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# AHP-Based new rural sports development policy priority study

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## ABSTRACT

According to analytic hierarchy process mathematical method, through referencing relative literatures and following to experts' opinions, the paper sets reasonable criterion layer, selects relative scheme policy layer, and establishes rural sports facilities resources analytic hierarchy process. Solve individual policies weights, define best policies, develop rural sports and let national fitness to move forward. Select optimal schemes from four alternative policies schemes, and meanwhile according to schemes weights, it defines schemes priorities, implementing policies priorities are in order as vigorously establish sports infrastructure, vigorously develop sports industry, perfect rural sports laws and regulations, diversification of rural sports investment.

## KEYWORDS

Analytic hierarchy process; New rural sports; Optimal scheme; Sports facility construction.

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## INTRODUCTION

Today, China economy rapidly develops and rises, urbanization speed quickens, and urban supporting services bear huge pressures. Though since China implemented “national fitness play outline” in 1995, national living standard in sports fitness aspect has been obviously improved, in view of China’s villages, rural residents’ fitness in village is still restricted. Many causes here as insufficient infrastructure, deficient peasants fitness awareness, imperfect sports laws and regulations and so on. And comprehensive implement national fitness, improve national physical quality, the key is to solve rural sports correlation problems.

Rural sports facility resources deficiency seriously restricts rural sports development. The paper targeted at the problem, it utilizes analytic hierarchy process mathematical methods, analyzes how to speed up and scientific construct rural sports facilities policies and schemes so as to define optimal schemes, speed up rural sports facilities construction and provide references for government policies support.

## CHINA SPORTS STATUS

China achieved competitive sports aspect performances are remarkable, and meanwhile nation also constantly increases supporting and investment on sports. Sports infrastructure construction, sports employees are continuously increasing. Sports development shows unprecedented vitality, and sports considerable progress will also promote economic growth, and propel to social harmony. It will plays huge impelling roles in improving people’s living standards. Figure 1 is sports system organizational staff amount in 2010-2012.

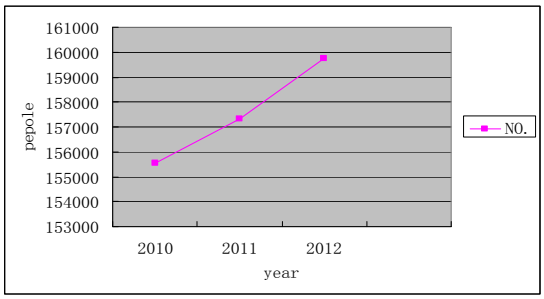


**Figure 1 : Sports organization employees’ numbers growth**

Figure 1 show sports are steady growing, but it mainly concentrates on cities and towns. Urban sports steady growth will drive rural sports development and form the development trend of city leading countryside. Countryside should make good preparation for sports facility construction; make joint efforts with cities and towns to implement national fitness and speed up construction.

## RURAL SPORTS HIERARCHICAL SCHEMES

According to experts opinions and literatures, define criterion layer, scheme layer to speed up rural sports construction as TABLE 1.

Analytic hierarchy process is systematic hierarchical mathematical analysis method that proposed by American famous scholar Saaty in the 70s of last century, that is AHP. The core of algorithm is weight computation. It specially applies to multiple target problems, and complex systematic decision problems, is a powerful mathematical method that transforms problems into quantitative research. Its features are simple thought, well-arranged, widely application range and so on, now analytic hierarchy process method has already been applied into each field to solve practical problems. The process of analytic hierarchy process is mainly divided into four procedures.

**TABLE 1 : Rural sports hierarchical structure**

| Target layer | Criterion layer C | Scheme layer P |
|---|---|---|
| Promote rural sports development (O) | Increase rural sports facility ( $C_1$ ) | Vigorously develop sports industry ( $P_1$ ) |
| | Strengthen physiques ( $C_2$ ) | Vigorously establish sports infrastructure ( $P_2$ ) |
| | Increase number of people that enjoying sports services ( $C_3$ ) | Perfect rural sports laws and regulations ( $P_3$ ) |
| | Increase fitness awareness ( $C_4$ ) | Diversification of rural sports investment( $P_4$ ) |

**Step one: establish hierarchical structure**

In analytic hierarchy process optimization decision algorithm, hierarchical structure are mainly three layers, 1, Target layer (O), that is final expected result, in the paper, it is promoting rural sports development. 2, Criterion layer ($C_m$), is problem's restricted conditions, criterion layer can cover sub layer. 3, Scheme layer ( $p_n$ ), alternative methods that can solve problems. For different schemes, according to criterion, it establishes hierarchical structure and then calculates scheme weight, the maximum weight one is best scheme.

**Step two: judgment matrix**

In sport scheme layer hierarchical structure's one layer, there are n pieces of factor $C=(C_1,\ C_2,\ \cdots\ C_n)$ that causes impacts on previous layer target or criterion. By paired comparison of factors, express comparison result with 1-9 or its reciprocal. $C_i, C_j$ importance comparison structure is using $a_{ij}$ to express, then all factors carry out comparison and then can get judgment matrix A. Its expression is as following:

$$A=\begin{pmatrix} a_{11} & a_{12} & \cdots & a_{1j} \\ a_{21} & a_{22} & \cdots & a_{2j} \\ \vdots & \vdots & \ddots & \vdots \\ a_{i1} & a_{i2} & \cdots & a_{ij} \end{pmatrix}$$

Among them, $a_{ij}$ value is respective expressed by 1~9 numbers and their reciprocals, after Saaty researching, it is thought that using 1~9 scale to express comparison structure conforms to people judgment ability in psychology. Numbers' respective expressive definitions are as following TABLE 2.

**TABLE 2: 1~9 scale meaning**

| Scale | Meaning |
|---|---|
| 1 | Indicates two factors have equal importance by comparing |
| 3 | Indicates the former is slightly more important than the later by comparing two factors |
| 5 | Indicates the former is more important than the later by comparing two factors |
| 7 | Indicates the former is relative more important than the later by comparing two factors |
| 9 | Indicates the former is extremely more important than the later by comparing two factors |
| Even number | Represents importance is between two odd numbers |
| Reciprocal | Represents factors positive and negative comparison orders. |

**Step-3: Weight vector and maximum feature value calculation**

Calculate weight vector. In the following, it introduces a kind of relative simple weight vectors computational method. Assume judgment matrix A's one layer has n piece of factors, and the n pieces of factors are all the factors. The weight on previous layer is using vector to express as

$$W = (w_1, w_2, w_3 \cdots w_n)$$

Weight meets :

$$w_1 + w_2 + w_3 \cdots + w_n = 1$$

Calculate n pieces of factors and get consistency matrix

$$A = \begin{pmatrix} w_1 / w_1 & w_1 / w_2 & \cdots & w_1 / w_n \\ w_2 / w_1 & w_2 / w_2 & \cdots & w_2 / w_n \\ \vdots & \vdots & \ddots & \vdots \\ w_n / w_1 & w_n / w_2 & \cdots & w_n / w_n \end{pmatrix}$$

1, Firstly make normalization on all column vectors of A and get matrix D:

$$D = \begin{pmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nn} \end{pmatrix} \bullet \begin{pmatrix} 1/\sum_{i=1}^{n} a_{i1} & 0 & \cdots & 0 \\ 0 & 1/\sum_{i=1}^{n} a_{i2} & \cdots & 0 \\ 0 & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & 1/\sum_{i=1}^{n} a_{in} \end{pmatrix}$$

2, Solve obtained matrix every line sum

$$E = D \bullet (1 \quad 1 \quad \cdots \quad 1)_{1\times n}^{T}$$

$$E = (e_{11} \quad e_{12} \quad \cdots \quad e_{1n})^{T}$$

3, Normalize matrix E that is weight vector

$$W = (w_1 \quad w_2 \quad \cdots \quad w_n)^{T} = \left( e_{11} / \sum_{i=1}^{n} e_{i1} \quad e_{12} / \sum_{i=1}^{n} e_{i1} \quad \cdots \quad e_{1n} / \sum_{i=1}^{n} e_{i1} \right)^{T}$$

4, Maximum feature value calculation
Weight vector corresponds to maximum feature value, then it surely has :

$$AW = \lambda_{\max} W$$

$$\lambda_{\max} = \frac{1}{n} \sum_{i=1}^{n} \frac{(AW)_i}{w_i}$$

**Step four: Consistency test**

*CI* represents matrix consistency indictor, *CR* represents matrix consistency ratio, test matrix consistency by calculating the two indicators:

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

Among them, $n$ represents judgment matrix one layer numbers of factors, and also the order number:

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

Among them, *RI* represents Random Consistency Index value, as following TABLE 3 show.

**TABLE 3 : RI value table**

| 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 |

Assume in layer A that m pieces of factors values computational result is $\alpha_m$, corresponding consistency indicator value is respectively $CI_m$, in next layer B, n pieces of factors to layer A computational weight is $\beta_{nm}$, then layer B factors total arrangement weight is:

$$w_i = \sum_{j=1}^{m} \alpha_i \beta_{ij}$$

Combination consistency test consistency ratio is:

$$CR = \frac{\sum_{j=1}^{m} \alpha_j CI_j}{\sum_{j=1}^{m} \alpha_j RI_j}$$

Criterion for judging matrix meets consistency or not is : When $CR \geq 0.1$, matrix inconsistency is unacceptable. When $CR < 0.1$,matrix inconsistency is acceptable.

## PROMOTE RURAL SPORTS DEVELOPMENT PLANS SELECTION

### Criterion layer and scheme layer weight vectors calculation

According to TABLE 1 rural sports development hierarchical structure constructed judgment matrixes and calculated weight vectors are respectively as following TABLE 4-8.

**TABLE 4 : Importance weight of factor C to target O**

| O | $C_1$ | $C_2$ | $C_3$ | $C_4$ | W |
|---|---|---|---|---|---|
| $C_1$ | 1 | 3 | 1 | 4 | 0.385 |
| $C_2$ | 1/3 | 1 | 1/3 | 2 | 0.143 |
| $C_3$ | 1 | 3 | 1 | 4 | 0.385 |
| $C_4$ | 1/4 | 1/2 | 1/4 | 1 | 0.087 |

**TABLE 5 : Importance weight of scheme P to criterion $C_1$**

| $C_1$ | $P_1$ | $P_2$ | $P_3$ | $P_4$ | W |
|---|---|---|---|---|---|
| $P_1$ | 1 | 1/5 | 2 | 3 | 0.166 |
| $P_2$ | 5 | 1 | 7 | 9 | 0.665 |
| $P_3$ | 1/2 | 1/7 | 1 | 3 | 0.114 |
| $P_4$ | 1/3 | 1/9 | 1/3 | 1 | 0.055 |

**TABLE 6 : Importance weight of scheme P to criterion $C_2$**

| $C_2$ | $P_1$ | $P_2$ | $P_3$ | $P_4$ | W |
|---|---|---|---|---|---|
| $P_1$ | 1 | 1/3 | 3 | 2 | 0.219 |
| $P_2$ | 3 | 1 | 7 | 5 | 0.589 |
| $P_3$ | 1/3 | 1/7 | 1 | 1 | 0.087 |
| $P_4$ | 1/2 | 1/5 | 1 | 1 | 0.104 |

**TABLE 7: Importance weight of scheme P to criterion $C_3$**

| $C_3$ | $P_1$ | $P_2$ | $P_3$ | $P_4$ | W |
|---|---|---|---|---|---|
| $P_1$ | 1 | 3 | 7 | 8 | 0.576 |
| $P_2$ | 1/3 | 1 | 5 | 5 | 0.276 |
| $P_3$ | 1/7 | 1/5 | 1 | 3 | 0.097 |
| $P_4$ | 1/8 | 1/5 | 1/3 | 1 | 0.052 |

**TABLE 8: Importance weight of scheme P to criterion $C_4$**

| $C_4$ | $P_1$ | $P_2$ | $P_3$ | $P_4$ | W |
|---|---|---|---|---|---|
| $P_1$ | 1 | 1 | 1/5 | 3 | 0.148 |
| $P_2$ | 1 | 1 | 1/5 | 3 | 0.148 |
| $P_3$ | 5 | 5 | 1 | 9 | 0.647 |
| $P_4$ | 1/3 | 1/3 | 1/9 | 1 | 0.057 |

## Calculation result test

Carry on consistency test and combination consistency test of above five judgment matrixes weight vector calculation, maximum feature value and consistency test indicators lists as following TABLE 9-10.

**TABLE 9: Selected schemes' three layers calculation results**

| P | $C_1$ | $C_2$ | $C_3$ | $C_4$ |
|---|---|---|---|---|
| | **0.385** | **0.143** | **0.385** | **0.087** |
| $P_1$ | 0.166 | 0.219 | 0.576 | 0.148 |
| $P_2$ | 0.665 | 0.589 | 0.276 | 0.148 |
| $P_3$ | 0.114 | 0.087 | 0.097 | 0.647 |
| $P_4$ | 0.055 | 0.104 | 0.052 | 0.057 |
| | 4.102 | 4.021 | 4.206 | 4.032 |
| | 0.038 | 0.008 | 0.076 | 0.012 |

**TABLE 10 : Scheme layer total arrangement weight table**

| Target layer | Scheme layer | Weight |
|---|---|---|
| Promote rural sports development | Vigorously develop sports industry ( $P_1$ ) | 0.330 |
| | Vigorously establish sports infrastructure( $P_2$ ) | 0.459 |
| | $\lambda_j$ | 0.150 |
| | $CR_j$ | 0.061 |

## CONCLUSION

By TABLE 9 calculation result, it can get conclusion that different schemes have their own advantages for four different criterions. Scheme one can promote criterion three formation and development, scheme two can promote criterion one formation and development, scheme three can promote criterion four formation and development, scheme four can promote criterion two formation and development.

In TABLE 10 by weight analysis of comprehensive considering schemes overall promotion to rural sports development, calculation result shows vigorously establish sports infrastructure can effective directly promote rural sports development, its weight is the largest, is optimal scheme of four schemes' comprehensive consideration. It means when implement policies, policies implementation priority should be in order as vigorously establish sports infrastructure, vigorously develop sports industry, perfect rural sports laws and regulations, diversification of rural sports investment.

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