

# Sport service evaluation of urban community based on fuzzy comprehensive evaluation

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## Abstract

Fuzzy comprehensive evaluation refers to a comprehensive assessment method based on fuzzy mathematics through quantifying the factors difficult to quantify with obscure boundaries and using the principle of fuzzy relation synthetic. Fuzzy comprehensive evaluation can comprehensively evaluate the object system involving fuzzy factors and is widely applied in the fields of economy and society. This paper takes new public service theory as the research perspective; designs evaluation index system which can comprehensively reflect sport development level of urban community applies fuzzy comprehensive evaluation to evaluate sport development level of urban community in Hunan province and provides the evaluation process. The evaluation results show leadership organization and team construction of the urban community fail to develop to certain level and that the health index of community residents is slightly low. This paper presents suggestions to improve this situation.

*Keywords:* Fuzzy Mathematics, Fuzzy Comprehensive Evaluation, Evaluation Index System, Urban Community, Sport Service

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## 1 Introduction

Fuzzy comprehensive evaluation (FCE) was first put forward by an American L.A. Sade in 1965 [1]. It is a method to describe fuzzy mathematics written in Fuzzy Sets. This method declared the birth of fuzzy mathematics. Since then, fuzzy phenomena have entered the field of human scientific research [2]. FCE is an important aspect of fuzzy mathematics applied in natural science field and social science field. Evaluation objects of comprehensive evaluation problem are decided by factors in multiple aspects, so it is required to evaluate every factor [3]. With regard to evaluation of sport development level of urban community, the influencing factors are very complex and fuzzy. Thus, fuzzy means is used to deal with fuzzy problems, which will make the evaluation results truer and more rational [4].

Community sport as the main base for national fitness and an important constituent part of community building is highly valued by the government [5]. However, it is found in practice real sport service system of urban community has not been established currently [6]. Various mass physical fitness organizations, grass-root fitness clubs, fitness stations and grass-root sport associations as well as the network formed on this basis are not perfect [7]. The development is unstable and disorderly [8]. How to make the input in community sport more scientific and rational, to make community sport resources utilized more fully and effectively, to make organizational measure of community sport more beneficial and to make community sport produce greater

social benefits requires scientific evaluation of community sport resources [9].

One thing often needs multiple indexes to depict its nature and characteristics. Besides, the people's evaluations for one thing are not simply good or bad, but they adopt fuzzy language to evaluate it with different degrees [10]. Since the relation of evaluation levels are fuzzy without absolutely explicit dividing line, so the evaluation is fuzzy [11]. Obviously, for this fuzzy evaluation problem, classical evaluation method is not rational. But the application of fuzzy mathematics for comprehensive judgment will gain better practical effects. So, this paper utilizes FCE method to evaluate community sport development level of a city on the basis of analysing the factors influencing community sport development level.

## 2 Public service level index system of community sport

With the advancement in networking and multimedia technologies enables the distribution and sharing of multimedia content widely [12]. In the meantime, piracy becomes increasingly rampant as the customers can easily duplicate and redistribute the received multimedia content to a large audience [13].

The hierarchy, regional nature, overall comprehensiveness and trend of public service of community sport decide public service level index system of community sport has the following characteristics [14]:

(1) Universality of evaluation content. There are many factors influencing public services of community sport, including two aspects: "hardware" and "software". Since the contents involved are many, index system design,

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standard formulation and method selection should follow the principle of combining subjectivity and objectivity, nature determination and quantification as well as self-evaluation and expert evaluation.

TABLE 1 Opinions of community residents on national fitness paths and equipment

	Able to exercise	Interesting	Good shape	Useless	Danger
n	115	27	28	20	10
%	57.5	13.5	14.0	10.0	5.0

(2) Regional correlation. Public service level of community sport is also restricted by social economic development level of the community. Construction environment of index system should start from practical situations and realistic demand, ensure combination of scientificness and practical applicability and meanwhile consider the imbalance of regional development. So, different things should not be treated as the same simply.

TABLE 2 Construction situations of fitness centers of 6 cities

	City A	City B	City C	City D	City E	City F
Fitness centers	10	8	7	10	17	4
Fitness sites	55	40	61	54	66	18
Communities	51	65	45	66	96	6
Proportion (fitness centers)	1.7	1.0	1.8	1.3	1.2	5.0

(3) Objective consistency. Consistency contains the maiming at two levels. At the first level, the objective to establish evaluation index system should be consistent with the demands of community members. The establishment of system index is to better serve community residents for physical fitness. So, the system should be able to reflect the common desire of the community residents and be oriented to their demands. At the second level, evaluation objective and construction objective should be consistent.

Overall structure of public service indexes of community sport refers to the core problem of index system design. During construction of this system, all indexes of public services of community sport should form an organic whole and coordinate mutually. There are many factors influencing public service of community sport. These factors involve various aspects. The influences of some indexes are very small and can be neglected. There are many evaluation indexes for sport development level of urban community, including qualitative index, quantitative index, macroscopic index and microcosmic index. In comprehensive evaluation, corresponding indexes are often selected from these for permutation and combination.

**3 FCE of sport development level of urban community**

FCE can comprehensively evaluate the object system involving fuzzy factors and is widely applied in economic and social fields [15]. FCE has strong subjectivity in

evaluation and cannot solve the problem of repeated evaluation information caused by evaluation indexes. In addition, there is no systematic method to confirm membership function [16]. Especially when faced with a complex system, since there are many factors in need of consideration; it is very difficult to confirm weight allocation of each factor when FCE is applied. Meanwhile, FCE applies normalization handling method. After weight allocation is confirmed, it is still necessary to comprehensively evaluate Sade operator for the index. Thus, the results cannot meet the due value. This paper based on the above considerations optimizes FCE and adopts multi-level FCE for multi-level processing of weight allocation. They are classified into several levels according to factors or indexes. Firstly, low-level factors are comprehensively evaluated; the evaluation results are used for higher-level comprehensive evaluation. Single factor evaluation of each level is multifactor comprehensive hiragana at lower-level. So, the evaluation is carried out from low level to high level one by one. Moreover, to consider from different perspectives, we can first classify the personnel participating in judging. In line with the steps of FCE, fuzzy statistics matrix of each type of judging personnel on the evaluation object is provided to calculate the judging results of each type of judging personnel on the evaluation object. The influences of the judges with different perspectives are considered through “quadric weighting”. The steps for construction of multilevel FCE model are shown in Fig.1:

(1) To confirm multilevel factor set according to original data of the evaluation object. The factor set includes all indexes used to evaluate the object. The factor set is expressed through collective concept. The matrix form of the collection is as follows:

$$U = (U_1, U_2, \dots, U_n) = \begin{pmatrix} (u_{11}, u_{12}, \dots, u_{1m}) \\ \vdots \\ (u_{n1}, u_{n2}, \dots, u_{nm}) \end{pmatrix} = \begin{pmatrix} \begin{pmatrix} (u_{111}, u_{112}, \dots, u_{11i}) \\ \vdots \\ (u_{1m1}, u_{1m2}, \dots, u_{1mi}) \end{pmatrix} \\ (\vdots) \\ \begin{pmatrix} (u_{n11}, u_{n12}, \dots, u_{n1i}) \\ \vdots \\ (u_{nm1}, u_{nm2}, \dots, u_{nmi}) \end{pmatrix} \end{pmatrix}, \quad (1)$$

where, U is factor set; n is the number of the first-level factors; each first-level indexes can be divided into  $U_i = (u_{i1}, u_{i2}, \dots, u_{im})$  second-level sub-indexes; m is the number of second-level indexes. By parity of reasoning, all lower-level I can be reasoned out.

(2) To catty out weight assignment for each index in the above index sets and the weight sets gained are as follows:

$$W = (W_1, W_2, \dots, W_n) = \begin{pmatrix} (w_{11}, w_{12}, \dots, w_{1m}) \\ (w_{21}, w_{22}, \dots, w_{2m}) \\ \vdots \\ (w_{n1}, w_{n2}, \dots, w_{nm}) \end{pmatrix} = \begin{pmatrix} \begin{pmatrix} (w_{111}, w_{112}, \dots, w_{11i}) \\ \vdots \\ (w_{1m1}, w_{1m2}, \dots, w_{1mi}) \end{pmatrix} \\ (\vdots) \\ \begin{pmatrix} (w_{n11}, w_{n12}, \dots, w_{n1i}) \\ \vdots \\ (w_{nm1}, w_{nm2}, \dots, w_{nmi}) \end{pmatrix} \end{pmatrix}, \quad (2)$$

where,  $W = (W_1, W_2, \dots, W_n)$  is the weight of the first-level index  $U = (U_1, U_2, \dots, U_n)$ ;  $W = (w_{i1}, w_{i2}, \dots, w_{im})$  is the weight of second-level index  $U_i = (u_{i1}, u_{i2}, \dots, u_{im})$  relative to the first-level index  $U = (U_1, U_2, \dots, U_n)$ .

(3) To conduct level evaluation for all indexes. Usually,  $V = (v_1, v_2, \dots, v_k)$  is expressed as the evaluation level of each index, where k is the number of evaluation level. In FCE, each level evaluation is classified into five levels {very good, good, general, bad, very bad}, and it is expressed in figure is  $V = \{5, 4, 3, 2, 1\}$ .

(4) After the above work is finished, confirm fuzzy mapping relationship between evaluation index and evaluation set in the index sets. The fuzzy mapping matrix is as follows:

$$W_j^{carbon} = (\alpha_1 + \alpha_2 + \alpha_3)\sigma\gamma_j q_j^s = M\gamma_j q_j^s \quad (3)$$

where, n is the number of the first-level indexes;  $R_i$  is fuzzy mapping if i indexes in the first-level indexes ( $i = 1, 2, 3, \dots, n$ );  $k_i$  is the number of the last-level indexes corresponding to every first-level indexes;  $r_{ij}$  means membership degree of last indexes to evaluation set V.

(5) Finally, implement matrix operations for matrix fuzzy relation and weight set  $B = RW$ . Then, fuzzy evaluation results are gained.

FCE is a very effective multi-factor decision-making method to comprehensively evaluate the things influenced by multiple factors. Evaluation of public services of community sport often involves multiple factors or indexes. At this moment, it is required to evaluate the thing according to multiple factors, instead of single factor. This paper establishes FCE model for public services of community sport through referring to pertinent literatures.

### 4 Application example

This paper takes urban community in Hunan province for example and conducts empirical analysis of urban community in Hunan province. In accordance with characteristics of urban community in Hunan province, software and hardware conditions of existing sport, an evaluation system including three second-level indexes (infrastructure and service, resident participation degree and sport benefit) and 11 third-level indexes under the basic principle of SERVQUAL. The indexes are shown in Table 3.

TABLE 3 Evaluation index system

Level 1 index	Level 2 index	Level 3 index
Sport service level of urban community	Infrastructure and service	Management rules
		Sport service team
	Resident participation degree	Sport field
Sport funds		
Form of sport activities		
Resident participation time		
Sport consumption expenditure		
Sport benefit	Large fitness activity	Participation in superior sport activity team
		Physical fitness measurement index
	Results of athletic contest	

Confirm the weight of each index, evaluation level and membership degree through analytic hierarchy process, as shown in Table 4.

TABLE 4 Evaluation index weight of urban community sport

Second-level	Third-level	Evaluation index and membership degree						
Index	Weight	Index	Weight	V1	V2	V3	V4	V5
U1	0.35	U11	0.25	0.1	0.25	0.3	0.2	0.15
		U12	0.3	0.2	0.2	0.1	0.3	0.2
		U13	0.25	0.3	0.2	0.4	0.1	0
		U14	0.2	0	0.3	0.2	0	0.5
		U21	0.3	0.4	0	0.1	0.3	0.2
U2	0.35	U22	0.2	0.2	0.4	0.1	0.1	0.2
		U23	0.25	0	0.4	0.2	0.3	0.1
		U24	0.25	0.3	0.2	0.2	0.2	0.1
U3	0.3	U31	0.3	0.3	0.1	0.1	0.3	0.2
		U32	0.4	0.2	0.2	0.4	0.1	0.1
		U33	0.3	0.1	0.1	0.3	0.3	0.2

The result matrix of each step is gained according to the process of FCE as follows:

#### 1) Index weight at each level

$$W = (W_1, W_2, \dots, W_n) = (0.35, 0.35, 0.3) = \begin{pmatrix} (w_{11}, w_{12}, w_{13}, w_{14}) \\ (w_{21}, w_{22}, w_{23}, w_{24}) \\ (w_{31}, w_{32}, w_{33}) \end{pmatrix} = \begin{pmatrix} (0.25, 0.3, 0.25, 0.2) \\ (0.3, 0.2, 0.25, 0.25) \\ (0.3, 0.4, 0.3) \end{pmatrix}$$

#### 2) Membership degree and evaluation matrix of the third-level index

$$R_1 = \begin{bmatrix} 0.1 & 0.25 & 0.3 & 0.2 & 0.15 \\ 0.2 & 0.2 & 0.1 & 0.3 & 0.2 \\ 0.3 & 0.2 & 0.4 & 0.1 & 0 \\ 0 & 0.3 & 0.2 & 0 & 0.5 \end{bmatrix}$$

$$R_2 = \begin{bmatrix} 0.4 & 0 & 0.1 & 0.3 & 0.2 \\ 0.2 & 0.4 & 0.1 & 0.1 & 0.2 \\ 0 & 0.4 & 0.2 & 0.3 & 0.1 \\ 0.3 & 0.2 & 0.2 & 0.2 & 0.1 \end{bmatrix},$$

$$R_3 = \begin{bmatrix} 0.3 & 0.1 & 0.1 & 0.3 & 0.2 \\ 0.2 & 0.2 & 0.4 & 0.1 & 0.1 \\ 0.1 & 0.1 & 0.3 & 0.3 & 0.2 \end{bmatrix}$$

3) Comprehensive evaluation

$$R = \begin{bmatrix} B_1 \\ B_2 \\ B_3 \end{bmatrix} = \begin{bmatrix} W_1 R_1 \\ W_2 R_2 \\ W_3 R_3 \end{bmatrix} = \begin{bmatrix} 0.16 & 0.23 & 0.25 & 0.17 & 0.20 \\ 0.24 & 0.23 & 0.15 & 0.24 & 0.15 \\ 0.20 & 0.14 & 0.28 & 0.22 & 0.16 \end{bmatrix}$$

$$B = WR = (0.20 \ 0.20 \ 0.23 \ 0.21 \ 0.17)$$

Carry out five-level FCE of the above results and gain the valuation result of community sport development level as follows:

$$BV = (0.20 \ 0.20 \ 0.23 \ 0.21 \ 0.17) \begin{pmatrix} 5 \\ 4 \\ 3 \\ 2 \\ 1 \end{pmatrix} = 3.05$$

The sport development of this urban community is 3.05, above general and below good. This analysis indicates sport development of urban community in Hunan province has large development space. This is mainly because the infrastructure and service level remain improving; resident participation awareness remains improving; resident health is at a low level. Thus, the community sport development needs urgent enhancement. The sport input and education should be highly valued by leadership organization of the community.

5 Conclusions and suggestions

5.1 CONCLUSIONS

This paper designs evaluation index system which can comprehensively reflect community sport service level,

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applies FCE to evaluate sport development level of an urban community and provides the evaluation process.

Evaluation system for sport service level of urban community contains 3 second-level indexes and 11 third-level indexes.

This paper adopts FCE to construct FCE mathematical model for public services of community sport and implements empirical research by taking urban community in Hunan province as example. The results show community sport development level of Hunan province is above average and remains further improving.

5.2 SUGGESTIONS

To establish and perfect public service performance evaluation system for community sport as soon as possible according to the requirement for community sport service construction put forward by modern social and economic development by taking evaluation as the means and improvement of public services of community sport as the objective;

In order to enhance service-oriented government construction. The government should position the role accurately in public services of community sport, specify the responsibility and improve service level.

To regard service as the common goal, standardize and perfect public service system of community sport, construct community sport public service convenient for people, favourable to people and friendly to people based on all residents and improve health level and life quality of residents through diversified public sport services.

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