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Consistency test of martial arts competition evaluation criteria based on mathematical ahp model

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ABSTRACT

The grading criterion of Martial art routine competition is fine and complex, the time for the referee to judge the game is very short and limit, such as boxing etc. optional routine only 90s, some competition time of the games is even less. Therefore, in such cases, the referee should give a more accurate grade according to the rules, and the difficulty is very great. In order to strictly abide by the rules and reach the simple, fast and accurate goal, we must select some indicators and variables that can accurately reflect the comprehensive ability of athletes. This paper attempts to introduce AHP mathematical model; the evaluation criteria are divided into two categories; it uses statistical software tools SPSS to establish judgment matrix and conduct consistency test; the results shows that: in the judgment matrix consistency test of walkthrough level, CR = 0.5953 <0.1; the judgment matrix consistency test of action completion is CR = 0.808 <0.1. The above judgment indicators all can go through consistency test evaluation and can be applied in the actual game.

KEYWORDS

AHP;
Martial arts competition;
Performance evaluation;
Consistency testing.

INTRODUCTION

The evaluation criteria during martial arts competitions is an important measure of value for experts and coaches to make preparations, is the basis for classification. Without this measurement and basis, the evaluation activities cannot be carried through.

This paper uses AHP method, and selects some indicators and variables that can accurately reflect the comprehensive ability of athletes. The evaluation criteria are divided into two categories: walkthrough level and action completion, where walkthrough level is divided into skill level, action choreography, and exercise tips; action completion is divided into posture, style and spirit three evaluation criteria. It constructs matrix and conducts consistency test, then judges whether the above indicators can become the judgment criteria of the match.

THE ESTABLISHMENT OF AHP MODEL

AHP method is proposed by the American operational research experts T. L. Saaty in 1970s. After years of development it has now become a more mature approach. The basic principle is: dividing the various elements of the alternatives of the evaluation system into a number of levels, and taking the various elements of the

same level in accordance with upper layer element as a criterion, conducts pair-wise comparison and calculates the weight of each element, determine the optimal weighting scheme according to comprehensive weight and the maximum weight principle. It is deduced on the basis of simple additive weighting method. It reasonably combines qualitative and quantitative strategies, layering and quantifies the decision-making process in accordance with thinking and mental discipline. Since the method was introduced to the country in 1982, with the characteristics of disposing various decision-making processes combining its qualitative and quantitative factors, as well as it is a simple and flexible system, it has been widely used and valued in our social and economic fields, such as energy systems analysis, urban planning, economic management, and scientific evaluation.

Establish a hierarchical structure model

This paper takes the martial arts athletes' performance evaluation as a target layer of hierarchy analysis, takes the walkthrough level and action completion as the intermediate layer, takes the skill level, technique, action choreography, posture, style, rhythm and innovation capability as the program layer of AHP, establishes the hierarchical model of performance analysis for martial arts athletes, as shown in Figure 1.

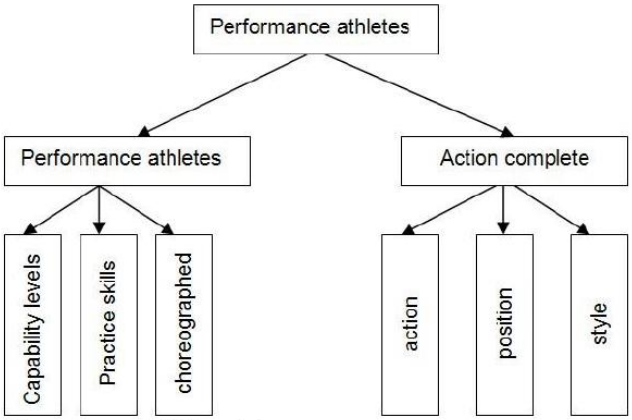

Figure 1 : The structure of AHP model

Construct judgment matrix and seek the largest eigenvalues and eigenvectors

Since hierarchical structure model determines the membership function of the upper and lower elements, you can construct pair-wise judgment matrix of different levels for the above layer criteria. If the pair-wise judgment matrix is $(a_{ij})_{n\times n}$, then $a_{ij} > 0$;

$$a_{ij} = \frac{1}{a_{ji}}, i.j = 1,2,3\cdots,n$$

The specific judgment matrix construction method of each level is: under the target layer of martial arts competition comprehensive evaluation, depending on the walkthrough level, action completion and other factors, conduct pair-wise comparison on the importance, the higher the class level is, the higher its importance becomes.

The inconsistencies of pair-wise comparisons:

$$A = \begin{bmatrix} 1 & 1/2 & 4 & \cdots \\ 2 & 1 & 7 & \cdots \\ \cdots\cdots & & & \end{bmatrix}$$

$$a_{12} = \frac{1}{2}(C_1 : C_2)$$

$$a_{13} = 4(C_1 : C_3) \Rightarrow a_{23} = 8(C_2 : C_3)$$

Allow inconsistent, but we need to determine the allowable range of inconsistent.

$$A = \begin{bmatrix} \frac{w_1}{w_1} & \frac{w_1}{w_2} & \cdots & \frac{w_1}{w_n} \\ \frac{w_2}{w_1} & \frac{w_2}{w_2} & \cdots & \frac{w_2}{w_n} \\ \cdots\cdots & & & \\ \frac{w_n}{w_1} & \frac{w_n}{w_2} & \cdots & \frac{w_n}{w_n} \end{bmatrix}$$

Consistent matrix properties:

(1) The rank of A is 1; the only non-zero eigenvalues of A is n.
(2) Any columns vector of A is corresponding to the eigenvectors of n.
(3) The normalized eigenvector of A can be used as weight vector.

For the inconsistent pair-wise comparison matrix A, recommend taking the corresponding eigenvector of maximum eigenvalue λ as the weight vector w, namely $A\varpi = \lambda\varpi$.

Comparison Scale: Saaty et al put forward

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$1 \sim 9$ scale, i.e. the value of a_{ij} is $1,2,3\cdots 9$ and its reciprocal $1,\frac{1}{2},\frac{1}{3}\cdots,\frac{1}{9}$, so as to facilitate the conversion from qualitative to quantitative.

TABLE 1 : Relative importance scale

Proportion Scale	Meaning
1	Represents the importance of the two elements are the same
3	Represents an factor is slightly important than another element
5	Represents an factor is significantly important than another element
7	Represents an factor is highly important than another element
9	Represents an factor is extremely important than another element
2,4,6,8	The median value of the above adjacent judgment
$1,\frac{1}{2},\cdots,\frac{1}{9}$	Is the reciprocal of the above scale

Psychologists believe that factors of pair-wise comparisons should be no more than nine.

Calculate the maximum eigenvalues and eigenvectors of judgment matrix by geometric mean approximation method (root method) ion. The calculation steps are:

(1)Calculate the product of matrix elements in each row:

$$m_i = \prod_{i=1}^{n} a_{ij}, i = 1,2,3\cdot n \quad (1)$$

(2)Calculate the n-th order root

$$\bar{\omega}_i = \sqrt[n]{m_i} \quad (2)$$

(3)Normalize the vector $\bar{\omega} = (\bar{\omega}_1, \bar{\omega}_2, \cdots \bar{\omega}_n)^T$:

$$\hat{\omega}_i = \frac{\bar{\omega}_i}{\sum_{J=1}^{n} \bar{\omega}_j} \quad j = 1,2,3\cdots n \quad (3)$$

The obtained $\hat{\omega} = (\hat{\omega}_1, \hat{\omega}_2, \cdots \hat{\omega}_1)^T$ is the eigenvector approximation, namely the weight of each factor.

(4)Calculate the maximum eigenvalue λ_{max} of the matrix;

$$\lambda_{max} = \frac{1}{n}\sum_{n=1}^{n} \frac{(A\hat{\omega})_i}{\omega_i} \quad (4)$$

Among them, $(A\hat{\omega})_i$ is the i -th element of the vector $A\hat{\omega}$.

Calculate the consistency index of judgment matrix and test its consistency

In order to test the consistency of the matrix, define

TABLE 2 : Average random consistency index

Order	1	2	3	4	5	6	7	8	9
5RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45

TABLE 3 : The judgment matrix consistency test of walkthrough level

X1	X2	X3	X4	M1	On cubic	Wi	Awi	AWi/Wi	CI=((λ-n)/(n-1))	CR=CI/RI
X2	1	1/3	4	1/3	0.57735	0.227930704	0.81	3.55	0.345284536	0.595318
X3	3	1	1/5	3	1.732051	0.683792113	2.14	3.13		
X4	1/4	1/5	1	0	0.223607	0.088277182	0.02	0.25		
					2.533008					
					Maximum eigenvalue =2.31					

X1: Walkthrough level; X1: Skill level; X3: Action choreography; X4: Exercise tips; M1: Multiplied by line

TABLE 4 : The judgment matrix consistency test of action completion

Action completion	Posture	Style	Spirit	Multiplied by line	On cubic	Wi	Awi	AWi/Wi	CI=(λ-n)/(n-1)	CR=CI/R
Posture	1	1/3	5	1.67	1.290994	0.318236656	0.91	2.86	0.468950025	0.808535
Style	3	1	2	6.00	2.44949	0.603811601	1.89	3.13		
Spirit	1/5	1/2	1	0.10	0.316228	0.077951743	0.02	0.20		
					4.056712					
					Maximum eigenvalue =2.06					

$CI = \frac{\lambda_{max} - n}{n-1}$. When it is fully consistent, then we have $CI = 0$. The larger is CI, the worse the consistency of the matrix is. For the $1 \sim 9$ order matrix, the average random consistency index RI is shown in TABLE.

When the order ≤ 2, the matrix has always complete consistency; when the order > 2, $CR = \frac{CI}{RI}$ is called random consistency of the matrix.

When $CR = \frac{CI}{RI} = \frac{\sum_{i=1}^{n} a_i CI_i}{\sum_{i=1}^{n} a_i CI_i} < 0.1$, the overall level sort results have a satisfactory consistency.

As can be seen from the TABLE $CR = 0.5953 < 0.1$, that the three indicators walkthrough level, action choreographed and exercise tips have gone through consistency test.

As can be seen from the TABLE $CR = 0.808 < 0.1$, that the three indicators: posture, style and spirit have gone through consistency test.

CONCLUSIONS

This paper introduces the AHP Comprehensive Evaluation indicators and gives judging mathematical model of martial arts competition. This model just needs general PC to run and operate, which is conducive to computerization. Evaluation criteria is divided into walkthrough level and action completion two indicators, where walkthrough level is divided into skill level, action choreography, and exercise tips; Action completion is divided into posture, style and spirit three evaluation criteria; establish judgment matrix and carry out consistency test through well-known statistical tools EXCLE, the results show: the judgment matrix consistency test of walkthrough level, , indicates that three indicators skill level, action choreography, and exercise tips have gone through consistency test; the judgment matrix consistency test of action completion, , indicates that three indicators posture, style and spirit have gone through consistency test. The above judgment indicators all have passed the assessment, and can be applied in the actual game.

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