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AHP and WSR analysis-based community sports facility layout evaluation research

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ABSTRACT

Community sports are important parts in national fitness, it has great effects on civil physical and psychological health, and sports facility selection no doubt is essential condition to construct sound community sports. Based on this, the paper analyzes community sports facility selection, in the paper, it puts forward principles of using AHP method and WSR method to make selection strategy, and constructs evaluation indicator system, in the hope of getting reasonable and scientific selection countermeasures and providing better fitness environment for community residents. The paper firstly on the basis of analyzing community sports facility selection evaluation elements, it gets facility life cycle quality evaluation process method and AHP analysis-based equipment facility layout evaluation indicator system, and gives computational steps of analysis methods. And then, in order to more scientific obtain selection strategy, it introduces WSR analysis method to provide method basis for facility selection. Finally, it proposes community sports facility selection strategy of opinion polls-based, environment planning-based, safety performance-based, multiple analysis methods combination-based and template revision-based. Research results show that scientific community sports facility layout is helpful for propelling to China's national fitness progress.

KEYWORDS

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INTRODUCTION

Xiao Lin-Peng (2007) pointed out with the improvement of urban residents living standards, residents fitness consciousness was constantly strengthening, community sports service as an important content in community services, was constantly improving, on the condition that urban residents material life being constantly met, leisure time constantly increased, people demands on living standards were gradually promoting, paid more attentions to physical health, which provide essential premise for urban community service development[1]. On this premise, the paper studies on Chinese community sports equipment facility assignment problem, in the hope of perfecting community sports system and building basis for promoting people's living standards.

For community sports research, lots of people have made efforts, by different scholars deepening researching on it, let Chinese community sports system to be relative scientific developed. Among them, Sun Li-Hai and others applied questionnaire survey and other methods, studied on community sports non-profit organizational operating system connotation, operational process model and operation status, and pointed out that community sports non-profit organizational horizontal and vertical orientations were not smooth, organizational structure was imperfect, organizational combination was loose, resource achieving overall ability was insufficient, its features showed as flexible management-oriented,lacked of effective external monitoring, on a whole was in the state of organizational unordered development[2]. Ji Yan-Xia and others (2013) applied documents literature, interviews method and investigation method as well as others, on the basis of summarizing public sports service system structure research results, they analyzed Hebei province community sports status, drew up Hebei province community sports service system frame, and analyzed system frame each grade indicator, stated each indicator importance, which provided theoretical references for relative departments policies making, and provides references for improving community sports service quality and propelling to comprehensive fitness deepening development[3]. Liang Bao-Jun (2013) investigated Henan province community sports resources assignment status, community sports usable area, facility layout status and different types, scale and development modes' community sports facilities, he got that community per capita sports facility usable area compared to legal per capita area, deficiency was bigger, sports facility items were relative concentrated and types coverage was not wide enough, sports facility " Not yet full assigned" communities proportions were bigger, sports facility layout and residential areas types and scale had high correlations, foreign-funded enterprises developed residential area sports facilities full assignment proportions were obviously higher than residential areas that were developed by state-owned enterprises, private enterprises and affordable housing project as well as other conclusions[4].

The paper on the basis of former researches, studies on community sports equipment and facilities assignment problems, it introduces AHP evaluation methods and WSR analysis method in the research, in the hope of providing theoretical references for Chinese community sports scientific development.

COMMUNITY SPORTS FACILITY SELECTION EVALUATION ELEMENTS ANALYSIS

Community sport emerged since fifties of 20th century followed by economic and technological development and people constantly increased sports demands, it mainly takes base levels communities as regional ranges, with the purpose of meeting community residents' entertainment and fitness demands.

To summarize, community sports can effective help to community residents' fitness demands, provide guarantee to people's living standards enhancement to a certain extent; in movement process, it effectively propels to community residents' exchanges, and provides friendly platform for people

friendly relations establishment; community sports itself is a kind of community cultural activity, it plays certain propelling roles in promoting the whole social spiritual civilization construction. Community sports have beauty building attributes, entertainment, self-control, individual targeted, randomness and consciousness as well as other features.

Therefore, Yuan Guo-Liang and others (2010) pointed out with transformation from planned economy to market economy, previous sports activities under unit system gradually were replaced by community sports activities, community sports surely would become material foundation of social sports development, sports facilities construction status became priority factors that restricted community sports development[5]. The paper studied contents are mainly community sports facilities selection, which is also exploring scientific sports facilities construction method, in the hope of providing theoretical references for making Chinese national fitness progress.

Song Jie (2012) pointed out community as a main front of national fitness project implementation, in recent years, under national relative policies systems guarantee and key supports, economic input increased per year, corresponding sports facilities construction scale and strength were constantly expanding[6]. By far, sports facilities have already spread Chinese each region communities, though present community spots facility construction has been obviously upgraded by comparing to previous', people still pay attentions to sports facilities optimal configuration and facilities selection in communities and other problems.

In order to explore community sports selection optimization strategy, establish sports facilities evaluation system is indispensible, only with scientific and reasonable sports facility evaluation indicator system, then can build basis for its selection. Wu Bo and others (2007) pointed out one of the reasons for current urban planning discipline's non-effective handling with community sports construction problems was caused by its single value objective of economy development in planning, social efficiency especially for sports social value recognition was not sufficient, to better solve community sports problems, it should firstly make social and scientific reviewing on current economic efficiency priority value judgment criterion and remodel the whole value thoughts[7].

The paper thought that scientific community sports facility evaluation elements should possess following three elements:
1) Sports facility life cycle is main reference for defining facility application age limits, we can evaluate facility selection from the perspective, so element one is sports facility life cycle.
2) Community residents' fitness consciousness, sports quality, personal attainments and knowledge reserve these factors are main factors that decide community sports facility application value reflection, excellent sports facility selection is been made best use, only community residents improve its evaluation and get pleasure from sport then can evaluate facility merits status. Therefore, spreading fitness knowledge and technology to community residents, establish rigorous facility management mechanism are the guarantee of community sports sound operation. Therefore element two is community advertising efficiency and facility management actual effects.
3) Marx had said that everything was changing, people surrounding economy, science and technology as well as sports forms were developing and changing, besides seasons changes from state to state as well as other factors are important reference quantities that affect community sports facility selection, relative static exists while there are changes. Therefore, take comprehensive consideration on isolated static equipment facilities and changing and developing surrounding dynamic information is one of important factors to sports facility evaluation. Therefore, it requires selection researchers to make selection that follows objective dynamic rules, make distinguish treatment according to different regions and different seasons, which is also introducing evaluation element three region, season and environment.

COMMUNITY SPORTS FACILITY EVALUATION INDICATOR SYSTEM CONSTRUCTION AND EVALUATION STEPS

Indicator system construction

Sports facility selection evaluation elements statements, the paper can make quality comprehensive evaluation on community sports facility life cycle according to research structure as Figure 1 shows. In Figure 1 each symbol definition is as TABLE 1 shows.

TABLE 1 : Figure 1 symbols definitions table

Symbol	Definition
A	Facility quality influential factors analysis.
B	Comprehensive indicator system.
C	Indicator screening
D	Defined indicator system
E	Fitness activities management service diversified indicator system
F	Facility layout quality evaluation indicator system
G	Multiple subjects participation
H	Expert consultation
I	Fuzzy clustering method
J	Humanity, society, economy, region and environment investigation
K	Indicator prediction and evaluation required basic information
L	Relative theory analysis
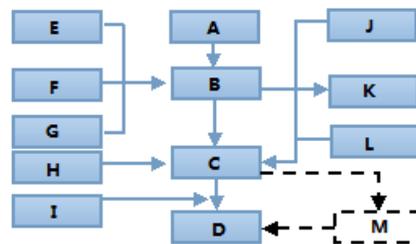
Figure 1 : Community sports facility life cycle quality evaluation process

In order to make community sports facility selection reasonable and scientific, the paper applies fuzzy clustering method and gets equipment facilities evaluation indicators system, the system have five first grade indicators, fourteen second grade indicators, twenty-eight third grade indicators, indicator status is as TABLE 2 shows.

TABLE 2 : Community sports facility layout evaluation indicators contents table

No.	Indicator contents	No.	Indicator contents	No.	Indicator contents	No.	Indicator contents
X	Facility performance	Z2	Psychology	Y12	Apparatus amount	W11	Facility management
Y	Facility perception	W1	Management and maintenance	Y21	Fields types	W12	Facility maintenance
Z	Fondness extent	W2	Science and technological ways	Y22	Apparatus types	W21	Scientific monitoring
W	Service level	W3	Stadium opening	Y31	Coordination	W22	Technical guiding
N	Cultural environment	N1	Fitness atmosphere	Y32	Attractive appearance	W31	Time rationality
X1	Physical properties	N2	Cultural acceptance	Y41	Accessibility	W32	Location convenience
X2	Safety	N3	Communicability	Y42	Material space sense	N11	Fitness performing
Y1	Quantity	X11	Materials	Y43	Convenience	N12	Fitness education
Y2	Types	X12	Structure	Y44	Hygiene extent	N21	Community characteristics
Y3	Aesthetics quality	X21	Hidden danger existence level	Z11	Usage mode	N22	Community tradition
Y4	Comfort level	X22	Environment anti-interference	Z12	Utilization frequency	N31	Beneficial to exchange

Z1	Behavior	Y11	Fields amount	Z21	Utilization attitude	Q	Comprehensive index

Note : X, Y, Z, Wand N are first grade indicators, (Xi etc.) represents second grade indicators, (Xij) represents third grade indicators.

Indicator system hierarchical structure is as Figure 2 shows.
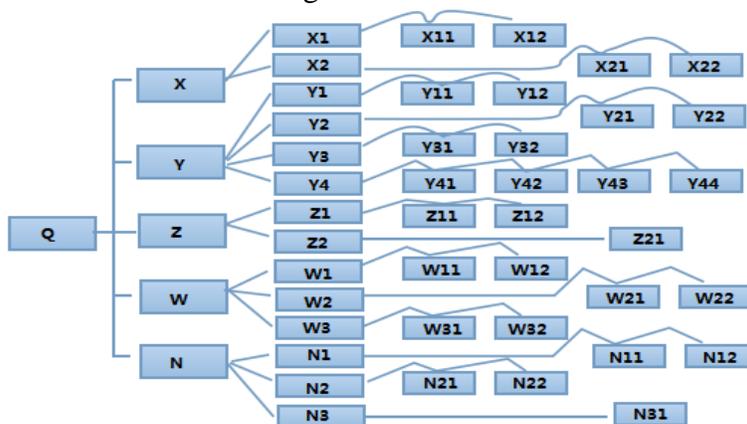
Figure 2 : Community sports equipment facility selection evaluation indicator system hierarchical structure schematic diagram

AHP-based indicator system evaluation method

When define 3.1 each indicator occupied proportions (that is weight),due to these factors proportions normally are not easy to quantitatively define, and if these factors influence factors are more, when constructing judgment matrix, it tends to cause decision- makers provide mutual contradiction data due of ill-considered and out at elbows. Therefore, the paper quotes Saaty proposed paired comparison method on factors to establish paired comparative construction judgment matrix. That is every time in the same layer, it takes two factors x_i and x_j, and use a_{ij} expressing x_i and x_j to factor Z influences, whole comparison result can use matrix $D = (a_{ij})_{n \times n}$ to express, call D as $Z - X$ judgment matrix. It is easy seen if x_i and x_j to Z influence ratio is a_{ij}, and then x_j and x_i to Z influence ratio is $a_{ji} = \dfrac{1}{a_{ij}}$.

Regarding a_{ij} value determination method, this paper quotes Saaty suggested number 1~9 and its reciprocal as scale. As following Table 3 show.

TABLE 3 : Definition of Scale

Scale	Definition
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 obviously more important than the later by comparing two factors
7	Indicates the former is intensely more important than the later by comparing two factors
9	Indicates the former is extremely more important than the later by comparing two factors
2,4,6,8	Indicates middle value of above adjacent judgment
Reciprocal	If factor i and factor j importance ratio is a_{ij}, and then factor j and factor i importance ratio is

$$a_{ji} = 1/a_{ij}$$

Calculate weight vector

For constructing judgment matrix, weight vector calculation method is: adopting extraction of root calculating maximum feature vector and maximum feature root. Solve the sum of A each row vector and take its average value, and then make normalization. Its formula is:

$$w_i = \frac{\left(\prod_{j=1}^{n} a_{ij}\right)^{\frac{1}{n}}}{\sum_{k=1}^{n}\left(\prod_{j=1}^{n} a_{kj}\right)^{\frac{1}{n}}} \quad i = 1,2,L,n \tag{1}$$

According to formula (1) and following calculation steps: Step one: A elements multiplied according to column and gets a new vector; Step two: Let each new vector every component extracts n powers; Step three: After making normalization of all vectors that gets weight vectors. $w = (w_1, w_2, \cdots w_n)^T$ that is approximate feature vector.

Consistency test

Calculate consistency indicator

Test consistency, at first it needs to firstly calculate matrix maximum feature root λ_{max}:

$$\lambda_{max} = \sum_{i-1}^{n} \frac{(AW)}{nw_i} = \frac{1}{n}\sum_{i-1}^{n} \frac{\sum_{j=1}^{n} a_{ij}w_j}{w_i} \tag{2}$$

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

Find out corresponding average consistency indicator RI. TABLE 4 provides 1~9 order positive and negative matrix average random consistency indicator.

TABLE 4 : Average random consistency indicator 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

RI value is got in this way that uses random method constructing 500 pieces of samples matrix: extract numbers from 1~9 and its reciprocal at random to construct reciprocal matrix, it solves maximum feature root average value λ'_{max}, and defines:

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

Calculate consistency proportion CR

n order reciprocal matrix A is consistent matrix when and only when its maximum feature root $\lambda_{max} = n$, and when reciprocal matrix A is not consistent, it surely has $\lambda_{max} > n$. A inconsistency degree will get more serious, λ_{max} corresponding standard feature vector would also cannot realistic reflect $X = \{x_1, \cdots, x_n\}$ proportion in factor z influence. Therefore, it is necessary to do consistency test at decision makers provided judgment matrix to decide whether can accept it or not.
Calculate consistency proportion CR as:

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

When $CR < 0.10$, it is thought that judgment matrix consistency is acceptable, otherwise it should make proper correction to judgment matrix.

WSR-BASED MATERIALS SELECTION METHOD AND COMMUNITY SPORTS FACILITY MATERIALS SELECTION STRATEGY

WSR methodology

The paper applies WSR system methods to select materials on community sports equipment and facility, the system is the abbreviation of "Wuli-Shili-Renli methodology", is a kind of oriental system thought belongs to qualitative and quantitative analysis comprehensive integration. In Chapter three, it provides factors and its evaluation system that need to consider in sports facilities material selection process, applies AHP analysis method, it can get sports facility material selection process quantity factor, in order to more scientific propose community sports facility material selection strategy, the chapter introduces WSR analysis method. WSR methodology working procedures are as Figure 3 shows.
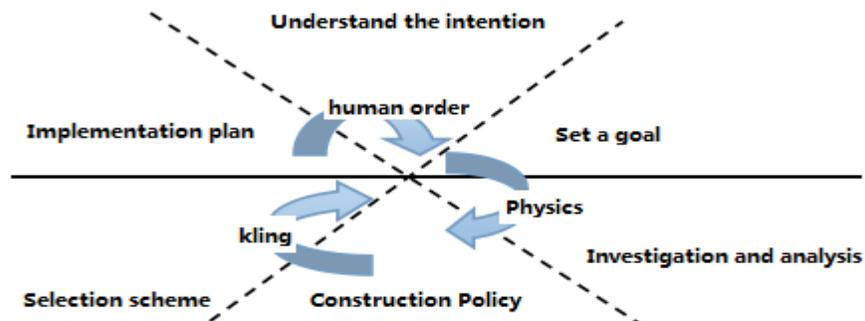
Figure 3 : WSR methodology working procedures

Zhu Zhi-Chang and others (2000) pointed out that WSR was not targeted at complex or ill-structured problems, it could use in general hard or soft systems problems, as problems in case structure was clear, intentions were definite and objects could be defined after analyzing, in these cases working procedures as following Figure 3 showed was relative suitable, but for more complex and ill-structured problems, Figure 3 could not adapt to[7]. The paper provides WSR general applicable steps, design of the steps has good guiding significances in specific projects and problems development, as Figure 4 shows.
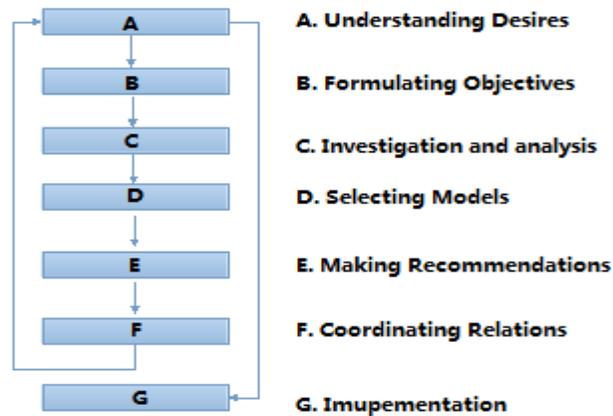
Figure 4 : WSR general applicable steps

As Figure 4 showed methods, it can guide selectors to think in multi-direction and multi perspective, and build basis for scientific material selection.

Community sports facility material selection strategy

Selectors carry on opinion polls and fitness knowledge popularization on responsible regions, establish questionnaire survey and questionnaire information processing system, and select materials according to community residents intentions, which is basic path that facilities are maximum utilized.

Selectors plan for responsible communities regional environment and seasons alternative rules as well as communities vacancy positions, considering for facilities installment and residents' convenient application, usually select communities central positions, and can also select a block of flats vacant position that has higher lodging ratio and more residents, in addition, it also should consider facilities maintenance.

Sports equipment and facility safety is one of most important factors for considering, it is related to equipment operation cycle and residents' personal safety, texture and physical properties of selected apparatus should arrive at national standard, selectors should also make clear equipment and facility re-testing period, and make re-testing plan for equipments.

Apply scientific analysis method, in the paper, it provides AHP indicators hierarchical structure evaluation method and WSR analysis method, due to the paper planned facility evaluation structure has already quite perfected, it needs selectors to make selective accept or reject according to their regional conditions, and carry on comprehensive predication and evaluation on community facilities, and then select materials according to evaluation results.

Selectors based on quantitative analysis and qualitative analysis combination, they should also focus on referencing similar relative successful communities sports facilities materials selection, and take this as template to make targeted revision,so that can get twice the result with half the effort.

CONCLUSION

The paper firstly on the basis of analyzing community sports facility selection evaluation elements, it gets facility life cycle quality evaluation process method and AHP analysis-based equipment facility layout evaluation indicator system, and gives computational steps of analysis methods. And then, in order to more scientific obtain selection strategy, it introduces WSR analysis method to provide method basis for facility selection. Finally, it proposes community sports facility selection strategy of opinion polls-based, environment planning-based, safety performance-based, multiple analysis methods combination-based and template revision-based, it provides theoretical references for Chinese communities' sports facility perfection, with an aim to propel to Chinese national fitness progress.

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