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Fuzzy theory-based athletes professional skills comprehensive evaluation research

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ABSTRACT

Athletes professional skills evaluation has very important significances in athlete ability and his professional skills are qualified or not. Professional ethics, physical quality, tactical quality, psychological quality, cultural quality, consciousness and others, all are factors that need to consider when evaluating on an athlete professional skills. The paper utilizes fuzzy comprehensive evaluation method, makes analysis of athletes professional skills numerous evaluation factors, starts from the perspective of quantity, defines grade set and each evaluation indicator weight, and then defines each factor importance degree on athletes' professional skills evaluation by comparing each weight size. In computation process, combine with analytic hierarchy process to calculate weights, establish hierarchical structure based on all evaluation indicators, make analysis and calculation layer upon layer, and finally get evaluation matrix, avoid experts evaluation and other methods caused human psychological factor errors, let computation result to be more accurate, so that conclusion will be more convincing. By analytic investigation, finally it gets a conclusion: tactical quality is a key factor to evaluate athlete professional skills, is most convincing on whether athlete professional skills are qualified or not.

KEYWORDS

Athlete; Professional skills; Fuzzy comprehensive evaluation; Tactical factor, Analytic hierarchy process.

INTRODUCTION

An excellent athlete, no matter in tactics, physical quality, psychological quality, or in cultural quality, professional spirits and other aspects, all conforms to excellent atheltes'professional skills, and these are just important indicators to evaluate an athlete professional skill. In athletes' professional skills research, it is very important to evaluate on his professional skills.

Always, scholars are constantly studying athletes' professional skills, and summarize some feasible conclusions. Ding Tao in the research of sports professional skills, he analyzed Chinese sports professional skills status, combined with lots of literatures, and consulted a great deal of reliable data according to statistical yearbook, carried out methods summary of sports professional exploitation and management; Ding Bo in sports industry specialized professional training, took Beijing city as an example, made field survey on professional training market status, got first hand information, and combines with formers' research results as well as current stage sports industry status, analyzed Beijing city sports industry specialized professional training market, and further put forward development countermeasures and orientation in some time in future; Zhang Yue-Ye in athletes' career planning research, analyzed present Chinese athletes' professional skills status, pointed out athletes made plans for their careers not only was helpful for athletes themselves improvements, but also were beneficial to their training with purposes and stages, and then arrived at better training effects;Ni Hui-Zhong in sports industry professional skills research, targeted at professional skills verification works, he made feasibility study, took sports industry skills work status as foundation, integrated professional skills theory and actual relations, got sports industrial professional skills should combine theory with practice, focus on theory application in practice, and further better developed sports professional skills works. Numerous scholars have continued to study Chinese athletes' professional skills; it could see that athletes' professional skills had very important impacts on Chinese sports development.

In athletes professional skills research, the paper applies mathematics fuzzy mathematical comprehensive evaluation method and analytic hierarchy process method, targeted at numerous evaluation indicator, calculates evaluation grades and weights, defines numerous indicators importance degree by comparing weights sizes, points out tactics are most important factors to evaluate an athlete professional skill, in some time in future, Chinese athletes should strengthen tactical training,promote professional basic skills, carry on special exercises targeted at each tactics, in addition they should focus on physical quality and psychological quality upgrading.

MODEL ESTABLISHMENTS

Just as its name implies, athletes' professional skill refers to an athlete techniques and ability, is a key to evaluate an athlete whether is qualified or not. And there are varieties of athletes' professional skills evaluation indicators, from which it mainly contains professional ethics, physical quality, tactical quality, psychological quality, cultural quality, consciousness. Under these evaluation indicators, there are multiple second grade indicators. Thereupon, evaluate an athlete professional skills are very complicated processes.

On this basis, utilize mathematics' fuzzy comprehensive evaluation method to make analysis, and establish fuzzy comprehensive evaluation method-based athletes' professional skills evaluation model.

Define evaluation indicator set

According to lots of literatures, it is clear that athletes' professional skills evaluation indicators can be classified into following six types: professional ethics, physical quality, tactical quality, psychological quality, cultural quality, consciousness. According to:

$$U = \{u_1, u_2, \cdots, u_m\}, m = 1,2,3,\cdots,6$$

Evaluation indicator set is={professional ethics,psychological factor, physical quality, tactics factor, consciousness, cultural quality}.

Define evaluation grade set

For system evaluation grade, mainly defining method is expert evaluation method. In athlete professional skills evaluation, its evaluation grade set is as following, according to:

$$V = \{v_1, v_2, \cdots, v_n\}, n = 1,2,3,4$$

Athlete professional skills evaluation grade set is={very good,good,normal,bad}.

Define each evaluation indicator weight

Weight main expression method is:

$$w = \{\mu_1, \mu_2, \cdots, \mu_m\}, m = 1,2,\cdots,6$$

Among them: $\sum_{m=1}^{6} \mu_m = 1$

Define evaluation indicator weight method mainly has analytic hierarchy process and normalization method, from which normalization method is as following:

$$w_i = \frac{\frac{C_i}{\overline{S_i}}}{\sum_{i=1}^{n} \frac{C_i}{\overline{S_i}}}, (i = 1,2,\cdots,m)$$

Among them, w_i is evaluation parameter i monitoring value; $\overline{S_i}$ is evaluation parameter i grade m criterion arithmetic average value, then weight set is:

$w = \{w_1, w_2, \cdots, w_m\}$。

Here, apply normalization method to carry on weight calculation, result is :

$$w=\{0.04,\ 0.20,\ 0.25,\ 0.30,\ 0.15,\ 0.06\}$$

DEFINE EVALUATION MATRIXES

Comprehensive evaluation matrix R evaluation methods mainly have expert evaluation method, analytic hierarchy process, and membership function method.

In above three methods, expert evaluation method is based on questionnaire survey and experts' evaluation result statistics, the result will have certain errors that are affected by human and psychological factors. So to let computed result to be more accurate, here uses analytic hierarchy process, define fuzzy relation matrix R ,from which: $R = (R_1,\ R_2,\ R_3,\ R_4,\ R_5,\ R_6)^T$.

Analytic hierarchy process-method athlete comprehensive evaluation matrix

Because athletes' evaluation indicators have ethical spirit and professional, psychological quality, physical quality, tactical quality, consciousness, cultural quality six kinds, carry on analytic hierarchy process on them one by one.

(1)Ethical spirit and professional

a. Target layer: Evaluation on Ethical spirit and professional

Criterion layer: Scheme influence factors, C_1 is moral character, C_2 is collective idea, C_3 is the determined spirit, C_4 is faith style.

Scheme layer: A_1 is very good, A_2 is all right, A_3 is ordinary, A_4 is bad.

By analyzing athletes' ethical spirit and professional, layer correlation influence factors from top to down, and get following hierarchical structure, as Figure 1.

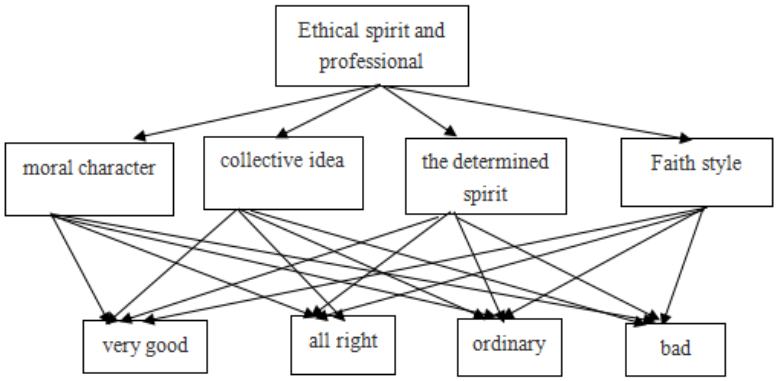

Figure 1: Class hierarchy

b.Construct paired comparison matrix

Construct paired comparison matrix is carrying on paired comparison among elements, using matrix to express each layer every element importance to previous layer all elements, here apply operational research expert proposed 1~9 ratio scale,as TABLE 1.

TABLE 1 : 1-9 Scale definition

Scale a_{ij}	**Definition**
1	factor i and factor j have equal importance
3	factor i is slightly more important than factor j
5	factor i is relative more important than factor j
7	factor i is extremely more important than factor j
9	factor i is absolute more important than factor j
2,4,6,8	Indicates middle state corresponding scale value of above judgments

According to above scale TABLE 1, set judgment matrix A as:

$$A = \begin{pmatrix} 1 & 3 & 3 & 3 \\ \frac{1}{3} & 1 & 5 & 5 \\ \frac{1}{3} & \frac{1}{5} & 1 & 1 \\ \frac{1}{3} & \frac{1}{5} & 1 & 1 \end{pmatrix}$$

And constructed scheme layer judgment matrixes correspond to different criterion layers are as following TABLE 2-5:

TABLE 2 : Criterion layer judgment matrix C_1

C_1	A_1	A_2	A_3	A_4
A_1	1	3	3	5
A_2	1/3	1	4	4
A_3	1/3	1/4	1	3
A_4	1/5	1/4	1/3	1

TABLE 3 : Criterion layer judgment matrix C_2

C_2	A_1	A_2	A_3	A_4
A_1	1	3	3	5
A_2	1/3	1	4	4
A_3	1/3	1/4	1	3
A_4	1/5	1/4	1/3	1

TABLE 4 : Criterion layer judgment matrix C_3

C_3	A_1	A_2	A_3	A_4
A_1	1	2	3	3
A_2	1/2	1	3	3
A_3	1/3	1/3	1	1/3
A_4	1/3	1/3	3	1

TABLE 5 : Criterion layer judgment matrix C_4

C_4	A_1	A_2	A_3	A_4
A_1	1	2	2	3
A_2	1/2	1	3	3
A_3	1/2	1/3	1	1/3
A_4	1/3	1/3	3	1

c. Calculate weight

For $A = \begin{pmatrix} 1 & 3 & 3 & 3 \\ \frac{1}{3} & 1 & 5 & 5 \\ \frac{1}{3} & \frac{1}{5} & 1 & 1 \\ \frac{1}{3} & \frac{1}{5} & 1 & 1 \end{pmatrix}$, firstly handling as following:

$$\xrightarrow{Column\ \ vector\ \ normalizat\ \ ion} \begin{pmatrix} 0.866 & 0.945 & 0.5 & 0.5 \\ 0.288 & 0.315 & 0.83 & 0.83 \\ 0.288 & 0.063 & 0.167 & 0.167 \\ 0.288 & 0.063 & 0.167 & 0.167 \end{pmatrix}$$

$$\xrightarrow{According\ \ to\ \ the\ \ row\ \ sum} \begin{pmatrix} 2.811 \\ 2.263 \\ 0.685 \\ 0.685 \end{pmatrix} \xrightarrow{The\ \ normalized} \begin{pmatrix} 0.703 \\ 0.566 \\ 0.171 \\ 0.171 \end{pmatrix} = W^0$$

Then,by $A\times W^{0}=\begin{pmatrix}0.703\\0.566\\0.171\\0.171\end{pmatrix}$ it further solves $\lambda^{0}{}_{\max}=4.242$。

Similarly, criterion layer judgment matrix corresponding maximum feature value and feature vector are successively:

$$\lambda^{(1)}{}_{\max}=2.874,\omega_1{}^{1}=\begin{pmatrix}0.883\\0.413\\0.140\end{pmatrix}$$

$$\lambda^{(2)}{}_{\max}=2.874,\omega_2{}^{1}=\begin{pmatrix}0.883\\0.413\\0.140\end{pmatrix};\lambda^{(3)}{}_{\max}=2.865,\omega_3{}^{1}=\begin{pmatrix}0.875\\0.406\\0.141\end{pmatrix}$$

d. Consistency test

Consistency indicator: $CI=\dfrac{\lambda_{\max}-n}{n-1}$

Random consistency indicator:Randomly generate multiple matrixes, add every matrix consistency indicator and then take average value, it gets RI TABLE 6.

TABLE 6 : Random consistency indicator

n	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51

Consistency ratio: If $CR=\dfrac{CI}{RI}<0.1$,constructed paired comparison matrix A passes consistency test.

By above steps' computation results, it can get that paired comparison matrix A maximum feature value $\lambda_{\max}=4,242$, $RI=0.90$

By consistency indicator $CI=\dfrac{\lambda_{\max}-n}{n-1}$,input data,it can calculate and get $CI=\dfrac{4.242-4}{4-1}=0.081$

And by consistency ratio $CR=\dfrac{CI}{RI}=\dfrac{0.081}{0.90}=0.089<0.1$,so constructed paired comparison matrix A passes consistency test. Similarly, it can verify criterion layer judgment matrixes also pass consistency test.

e. Calculate combination weight vector

By $W^{1}=\left(w_1,\quad w_2,\quad w_3,\quad w_4\right)$,and $W_1=W^{1}\times W^{0}$ it can calculate and get $W_1=\begin{pmatrix}0.1\\0.3\\0.5\\0.1\end{pmatrix}$

(2) Other evaluation indicator combination weight based on analytic hierarchy process

By above process, it can calculate and get psychological quality, physical quality, tactical quality, consciousness, cultural quality combination weight are successively as:

$$W_2=\begin{pmatrix}0.2\\0.3\\0.4\\0.1\end{pmatrix};W_3=\begin{pmatrix}0.2\\0.25\\0.5\\0.05\end{pmatrix};W_4=\begin{pmatrix}0.05\\0.4\\0.45\\0.1\end{pmatrix};W_5=\begin{pmatrix}0.1\\0.3\\0.4\\0.2\end{pmatrix};W_6=\begin{pmatrix}0.2\\0.35\\0.35\\0.1\end{pmatrix}$$

Comprehensive evaluation matrix

By above computed results, it is clear:

$$R_1=\begin{pmatrix}0.1\\0.3\\0.5\\0.1\end{pmatrix};R_2=\begin{pmatrix}0.2\\0.3\\0.4\\0.1\end{pmatrix};R_3=\begin{pmatrix}0.2\\0.25\\0.5\\0.05\end{pmatrix};R_4=\begin{pmatrix}0.05\\0.4\\0.45\\0.1\end{pmatrix};R_5=\begin{pmatrix}0.1\\0.3\\0.4\\0.2\end{pmatrix};R_6=\begin{pmatrix}0.2\\0.35\\0.35\\0.1\end{pmatrix}$$

And further by $R=(R_1,\ R_2,\ R_3,\ R_4,\ R_5,\ R_6)^T$ it can get comprehensive evaluation matrix as following:

$$R=\begin{pmatrix}0.1&0.2&0.2&0.05&0.1&0.2\\0.3&0.3&0.25&0.4&0.3&0.35\\0.5&0.4&0.5&0.45&0.4&0.35\\0.1&0.1&0.05&0.1&0.2&0.1\end{pmatrix}$$

Make comprehensive evaluation

Known $W=(\mu_j)_{1\times m}$, $R=(r_{ji})_{m\times n}$, by:

$$S=w\circ R=(\mu_1,\ \mu_2,\cdots,\ \mu_m)\circ\begin{pmatrix}r_{11}&r_{12}&\cdots&r_{1n}\\r_{21}&r_{22}&\cdots&r_{2n}\\\vdots&\vdots&\vdots&\vdots\\r_{m1}&r_{m2}&\cdots&r_{mn}\end{pmatrix}=(s_1,\ s_2,\cdots,\ s_n)$$

It can get fuzzy evaluation set S ,from which"$\circ$" is fuzzy composition operator. Here take fuzzy operator as $M(\cdot,\oplus)$ operator,that:

$$s_k=\min\left(1,\sum_{j=1}^{m}\mu_j r_{jk}\right),k=1,2,\cdots,n$$

Input above computed result into above formula, it can get:

$$S=(0.103,\ 0.298,\ 0.321,\ 0.441,\ 0.221,\ 0.136)$$

By analyzing fuzzy evaluation vector S, it makes comprehensive conclusion. Generally, it can adopt maximum membership principle, weighted average principle, fuzzy vector uniformization, and here apply maximum membership principle.

For maximum membership principle, if given fuzzy evaluation set $S=(S_1,S_2,\cdots,S_n)$,(from which S_i is grade v_i to fuzzy evaluation set membership), $M=\max(S_1,S_{2,}\cdots,S_n)$, M corresponding element is comprehensive evaluation result of evaluation.

By $S=(0.103,\ 0.298,\ 0.321,\ 0.441,\ 0.221\ 0.136)$, it is clear: $M=\max(S_1, S_2, \cdots, S_n)=0.441$。

Therefore, in athletes' professional skills evaluation, tactical quality is upmost factor in athletes' professional skills evaluation. Whether an athlete conforms to standard, his professional skill is qualified or not, it is mainly up to his tactics are qualified or not, from which it mainly contains basic tactics, professional technical and theoretical knowledge, technique foundation and others multiple aspects. In addition, other several kinds of indicators importance degree on athletes' professional skills evaluation are in order as: physical quality, psychological quality, consciousness, cultural quality, ethical spirit and professional.

CONCLUSION

The paper utilizes fuzzy comprehensive evaluation method to make quantitative analysis of athletes' professional skills, combines with tactics factor, physical quality, psychological quality, consciousness, cultural quality, ethical spirit and professional and others numerous indicators, calculates each indicator weight, by comparing weights size method to define numerous factors importance degree. On the basis of fuzzy comprehensive evaluation, utilizes analytic hierarchy process method to calculate evaluation matrix, establish hierarchical structure, and then calculate result. With respect to experts' evaluation, questionnaire survey and other methods, analytic hierarchy process computed result is more correct, conclusion is more convincing. By mathematical method, analyze athletes' professional skills evaluation numerous evaluation indicator, and then get a conclusion: tactical factor is upmost evaluation indicator to evaluate an athlete professional skill, secondly is physical quality, psychological quality, consciousness, cultural quality, ethical spirit and professional. In some time in future, Chinese athletes should strengthen professional basic skills, and carry on specialized training on each tactic; in addition they should also focus on physical quality and psychological quality promotion, which provides orientations for future Chinese athletes' professional skills promotion.

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