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Analytic hierarchy process-based high-level coaches teaching capacity development research

Pengcheng Li

Institute of Physical Education, Jiangsu Normal University, Xuzhou, Jiangsu, (CHINA)

ABSTRACT

With the constantly deepening of China's opening-up and reform, competitive sports emphasis is also constantly enhancing, the paper makes analysis of high-level coaches' teaching capacity influential three hierarchical factors by applying documents literature, mathematical statistics and analytic hierarchy process and other s, applies analytic hierarchy process method to define weights, and handles with obtained data by using SPSS software, finally gets Chinese high-level coaches put higher attentions to sports team management and training guiding capacity such aspects, while they still need to be further improved in their language expression ability and scientific talents selection aspects' emphasis.

KEYWORDS

Analytic hierarchy process; High-level coaches; Teaching capacity; Factor analysis; Consistency test.



INTRODUCTION

Competitive sports development as an important sign of a country sports development extent in today, competitive sports development not only lies in athletes' efforts but also is closely linked to coaches' levels, so research on coaches' teaching capacity has already become key topic in today's research.

Regarding high-level coaches' teaching capacity research, formers have already made many efforts, such as : Cao Fu-Gui in the article regarding tennis coaches' teaching capacity analysis, he analyzed and studied on Chinese tennis coaches' teaching capacity by applying documents literature, interviewing, questionnaire survey, mathematical statistics and other methods, and compared people in different age phases, got their existing differences; Wang Xiao-Chun made analysis of Chinese universities high-level coaches' teaching capacity influential factors, he thought that universities athletics coaches professional learning and educational ability well mastering could let them to possess stronger ability to solve practices, but their environment had passive effect on their development.

The paper just based on formers researches basis, makes analysis and researches on high-level coaches' teaching capacity, and finally gets conclusion to provide references for present Chinese sports circle selecting high-level coaches and breathing new life into Chinese sports development.

HIGH-LEVEL COACHES' TEACHING CAPACITY FACTORS ANALYSIS

With Beijing Olympic Games successfully host, China's emphasis on coaches is also constantly promoting, every coach teaching capacity plays crucial roles in athletes' development.

By consulting lots of literatures, the paper finally defines regarding high-level coaches' teaching capacity influence factors three levels factors. As following TABLE 1 shows:

To establish a relative clearly and reasonable analysis model, firstly it should establish three-levels relationship, classified layers numbers are related to research objects complex and detailed extent.

Construct each layer judgment matrix

In criterion layer, each criterion objective proportion is different, by researcher' researching on criterion layer, and according to number1~9 and its reciprocal, it judges each criterion objective proportions.

The paper takes TABLE 1 showed 1~9 scale table as evidence, it makes weight analysis, as TABLE 2 shows:

At first, solve judgment matrix, according to above principle, reference1~9 scale setting, and according to experts' experiences and refer to lots of documents, it gets paired comparison matrix.

According to first grade indicator's judgment matrix vector, carry out normalization with it; solve the sum and then make normalization, then it can get weight vector. According to feature value and feature vector relations, it can solve feature value; its implementation method is as following:

Firstly, normalize judgment matrix every column, its result is:

$$K_{ij} = K_{ij} / \sum_{k=1}^n K_{kj} \quad (i, j = 1, 2, \dots, n) \tag{1}$$

Then solve the sum by lines on judgment matrix that makes normalization by column, it can get:

$$\bar{\omega}_i = \sum_{j=1}^n K_{ij} \quad (i = 1, 2, \dots, n) \tag{2}$$

Above vector $\bar{\omega} = [\bar{\omega}_1, \bar{\omega}_2, \dots, \bar{\omega}_n]^T$ proceeds with normalization processing:

TABLE 1 : High level coaches' teaching capacity each level factor

| | | |
|--|--|--|
| High level coaches' teaching capacity influence factors U | Social environment K_1 | T_{11} Funds support |
| | | T_{12} Motivation system |
| | | T_{13} Social capacity |
| | Ability to manage sports team and guide training K_2 | T_{21} Ability to make effective decisions |
| | | T_{22} Ability to guiding athletes competition |
| T_{23} Cooperation, communicative competence | | |
| T_{24} Sports nutrition reasonable application ability | | |
| T_{25} Language expression ability | | |
| T_{26} Individualized training ability | | |
| T_{27} Pacifying and adjusting athletes emotions ability | | |
| T_{28} Cultivate athletes thinking training problems abilities | | |
| Scientific research and innovation ability K_3 | T_{31} Training load master ability | |
| | T_{32} Updating knowledge ability | |
| | T_{33} Innovation ability in training methods and ways | |
| | T_{34} Knowledge crossover and optimization grouping ability | |
| | T_{35} Discover and solve training problems' ability | |
| | T_{36} Training pattern innovation ability | |
| Professional quality K_4 | T_{41} Training plan making and executing ability | |
| | T_{42} Sports experiences and teaching experiences | |
| | T_{43} Mastering and applying professional knowledge level ability | |
| | T_{44} Scientific talents selection ability | |
| | T_{45} Organizing training and competition spot strain capacity | |
| | T_{46} Training methods and ways application ability | |
| | T_{47} Emotion control ability | |
| | T_{48} Technical motions modeling ability | |
| Professional ethics K_5 | T_{51} Fair competition | |
| | T_{52} Moral cultivation | |
| | T_{53} Political thought | |
| | T_{54} Spirit of utter devotion | |
| | T_{55} Teamwork | |

TABLE 2 : 1~9 scale table

| 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 |
| Reciprocal | If i factor and j factor are weak, obtained judgment value is reciprocal |

$$\bar{\omega}_i = \frac{\bar{\omega}_i}{\sum_{j=1}^n \bar{\omega}_j} (i = 1, 2, \dots, n) \tag{3}$$

Then: $\omega = [\omega_1, \omega_2, \dots, \omega_n]^T$ is solved feature vector.

In addition, calculate maximum feature root, the process is:

$$\lambda_{\max} = \sum_{i=1}^n \frac{(U\omega)_i}{n\omega_i} \tag{4}$$

In above formula $(U\omega)_i$ represents vector $(U\omega)$'s the i component.

According to above formula, we can respectively solve Chinese sports scientific research and innovation ability comprehensive assessment analysis first grade indicator, second grade indicator to first grade indicator weight and maximum feature value. After that, calculate consistency influence factor CI :

$$CI = \frac{\lambda_{\max} - n}{n - 1}$$

Then go ahead with consistency ratio test CR :

$$CR = \frac{CI}{RI}$$

Model application

According to above analytic hierarchy process theory, combine with the paper proposed high-level coaches' teaching capacity analysis, it constructs corresponding judgment matrix, as following:

$$U = \begin{pmatrix} 1 & 1/4 & 1/4 & 1/5 & 1 \\ 4 & 1 & 3 & 1/3 & 4 \\ 4 & 1/3 & 1 & 1/3 & 4 \\ 5 & 3 & 4 & 1 & 5 \\ 1 & 1/4 & 1/4 & 1/5 & 1 \end{pmatrix}$$

$$U_{K1} = \begin{pmatrix} 1 & 1/2 & 1/3 & 1/2 & 1/2 \\ 2 & 1 & 1/2 & 1 & 2 \\ 3 & 2 & 1 & 2 & 1 \\ 2 & 1 & 1/2 & 1 & 1 \\ 2 & 1 & 1/2 & 1 & 1 \end{pmatrix}$$

$$U_{K2} = \begin{pmatrix} 1 & 1 & 3 & 1/2 & 2 & 1 & 3 & 6 \\ 1 & 1 & 3 & 1/2 & 2 & 1 & 3 & 6 \\ 1/3 & 1/3 & 1 & 1/2 & 1/3 & 1/3 & 1 & 4 \\ 2 & 2 & 2 & 1 & 1/2 & 1/2 & 2 & 4 \\ 1/2 & 1/2 & 3 & 2 & 1 & 1/2 & 1/2 & 5 \\ 1 & 1 & 3 & 2 & 2 & 1 & 3 & 6 \\ 1/3 & 1/3 & 1 & 1/2 & 2 & 1/3 & 1 & 4 \\ 1/6 & 1/6 & 1/4 & 1/4 & 1/5 & 1/6 & 1/4 & 1 \end{pmatrix}$$

$$U_{K3} = \begin{pmatrix} 1 & 1 & 2 & 1 & 1/2 & 2 \\ 1 & 1/2 & 2 & 1 & 1/2 & 2 \\ 1/2 & 1 & 1 & 1/2 & 1/3 & 1 \\ 1 & 1 & 2 & 1 & 1/2 & 2 \\ 1 & 2 & 3 & 2 & 1 & 1 \\ 1/2 & 1/2 & 1 & 1/2 & 1/3 & 1 \end{pmatrix}$$

$$U_{K4} = \begin{pmatrix} 1 & 1/5 & 2 & 1/5 & 6 & 6 & 5 & 4 \\ 3 & 1 & 4 & 1 & 7 & 6 & 6 & 5 \\ 1/2 & 1 & 1 & 1/5 & 5 & 4 & 3 & 2 \\ 3 & 1/4 & 5 & 1 & 7 & 6 & 6 & 5 \\ 1/5 & 1/7 & 1/5 & 1/7 & 1 & 1/2 & 1/2 & 1/3 \\ 1/5 & 1/6 & 1/4 & 1/6 & 2 & 1 & 1/2 & 1/3 \\ 1/4 & 1/6 & 1/3 & 1/6 & 2 & 2 & 1 & 1/2 \\ 1/3 & 1/5 & 1/2 & 1/5 & 3 & 3 & 2 & 1 \end{pmatrix}$$

$$U_{K5} = \begin{pmatrix} 1 & 1/5 & 1/5 \\ 5 & 1 & 1 \\ 5 & 1 & 1 \end{pmatrix}$$

Weight calculation and consistency test

By above judgment matrix, the paper does normalization processing with data: $\bar{p}_{ij} = \frac{P_{ij}}{\sum_{k=1}^n \bar{P}_{ij}}$

($i, j=1, 2, 3, \dots, n$), it can get:

$$\begin{bmatrix} 1 & \frac{1}{4} & \frac{1}{4} & \frac{1}{5} & 1 \\ 4 & 1 & 3 & \frac{1}{3} & 4 \\ 4 & \frac{1}{3} & 1 & \frac{1}{3} & 4 \\ 5 & 3 & 4 & 1 & 5 \\ 1 & \frac{1}{4} & \frac{1}{4} & \frac{1}{5} & 1 \end{bmatrix} \Rightarrow \bar{p}_{ij} = \begin{bmatrix} 0.067 & 0.052 & 0.029 & 0.097 & 0.067 \\ 0.267 & 0.207 & 0.353 & 0.161 & 0.267 \\ 0.267 & 0.069 & 0.118 & 0.161 & 0.267 \\ 0.333 & 0.621 & 0.471 & 0.484 & 0.333 \\ 0.067 & 0.052 & 0.029 & 0.097 & 0.067 \end{bmatrix}$$

After that, for above result, go ahead with line transformation and column transformation, and then carry on normalization on obtained vectors

$$W_i = \frac{W_i}{\sum_{j=1}^n \bar{W}_j} (i = 1, 2, 3 \dots n) \tag{5}$$

It gets:

$$W = \begin{bmatrix} 0.095 \\ 0.206 \\ 0.339 \\ 0.180 \\ 0.180 \end{bmatrix}$$

According to above formula, calculate maximum feature root λ_{max} , $\lambda_{max} = \sum_{i=1}^n \frac{(PW)_i}{nW_i}$, among them:

$$(PW)_i = \begin{bmatrix} 0.491 \\ 1.105 \\ 1.756 \\ 0.926 \\ 0.926 \end{bmatrix} \quad nW_i = \begin{bmatrix} 0.476 \\ 1.032 \\ 1.696 \\ 0.898 \\ 0.898 \end{bmatrix}$$

$$\lambda_{max} = 0.491/0.476 + 1.105/1.031 + 1.756/1.696 + 0.926/0.898 + 0.926/0.898 = 5.199$$

Then, go ahead with consistency test

$$\left. \begin{aligned} CI &= \frac{\lambda_{max} - n}{n-1} = \frac{5.199-5}{5-4} = 0.05 \\ RI(n=5) &= 1.12 \end{aligned} \right\} CR = \frac{CI}{RI} = 0.045 < 0.10$$

According to above steps, by obtained judgment matrix, it can get its result as following TABLE 3 shows:

By above two tables second, third level factors, in order to more vividly present mutual relationships, draw pictures, from which it draw bar charts on second level indicators, as following Figure 1 shows:

Draw third level indicators into broken line Figure, as following Figure 2 shows :

By high level coaches' teaching capacity each factor weight, it can get factors maximum feature value, consistency result, as following TABLE 4 shows:

By above TABLE 4, we can get random consistency ratio $CR < 0.1$, so it proves the judgment matrix construction has satisfactory consistency.

TABLE 3 : Second, third level factors weights

| First level factor | Factor value | Second level factor | Weight | Third level factor | Weight |
|--------------------|--------------|---------------------|--------|--------------------|--------|
| U | 1 | K_1 | 0.061 | T_{11} | 0.456 |
| | | | | T_{12} | 0.454 |
| | | | | T_{13} | 0.091 |
| | | K_2 | 0.458 | T_{21} | 0.100 |
| | | | | T_{22} | 0.289 |
| | | | | T_{23} | 0.144 |
| | | | | T_{24} | 0.033 |
| | | | | T_{25} | 0.026 |
| | | | | T_{26} | 0.297 |
| | | | | T_{27} | 0.067 |
| | | | | T_{28} | 0.064 |
| | | K_3 | 0.164 | T_{31} | 0.089 |
| | | | | T_{32} | 0.170 |
| | | | | T_{33} | 0.170 |
| | | | | T_{34} | 0.089 |
| | | | | T_{35} | 0.31 |
| | | | | T_{36} | 0.170 |
| | | K_4 | 0.255 | T_{41} | 0.100 |
| | | | | T_{42} | 0.289 |
| | | | | T_{43} | 0.144 |
| | | | | T_{44} | 0.033 |
| | | | | T_{45} | 0.026 |
| | | | | T_{46} | 0.297 |
| | | | | T_{47} | 0.067 |
| | | | | T_{48} | 0.064 |
| | | K_5 | 0.061 | T_{51} | 0.339 |
| | | | | T_{52} | 0.206 |
| | | | | T_{53} | 0.095 |
| T_{54} | 0.180 | | | | |
| T_{55} | 0.180 | | | | |

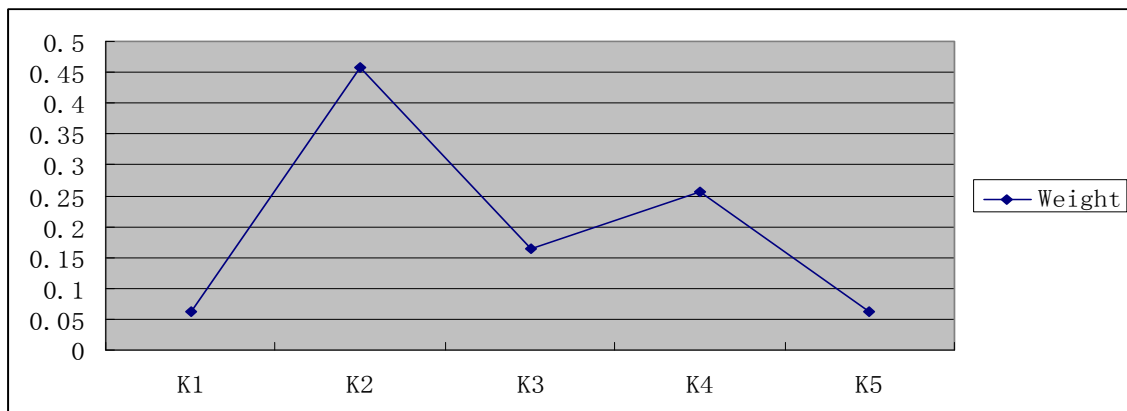


Figure 1 : Figure two factors weights

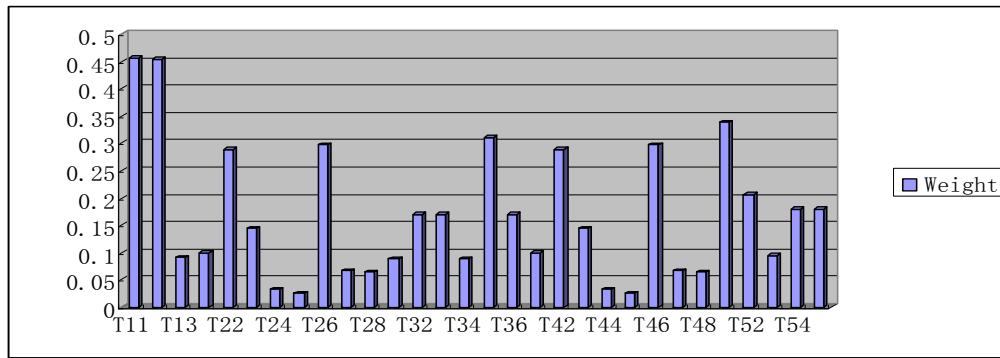


Figure 2 : Figure three factors weights

TABLE 4 : Consistency proportion value

| Factor | U | K_1 | K_2 | K_3 | K_4 | K_5 |
|-----------------|-------|-------|-------|-------|-------|-------|
| λ_{max} | 5.348 | 5.199 | 8.61 | 6.014 | 8.427 | 3 |
| CI | 0.087 | 0.05 | 0.087 | 0.003 | 0.061 | 0 |
| RI | 1.12 | 1.12 | 1.41 | 1.24 | 1.41 | 0.58 |
| CR | 0.078 | 0.045 | 0.062 | 0.002 | 0.043 | 0 |

CONCLUSION

By researching on high-level coaches' teaching capacity, the paper finally gets high-level coaches' teaching capacity influential second level factors' coaches' athletes management ability and training guiding ability occupy most proportions by Figure 1, it proves Chinese coaches' emphasis on these aspects are higher, while proportions in professional ethics and social environment aspects are small, it proves Chinese coaches should further improve in these aspects.

By Figure 2's third level influence factors, we can get high-level coaches occupy larger proportions in funds support and motivation system, while occupy smaller proportions in language expression ability and scientific talents selection, it shows China should make larger improvements in the fields, Chinese sports teaching capacity level then can make larger leap, and new life would breath into Chinese sports development.

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