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Public sports service contents analysis-based and multilayer fuzzy comprehensive evaluation application

Yunwu Wang
Institute of Physical Education, Chuzhou College, Chuzhou 239000, Anhui, (CHINA)
E-mail: wangyunwu1968@126.com

ABSTRACT

With the deepening of reform and opening up, all walks of life is running stable and orderly, but it lacks of emphasis on public sports, establish a set of completely public sports service comprehensive evaluation system is particularly important. The paper just along this direction, by establishing multilayer fuzzy evaluation method, applies mathematical statistics, analytic hierarchy process, questionnaire survey, component analysis and other methods to go deep into research, and refer to maximum membership corresponding principles. Research table concludes that a Chinese public sport service basically belongs to satisfied state, but it still has many problems that need us to constantly improve them.

KEYWORDS

Public sports service;
Maximum membership;
Multilayer model;
Fuzzy evaluation.

INTRODUCTION

For public service aspect researches, lots of people have made efforts, such as: Qin Xiao-Ping proposed that so as to improve sports service equalization, no matter in village or in city, every citizen could get government supplied public sports service resources' sports public product that needed every citizen in society to make joint efforts; in the aspect of government function, Liu Yu thought that public sports service was that government provided broad masses with different, basic standards and on the premise that provided maximum equal sports public service indicators for them.

On this basis, the paper proceeds with more deep research, uses multilayer fuzzy comprehensive evaluation method to evaluate government public sports service qualities, meanwhile it proposes constructive opinions, which provides theoretical premises for improving public sports service quality.

MULTILAYER FUZZY COMPREHENSIVE EVALUATION MODELS

Model establishments

The model principle is utilizing linear transformation method and combining with maximum membership, carrying out comprehensive consideration and research on the premise that considers multiple factors, realizing relative reasonable evaluation effects, so using fuzzy mathematics to do comprehensive evaluation, the method and steps are as following:

At first it should define evaluated object, it is up to x pieces of factors to effect on individual variable, and

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its factor set is β that first grade evaluation indicator is defined as:

$$\beta = (\beta_i, \beta_i, \beta_i, \cdots, \beta_j) \quad (1)$$

Then, corresponding second grade evaluation indicator is:

$$\{\beta^1, \beta^2, \beta^3, \cdots, \beta^n\} \quad (2)$$

And three grade evaluation indicators are:

$$\{\beta^1 1, \beta^2 2, \beta^3 3, \cdots \beta^n j\} \quad (3)$$

And stipulate: $\{\beta^n j \mid n = 1,2,3,\cdots m \ ; \ j = 1,2,3,\cdots i\}$

Due to each variable weight is different, impact is also different to defined judgment grade, assume its evaluation set is:

$$b_i = (b_1, b_2, b_3, b_4, b_5)$$

$$= (\text{very satisfied}, \text{basically satisfied}, \text{dissatisfied}, \text{extremely dissatisfied}) \quad (4)$$

Among them, $b_i (i = 1,2,3,\cdots, y)$

Above weight, according to common sense we are clear that $b_i \geq 0$ and $\sum_{i=1}^{y} b_i = 1$

If every factor b_i includes n pieces of sub factors, its factor set is:

$$\beta_j = (\beta_{j,1}, \beta_{j,2}, \beta_{j,3}, \cdots \beta_{j,n}) \quad (5)$$

Then corresponding weight is:

$$b_i = (b_{i,1}, b_{i,2}, b_{i,3}, \cdots b_{i,n}) \quad (6)$$

To $\beta_{i,j}$ weight b_i, according to common sense, it is clear that $b_{i,j} \geq 0$ and:

$$\sum_{j=1}^{n} b_{i,j} = 1 \quad (7)$$

According to above formula, its first grade weight is100%, and second grade indicator is:

$$b_i = (b^1, b^2, b^3, \cdots b^n) \quad (8)$$

And corresponding three grade weight set is:

$$b_i = (b^1{}_1, b^2{}_1, b^3{}_1, b^4{}_1, b^1{}_2, \cdots b^j{}_n) \quad (9)$$

Regarding evaluation membership vector set, we let it to be:

$$k^n j = \{k^n j1, k^n j2, k^n j3, k^n j4, k^n j5\} \quad (10)$$

So corresponding membership relative matrix is:

$$k = \begin{vmatrix} k^1 \\ k^2 \\ k^3 \\ \vdots \\ k^n \end{vmatrix} = \begin{vmatrix} k^1 11 & k^1 12 & k^1 13 & k^1 14 & k^1 15 \\ k^2 21 & k^2 22 & k^2 23 & k^2 24 & k^2 25 \\ k^3 31 & k^3 32 & k^3 33 & k^3 34 & k^3 35 \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ k^n j1 & k^n j2 & k^n j3 & k^n j4 & k^n j5 \end{vmatrix} \quad (11)$$

By integrating above process, it gets its first grade evaluation result is:

$$k^n = H^n \cdot (k^n j1, k^n j2, k^n j3, k^n j4, k^n j5)$$

So second evaluation result is:

$$k = H \cdot (k^1, k^2, k^3, \ldots k^n)$$

Make normalization processing with above process, its principle is as following:

In order to more clearly and reasonable define multilayer fuzzy evaluation indicators' mutual relations, the paper adopts analytic hierarchy process method (AHP), so it can apply the method to arrange above multilayer indicators, and use technical indicators utility and popularity to make further analysis.

Analytic hierarchy process theoretical model

Any one system requires using a great deal of information as basis to make correlation analysis, the AHP is making comparison and judgment of any one layer indicators' weights and using numerical values to represent and so it can form into corresponding judgment matrix, from which maximum feature value is defined as λ_{MAX} to calculate correlation feature vector and feature value, if define g as weight allocation values, then for feature vector, we can define it as:

$$k = (k_1, k_2, \cdots k_n) \quad (12)$$

In order to judge whether the model evaluation weight judgment matrix is disordered or not, make consistency test on the model, its corresponding ratio formula is:

$$C \cdot R = \frac{C \cdot I}{R \cdot I} \quad (13)$$

$$C \cdot I = \frac{\lambda_{MAX} - n}{n-1} \ (n > 1) \quad (14)$$

In above formula, $I \cdot R$ value is as following Table 1 show:

When value of matrix orders go beyond three, meanwhile it has $C \cdot R < 0.1$,then it can be thought it is

acceptable, otherwise it continues to make corresponding adjustment till it can be acceptable. With TABLE 2 showed 1~9 scale table as evidence, it makes weight analysis.

TABLE 1: Random consistency indicator

Number of matrix orders	1	2	3	4	5	6	7	8	9	10
$R \cdot I$	0	0	0.58	0.9	1.12	1.26	1.36	1.41	1.46	1.49

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 very important than factor j
9	factor i is absolutely very important than factor j
2 ,4 ,6 ,8 ,	Indicates middle state corresponding scale value of above judgments
Reciprocal	If compare factor i with factor j, it gets judgment value as $b_{ji} = 1/\ b_{ij}$, $b_{ii} = 1$

Refer to Figure 1, it is 1~9 scale graph.

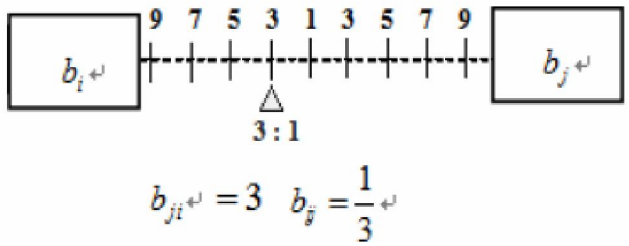

Figure 1: Scale of 1 to 9

In above TABLE 2, 1-9 Values ratio selection requires to compare in two compared things between approximate order of magnitudes so that can have higher accuracy.

After normalizing above model, it can get comprehensive evaluation result F is: $F = k \cdot h$, in formula, h represents evaluation grades' assigned values.

MULTILAYER EVALUATION MODEL INDICATORS SELECTION AND VALUES ASSIGNING

Assign values to indicators

Establish public sports indicator service evaluation indicator system; carry out selection according to the basic principle as complying with independence and operability, select eight main items and twenty-five small items according to established public sports service system, in order to more clearly present distinction of

TABLE 3 : First grade indicator weight vector

First grade indicator	A	B	C	D	E	F	G	H	I	Weight
Public sports documents and policies input indicator	4	2	4	1/3	2	3	1/4	2	3	0.056
Funding target	1	1/2	1	1/4	1/2	2	1/3	1/2	2	0.118
Service indicator	1	1/4	1	1/6	1/4	1/2	1/5	1/3	1/3	0.037
Organization and management indicator	5	5	5	2	5	5	3	3	5	0.126
Fitness and health monitoring	1	1/2	1	1/4	1/2	2	1/3	1/2	2	0.008
Sports activity	1	1/4	1	1/6	1/4	1/2	1/5	1/3	1/3	0.41
Community satisfaction degree	3	1	3	1/3	1	3	2	2	3	0.064
Health promotion indicator	2	2	2	1/3	2	3	1/2	2	3	0.184

good or bad, assign weight on the numbers from one to nine, from which even number represents importance between cardinal numbers, and cardinal numbers are successively defined from big to small as absolute important, obvious important, considerable important, slightly important and equal important, after that, integrate every column, and then integrate the column corresponding line, get its weights after calculation as following show: among them first grade indicators is TABLE 3:

Then, corresponding second grade indicator is TABLE 4:

Consistency test

According to random consistency indicators, calculate and then can get transfer table maximum feature value is $\lambda_{max} = 8.158$, then corresponding consistency index is $CI = 0.0226$, so it further can get development rate $CR = 0.016 < 0.1$, the matrix is reasonable. By that analogy, respectively verify above second grade indicators and can get that all matrixes have unified consistency. Therefore, it proved the weight is reasonable.

Investigation and statistics

In order to more accurate make reasonable analysis and evaluation on public sports service construction, the paper selects multiple sites to make investigation on many people, and it is a kind of random way in whole process, its result is as following TABLE 5 show:

TABLE 4 : Second grade indicator weight vector

Second grade indicator	A	B	C	D	E	F	权重
Sports public service relative policies appropriated funds	1/3	2	1/4				0.247
Sports fiscal appropriation	2	3	1/3				0.114
Quantity of sports public service relative policies documents	3	4	2				0.651
Sports public undertakings fiscal appropriation proportion occupies total appropriation	3	2	1/3				0.45
Per capita public service fiscal input ratio	1/3	1/2	1				0.154
Per capita sports public facilities input ratio		2	2				0.124
Number of possessed sports instructors per ten thousand people		2	2				0.234
The public achieved service average distance	2	1/5	1/3				0.124
Quantity ratio of possessed public service per ten thousand people	2	1/3	1				0.234
Amount of possessed public service activities facilities per ten thousand people	4	2	2				0.598
Public sports site area ratio per ten thousand people	3	1	2	4	2	1	0.223
Public sections' regulation system perfection degree	3	2	1/3	3	1/3	2	0.156
Sports public section fiscal management degree	2	1/3	1/5	1/3	1/5	1/3	0.076
Sports public service morality and professional levels	3	2	1/3	3	1/3	2	0.156
Public fitness and health monitoring popularizing rate	3	1	2	4	2	1	0.223
Public fitness and health monitoring frequency ratio	3	1/3	1/2	2	1/2	1/3	0.089
Public fitness and health monitoring times rate	2	3	5				0.567
Public large-scale sports competitions watching ratio	1/3	1/2	1				0.145
Public residents amateur sports competitions organizing frequency ratio	1/3	2	3				0.36
Public sports activities participating frequency ratio	1/2	3	2				0.256
Community sports instructors satisfaction degree on working income	2	5	4				0.159
Community site facilities satisfaction degree	1/4	2	1/2				0.302
Community administrative staff ability satisfaction degree	6	4	2				0.526
Community satisfaction degree on service price	3	2	1/2				0.302
Public physical health pass percentage ratio	2	1/3	1/4				0.145
Public sports population size annual growth rate ratio	2	1/4	1/3				0.6
Public health care knowledge information awareness rate ratio	3	1/3	2				0.6

TABLE 5 : Random evaluation investigation result

Evaluation objects	Extremely dissatisfied	Dissatisfied	Basically satisfied	Relative satisfied	Very satisfied
Sports public service relative policies appropriated funds	0.18	0.05	0.21	0.07	0.34
Sports fiscal appropriation	0.14	0.06	0.18	0.26	0.29
Quantity of sports public service relative policies documents	0.06	0.18	0.28	0.24	0.29
Sports public undertakings fiscal appropriation proportion occupies total appropriation	0.07	0.16	0.14	0.14	0.34
Per capita public service fiscal input ratio	0.18	0.15	0.14	0.17	0.34
Per capita sports public facilities input ratio	0.14	0.22	0.28	0.18	0.12
Number of possessed sports instructors per ten thousand people	0.19	0.22	0.32	0.18	0.12
The public achieved service average distance	0.13	0.26	0.28	0.22	0.16
Quantity ratio of possessed public service per ten thousand people	0.04	0.14	0.35	0.33	0.19
Amount of possessed public service activities facilities per ten thousand people	0.05	0.20	0.21	0.32	0.27
Public sports site area ratio per ten thousand people	0.15	0.22	0.32	0.22	0.13
Public sections' regulation system perfection degree	0.13	0.22	0.32	0.22	0.16
Sports public section fiscal management degree	0.14	0.29	0.31	0.18	0.13
Sports public service morality and professional levels	0.11	0.21	0.22	0.30	0.21
Public fitness and health monitoring popularizing rate	0.12	0.18	0.22	0.23	0.25
Public fitness and health monitoring frequency ratio	0.14	0.18	0.20	0.23	0.24
Public fitness and health monitoring times rate	0.12	0.20	0.30	0.18	0.15
Public large-scale sports competitions watching ratio	0.13	0.24	0.34	0.20	0.04
Public residents amateur sports competitions organizing frequency ratio	0.15	0.20	0.28	0.18	0.17
Public sports activities participating frequency ratio	0.08	0.17	0.25	0.21	0.25
Community sports instructors satisfaction degree on working income	0.09	0.18	0.24	0.20	0.24
Community site facilities satisfaction degree	0.13	0.25	0.31	0.21	0.13
Community administrative staff ability satisfaction degree	0.18	0.24	0.34	0.26	0.17
Community satisfaction degree on service price	0.17	0.24	0.35	0.15	0.07
Public physical health pass percentage ratio	0.18	0.27	0.32	0.16	0.08
Public sports population size annual growth rate ratio	0.21	0.28	0.30	0.15	0.04
Public health care knowledge information awareness rate ratio	0.12	0.20	0.31	0.22	0.14

MODEL APPLICATIONS

Due to above process involves more factors, the paper selects one of them (public sports documents and policies indicator) to do research, and its comprehensive evaluation result is:

$$k^n = H^n \cdot k^n j = \left(k^1 1, k^1 2, k^1 3, k^1 4, k^1 5, k^1 6\right) \cdot \left(k^n j1, k^n j2, k^n j3, k^n j4, k^n j5\right)^{26}$$

$$= (0.247, 0.114, 0.651, 0.45, 0.154) * \begin{vmatrix} 0.18 & 0.05 & 0.21 & 0.07 & 0.34 \\ 0.14 & 0.06 & 0.18 & 0.26 & 0.29 \\ 0.06 & 0.18 & 0.28 & 0.24 & 0.21 \\ 0.07 & 0.16 & 0.14 & 0.14 & 0.34 \\ 0.18 & 0.15 & 0.14 & 0.17 & 0.34 \end{vmatrix}$$

$$= (0.13, 0.28, 0.27, 0.15, 0.14)$$

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After normalization processing,

$k^1 = (0.146,0.259,0.264,0.232,0.149)$,

Similarly it can get

$k^2 = (0.152,0.203,0.264,0.185,0.159)$

$k^3 = (0.120,0.165,0.234,0.268,0.231)$

$k^4 = (0.108,0.186,0.197,0.224,0.254)$

$k^5 = (0.114,0.231,0.325,0.184,0.139)$

$k^6 = (0.136,0.182,0.246,0.192,0.261)$

$k^7 = (0.165,0.247,0.316,0.162,0.106)$

$k^8 = (0.189,0.269,0.312,0.154,0.117)$

So second grade comprehensive evaluation result is:

$$k = H \cdot \begin{vmatrix} k^1 \\ k^2 \\ k^3 \\ k^4 \\ k^5 \\ k^6 \\ k^7 \\ k^8 \end{vmatrix}$$

$$= (0.056, 0.118, 0.037, 0.126, 0.008 0.041, 0.008, 0.184)$$

$$* \begin{vmatrix} 0.201 & 0.155 & 0.128 & 0.247 & 0.245 \\ 0.186 & 0.167 & 0.149 & 0.263 & 0.278 \\ 0.236 & 0.115 & 0.241 & 0.198 & 0.244 \\ 0.148 & 0.118 & 0.263 & 0.196 & 0.260 \\ 0.165 & 0.126 & 0.156 & 0.245 & 0.351 \\ 0.143 & 0.131 & 0.243 & 0.273 & 0.234 \\ 0.116 & 0.179 & 0.017 & 0.255 & 0.312 \\ 0.154 & 0.189 & 0.105 & 0.198 & 0.229 \end{vmatrix}$$

$$= (0.196, 0.268, 0.225, 0.173, 0.160)$$

Make normalization processing and get:

$k = (0.167,0.245,0.241,0.217,0.133)$

So according to above comprehensive evaluation model, it has:

$$F = (0.167, 0.245, 0.241, 0.217, 0.133) \cdot \begin{vmatrix} 5 \\ 4 \\ 3 \\ 2 \\ 1 \end{vmatrix}$$

$$= 0.167*5 + 0.245*4 + 0.241*3 + 0.217*2 + 0.133*1$$

$$= 3.105$$

By above calculation result and according to scores criterion, it can get public to government public sports service quality belongs to basically satisfied evaluation.

CONCLUSIONS

By analyzing and deep researching on public sports service contents, apply multilayer fuzzy comprehensive evaluation model to make evaluation, finally it gets satisfied answers for paper listed public facilities' service aspect, which proves public infrastructure aspect still has some shortcomings, so government still need to improve public sports service and should increase government functions so that let public sports service quality arrive at higher level.

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