4.073 - 4}{4 - 1} = 0.24$$

$$DR = \frac{DI}{RI} = \frac{0.024}{0.90} = 0.027 < 0.1$$

Eigenvector is used to substitute weight vector, which indicates A that is in degree of inconsistence in the allowable range.

The establishment of fuzzy consistent judgment matrix

We let r_{ij} be qualitative sequence scale of the importance, and its value be between 0, 0.5, and 1, then, binary contrast is carried out between the index B_i and the index B_j two yuan, the setting is just binary contrast principle on the importance of the index

If $B_i = B_j$, then $r_{ij} = r_{ji} = 0.5$;

If $B_i < B_j$, then $r_{ij} = 1; r_{ji} = 0$;

If $B_j > B_i$, then $r_{ij} = 0; r_{ji} = 1$;

First, as to the criterion C_1, binary contrast qualitative permutation matrix of its corresponding 8 indexes contained is:

$$\mathbf{r} = \begin{bmatrix} 1 & 0 & 0.5 & 1 & 0.5 & 1 \\ 0.5 & 0.5 & 1 & 1 & 1 & 1 \\ 1 & 1 & 0.5 & 1 & 1 & 1 \\ 0 & 0 & 0 & 0.5 & 0.5 & 0.5 \\ 0 & 0 & 0 & 1 & 0.5 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0.5 \end{bmatrix}$$

According to this matrix, ask each index weight value:

$$\mathbf{r} = \begin{bmatrix} 1 & 0 & 0.5 & 1 & 0.5 & 1 \\ 0.5 & 0.5 & 1 & 1 & 1 & 1 \\ 1 & 1 & 0.5 & 1 & 1 & 1 \\ 0 & 0 & 0 & 0.5 & 0.5 & 0.5 \\ 0 & 0 & 0 & 1 & 0.5 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0.5 \end{bmatrix}$$

Which is combined with the affiliation, vector form of relative membership degree is listed considering criteria B_1 as follows:

η_0 =(0.7 1 0.7 0.36 0.36 0.09)

After normalization, it is

η_1 =(0.22 0.31 0.22 0.11 0.11 0.03)

Second, the criterion B_2:

$$\mathbf{r_2} = \begin{bmatrix} 0.5 & 1 \\ 0 & 0.5 \end{bmatrix}$$

η_{20} =(1 0.33)

after normalization, it is

η_2 =(0.75 0.25)

Third. Under relative case of the given target hierarchy A for the criterion hierarchy B, formal matrix of binary contrast orderly consistency judgment is shown like this:

$$\mathbf{r'} = \begin{bmatrix} 0.5 & 1 \\ 0 & 0.5 \end{bmatrix}$$

η =(1 0.33)

after normalization, it is:

η =(0.75 0.25)

Fourth, according to the three calculation indexes, the weight β_{ij} of goal hierarchy can be obtained as follows:'

$$\beta_{ij} = \eta_i * \eta_{ij} (\text{if } i = 1; j = 1,2,3,4,5,6 \text{ ; if } i = 2, j = 1,2) \quad (11)$$

Calculation for comprehensive sequence vector of weight

First of all, the weight vector of judgment matrix is calculated, which is given by all experts. According to the given judgment matrix: $Bk = (\alpha k_{ij})_{n \times n}$, and the steps above, the weight vector can be established as follows:

$:Yk = \{Y_{k1}, Y_{k2}, Y_{k3}, \cdots, Y_{kn}\}\ (k = 1, 2, \cdots x)$

Here, k represents one of the experts, x represents the total number of experts, j indicates an index from a target hierarchy, n and acts as the index number of a target hierarchy.

Thirdly, calculate geometric average of the weight vector, according to the following formula:

$$Y^{'} j = \sqrt{Y_{f1} \times Y_{f2} \times k \times Y_{fs}} \quad (12)$$

In it, $W^{'} j$ is the geometric average value of the weight value endowed by x experts on a index of a target hierarchy. Normalized, according to the formula:

$$Y_j = \frac{Y^{'} f}{\sum_{j=1}^{n} Y^{'} f} \quad (13)$$

In formula(13), geometric average values are normalized, the processed weight values is shown by $Y^{'} j$, and it is the weight value of index j in a target hierarchy, so the weight of $Y^{'} j$ is obtained, thereby total hierarchy permutation table of the hierarchy is obtained as shown in TABLE 2

TABLE 2 : Total hierarchy permutation table

index	Index weight
B_{11}	0.23
B_{12}	0.10
B_{13}	0.09
B_{14}	0.04
B_{15}	0.15
B_{16}	0.17
B_{17}	0.15
B_{18}	0.06

Through TABLE 2 above, we can get offense ability of basketball guard; larger weights in total hierarchy permutation are in sequence of basketball skills, physical quality, psychological quality, field experience. That is, offensive ability of a basketball guard mainly depends on these four items, therefore, the index should be strengthened in the defender selection and training.

The establishment of comprehensive evaluation model

After calculating each index weights through the fuzzy hierarchy problem, according to experts' scoring and the comprehensive evaluation on the offensive ability of basketball guard targeting at determined weights evaluation function is shown as follows: $y = \sum_{i=1}^{8} w_i B_{1i}$

Among it, B indicates the evaluation value of the evaluation index of basketball guard players, w indicates an index weight

CONCLUSIONS

In this paper, fuzzy AHP method was applied to the defense ability of basketball guard by which the mathematical model was built based on combining the subjective evaluation and objective technical index, the weight problem on *each index* in basketball guard players was solved scientifically and reasonably, which will provide a simple way for the University Basketball Sports team selection, meanwhile, provide objective measures for evaluating a basketball defender athlete's skill objectively and reasonably so as to get rid of the subjective evaluation only given by the judges and the referees.

There is difference in each index ability of the different athletes' basketball guard ability. Comparing it with the size of weight of index can provide certain basis for the coaches' training to athletes, for example, it is highlighted to training basketball skills, physical quality, psychological quality, game experience so as to improve the ability of basketball guard player's rapidly6.

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