

The Comprehensive Study and Evaluate of the Excellent Sports Community of a City Based on the Analytic Hierarchy Process

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Abstract: In recent years, the living standard of the people in our county is getting higher and higher. Most people added sports activities in their lives based on the guarantee of eating and wearing fine. More and more people participated in the community sports activities especially after the Beijing Olympic Games in 2008. Our country also gives its high attention and full support. Yet, it is not very optimistic in the development of the sports community. This article makes the Gulanyu Island of Xiamen, Haidian District in Beijing, Pudong in Shanghai as the object of the study, and we use the Analytic Hierarchy Process build the model to judge the excellent sports community. And this criterion including expenditure of the activity, the sports ground, the guidance team, activity organization and the sports conscious of the residents. We appraise the importance comparison value in pairs of factors through the related data and experience. And we calculate the result by Matlab in using of Analytic Hierarchy Process. The result shows that the excellent sports community is Gulanyu Island of Xiamen.

Keywords: Analytic hierarchy process, health standard, judgment matrix, sports community, sports industry.

1. INTRODUCTION

Sports community is a part of the culture category in public service which advocated by the country. Its commonweal and amusing were loved by some residents. Yet, the development situation of the sports activity in the community is not optimistic because of the factors influenced as short in expenditure of the activity and the limitation of the sports ground [1]. To increase the enthusiasm of sports among the residents, governments at all levels will hold corresponding games to evaluate the sports communities. There are so many factors that affecting, this article will pay attention to study that which one of them mainly does the affection [2].

Li Zhongtao made the City of Guilin as the study object, and used many ways to investigate the problem in the article of The Study of the Development Countermeasure of the Problem of Sports Guidance Service in Community of a City [3]. The result showed that the reason of the unwell development of the community sports are the unreasonable location of the sports ground distribution, lack of the expenditure of the activity, the irresponsible of the guidance work and so on [4].

Wang Huiwen investigated a community in the City of Chongqing, and the result was showed in the form of data in

the article of The Individual Case Study of the Instruction of the Community Sports Public Service System in Cities. Wang made the analysis and pointed out that the problems that exist in the community including the incomplete of the organization system, the lack of the communication between the administrator and the residents, the lack of the sports ground and so on. Zeng Chaohui concluded the situation of the sports public service in our country and abroad, at the same time, Zeng set the evaluation factors of the public service of a community in Hangzhou in the article of The Study of the Community Sports Public Service Evaluation System in Cities [5]. And Zeng continued screen the influence factors combined with the situation of that area, and confirmed the evaluation system of public service in that district. Liu Wei comprehensively used many ways of study in the article of The Investigation and Study of the Situation of the Community Sports in the City of Qingdao. Liu sampled seven district in the city of Qingdao, and studied organizing situation, the participating situation of the participant, facility of the ground, expenditure of the activity, guidance team and so on. Based on that, he provided the reference suggestion to the sports department of Qingdao in the sports situation of the city of Qingdao. And these problems stucked the development of the sports community in the city of Linfen [6].

Above all, we can see that there are the same limitation factors about the development of community sports in different cities. This article will use Analytic Hierarchy Process to find the excellent sports community in three.

2. THE BASIC THEORY OF MODELING

AHP could solve the complicated and vague decision problems. To modeling in use of this theory need four steps:

- (1) Make the project of Hierarchical Structure building.
- (2) Construction all the Judgment Matrix of every tier.
- (3) Single sort of the tier and the inspection of the consistency.
- (4) The whole sort of the tiers and the inspection of the consistency.

2.1. Hierarchical Structure

The problem that AHP could solve should be in tiers, in method and logically. We can construct the hierarchical project only in this way. We make the factors of the complicated problems in many progressive tiers by the order of its attribute, the degree of subordinate and the relations [7]. the elements of the last tier could govern it, and in the normal situation, there are three kinds of tiers:

- (1) Top tier, there is only one factor included, and normally, it is the final goal of the problem that studied. We can also call this tier as the Objective tier.
- (2) Middle tier, there are progresses in order to reach the goal. It could be many tiers, and including many standards in consideration. We can also call this tier as the Standard tier.
- (3) Bottom level; there are the methods and ways to use in order to reach the goal. We can also call this tier as the Project tier.

The number of tiers in Hierarchical Structure are concerning with the complication degree of the problem and the detail request of the analysis. Usually, the number of tiers will not be limited, and normally, the factors that governed by the elements of every tiers are no more than nine. The Hierarchical Structure is as Fig. (1).

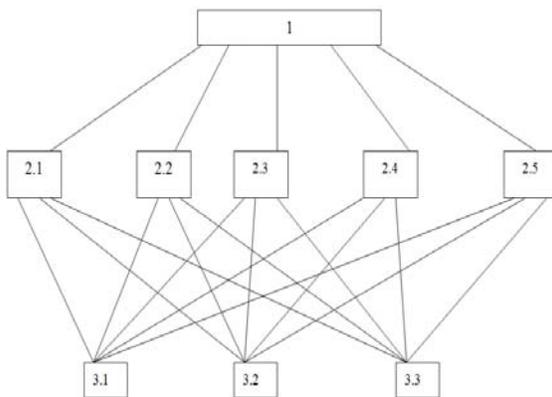


Fig. (1). Hierarchical structure chart.

The tier 1 in Fig. (1) is the Objective tier---the final goal of the problem studying. Tier 2 is the Standard tier---the progress in the problem studying. Tier 3 is the Project tier---the reference projects.

2.2. The Construction of the Judgment Matrix

The structure of every tier could stand for the relations in factors, but it will not be totally the same of the proportion of the factors in the middle tier in the evaluation of the goal. In the evaluator's mind, there are each proportion of every factors.

To confirm the proportion of every factor is to compare the degree of influential of n factor determinants $X = \{x_1, L, x_n\}$ to the factor Z . Saaty et al raised to compare the factors in pair, make the method of matrix comparison.

That is to say, choose two factors x_i and x_j each time, use a_{ij} stand for the proportion of degree in influential of x_i and x_j to Z , all the comparison matrixes showed by $A = (a_{ij})_{n \times n}$, and A became the Judgment Matrix between $Z - X$. We can see from the matrix that the proportion of influential in x_i and x_j to Z is a_{ij} , then the proportion of influential in x_j and x_i to Z is $a_{ji} = \frac{1}{a_{ij}}$.

According to the theory of Linear Algebra, if matrix $A = (a_{ij})_{n \times n}$ satisfied with $a_{ij} > 0$ and $a_{ji} = \frac{1}{a_{ij}}$ ($i, j = 1, 2, L, n$), then matrix A is the straight Reciprocal Matrix.

The confirming of the value of a_{ij} could accord the value of scale as Table 1.

Table 1. The value of scale.

Scale	Implications
1	Two factors are the same importance in the target of the last hierarchies
3	One factor is important than the one after it a little
5	One factor is more important than the one after it
7	One factor is very important than the one after it
9	One factor is extremely important than the one after it
2,4,6,8	The importance is in the middle dedree
Reciprocal	The importance proportion of i and j is a_{ij} , then the importance proportion of j and i is $a_{ji} = \frac{1}{a_{ij}}$

2.3. The Construction of the Judgment Matrix

Normalization the eigenvector W eigenvalue of maximum λ_{max} that matrix A corresponding to---the corresponding elements of the same tier's importance rank weight for the last level. This progress was called single hierarchical arrangement. Although this progress could

reduce the disturbing of the other factors, there will be inconformity in comprehensive comparison result inevitably. If the comparison result are all the same, then the factors of A should satisfied with:

$$a_{ij}a_{jk} = a_{ik}, \forall i, j, k = 1, 2, \dots, n \tag{1}$$

The straight Reciprocal Matrix that satisfied with this formula is called Uniform Matrix. In order to confirm whether A could be accepted or not, we have to prove if the inconsistency of A is very serious.

If A is consistent matrix, then

A sure is the straight Reciprocal Matrix.

Transpose Matrix A^T is Uniform Matrix.

Any two lines of matrix A pro rata, and the factor determinant greater than 0, so $rank(A) = 1$, and it is the same of list.

In A , $\lambda_{max} = n$, n is the order of matrix A . The other characteristic root of A is 0.

The corresponding eigenvector $W = (w_1, \dots, w_n)^T$ of λ_{max}

, then $a_{ij} = \frac{w_i}{w_j}, \forall i, j = 1, 2, \dots, n$, so we get

$$A = \begin{bmatrix} \frac{w_1}{w_1} & \frac{w_1}{w_2} & \dots & \frac{w_1}{w_n} \\ \frac{w_2}{w_1} & \frac{w_2}{w_2} & \dots & \frac{w_2}{w_n} \\ \frac{w_3}{w_1} & \frac{w_3}{w_2} & \dots & \frac{w_3}{w_n} \\ \vdots & \vdots & \ddots & \vdots \\ \frac{w_n}{w_1} & \frac{w_n}{w_2} & \dots & \frac{w_n}{w_n} \end{bmatrix} \tag{2}$$

A is n orders straight Reciprocal Matrix, when it be Uniform Matrix and only when $\lambda_{max} = n$, and A is inconsistent, there must be $\lambda_{max} > n$. According to this, by the relation proving of λ_{max} and n , A is inconsistent matrix.

The inspection of the consistency steps of A :

Calculate the consistency goal CI ,

$$CI = \frac{\lambda_{max} - n}{n - 1} \tag{3}$$

Look up for the corresponding average random coincidence indicator RI . Saaty figured out the value of RI , see the value of RI in Table 2.

Table 2. The value of RI .

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

The value of RI was came from the theory of constructing 500 samples randomly. Choosing from 1~9 and its

reciprocal, calculate the numbers to get the straight Reciprocal Matrix, and figure out the average value of the characteristic root of maximum λ'_{max} , and define

$$RI = \frac{\lambda'_{max} - n}{n - 1} \tag{4}$$

Figure out the consistency proportion CR

$$CR = \frac{CI}{RI} \tag{5}$$

When $CR < 0.10$, the consistency of A could be passed. On the opposite, adjust the value.

There also including the whole hierarchical arrangement and the inspection of the consistency in this progress. Because of the limitation paragraph of this article, we will not give further discuss, and use it straightly as follow.

3. THE CONSTRUCTION OF THE COMMUNITY SPORTS MODEL

This article holds the idea of find the important index of excellent sports community. Therefore, the factor of the Objective tier should be the excellent sports community. By the reference of many literatures, the five factors that influence the community sports including expenditure of the activity, the sports ground, the guidance team, activity organization and the sports conscious of the residents. So, the Standard tier should include the five factors. Suppose that the three sports community as P_i , then the Project tier include three projects. The hierarchical structure is as Fig. (2).

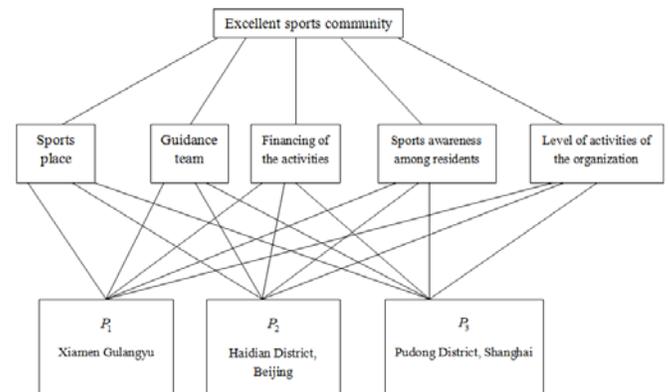


Fig. (2). The hierarchy chart of excellent sports community

The Construction of the Judgment Matrix

The construction of the Judgment Matrix should firstly confirm the importance of the five factors that influencing the sports community. Table 3 is the main problem of the active point, and the source is from China foreign network. From Table 3 we can see the influential degree of expenditure of the activity, the sports ground, the guidance team, activity organization and the sports conscious of the residents.

Table 3. The main problem of the active point.

	Numbers	Percent (%)	Order
Expenditure of the activity	190	50	1
The sports ground	161	42.3	2
The guidance team	153	40.1	3
Activity organization	74	19.4	4
Sports conscious	39	10.2	5

According to this, we build the comparison matrix of the Objective tier as Table 4.

Table 4. The comparison matrix of the Objective tier.

A	B ₁	B ₂	B ₃	B ₄	B ₅
B ₁	1	3	4	7	8
B ₂	1/3	1	2	5	7
B ₃	1/4	1/2	1	4	6
B ₄	1/7	1/2	1/4	1	3
B ₅	1/8	1/7	1/6	1/3	1

And then, build the comparison matrix of the Standard tier as Tables 5-9.

Table 5. The comparison matrix of the Standard tier 1.

B ₁	P ₁	P ₂	P ₃
P ₁	1	3	1/3
P ₂	1/3	1	1/5
P ₃	3	5	1

Table 6. The comparison matrix of the Standard tier 2.

B ₂	P ₁	P ₂	P ₃
P ₁	1	1/3	3
P ₂	3	1	5
P ₃	1/3	1/5	1

Table 10. The whole hierarchical arrangement.

Standard	Expenditure of the Activity	The Sports Ground	The Guidance Team	Activity Organization	The Sports Conscious of the Residents	Weight of the Whole Hierarchical Arrangement
Weight of Standard tier	0.0961	0.0332	0.0332	0.0559	0.122	
The single hierarchical arrangement of the Project tier	Project 1	0.4848	0.2583	0.2583	0.2790	0.3946
	Project 2	0.3506	0.6370	0.1047	0.0719	0.3056
	Project 3	0.1645	0.1047	0.6370	0.6491	0.3050

Table 7. The comparison matrix of the Standard tier 3.

B ₃	P ₁	P ₂	P ₃
P ₁	1	3	1/3
P ₂	1/3	1	1/5
P ₃	3	5	1

Table 8. The comparison matrix of the Standard tier 4.

B ₄	P ₁	P ₂	P ₃
P ₁	1	5	1/3
P ₂	1/5	1	1/7
P ₃	3	7	1

Table 9. The comparison matrix of the Standard tier 5.

B ₅	P ₁	P ₂	P ₃
P ₁	1	5	1/2
P ₂	1/5	1	1/7
P ₃	2	7	1

The Result of Calculation

Through the calculation by *Matlab*, the result is in Table 10.

To show the evaluation situation of the sports community in Gulangyu Island of Xiamen, Haidian District in Beijing, Pudong in Shanghai, see Fig. (3).

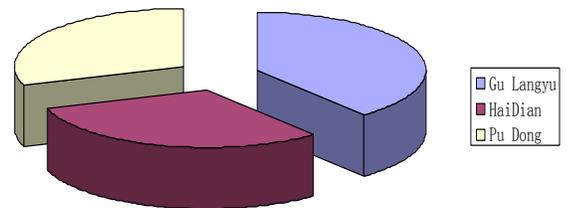


Fig. (3). The figure of evaluation results.

Trough Fig. (3) we can conclude that Gulangyu Island of Xiamen is the excellent sports community. And in our

calculation, there are only two factors in importance comparison, not the whole factors. To find out the difference between the excellent sports community to the other communities, we drew the line chart as Fig. (4).

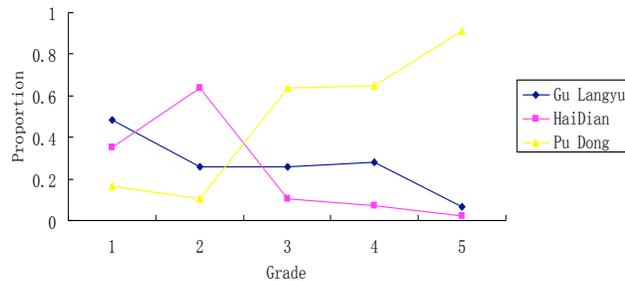


Fig. (4). Comparison chart of each factor of three communities.

From Fig. (4) we can see that, there is smaller differences distribution among the factors of Gulangyu Island of Xiamen. But there are bigger differences distribution among the factors of Haidian District in Beijing and Pudong in Shanghai. Therefore, we can infer that, when differences of every factor distributes smaller, the more excellent the sports community it will be.

CONCLUSION

Analytic Hierarchy Process was used widely in every field. For example, in the evaluation of the financial risk of an enterprise, the safety production index of a coal mine, the safety evaluation of the information system of a bank and so on. It has the feature of simplicity, precision and flexibility. Because this method needs to judge the importance ratio of the factors in pair, so when the ratio set was not exact, the result got from this method was also not exact.

This article use Analytic Hierarchy Process in the evaluation of the sports community, and evaluated Gulangyu Island of Xiamen, Haidian District in Beijing and Pudong in Shanghai. The result showed that Gulangyu Island of Xia-

men is the excellent sports community. And according to the result, we analyzed the data feature of every factor in the three sports communities and find out that the more uniformity the factor's data distribute, the better evaluation result it will get.

CONFLICT OF INTEREST

The authors confirm that this article content has no conflicts of interest.

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