Available online www.jocpr.com

Journal of Chemical and Pharmaceutical Research, 2014, 6(3):1320-1325

Research Article

ISSN : 0975-7384
CODEN(USA) : JCPRC5

Large-scale gymnasium operation influence factor consistency test based on analytic hierarchy process

Yaping Zhang

Department of Physical Education, Jinhua Polytechnic, Jinhua, Zhejiang, China

---

ABSTRACT

Apply analytic hierarchy process in making research on after competition large-scale gymnasium operation use main influence factors. Establish operation use efficiency and influence factors energy saving and environmental protection design, after competition reconstruction design, stadium scale design, government and enterprise cooperation, government, enterprise, sports activity, business activity, public service activity, recreational activity hierarchical structure, besides calculate each factor weight respectively as 0.150 0.107 0.085 0.043 0.071 0.047 0.036 0.093 0.161 0.069 0.138. From research, it gets operation use efficiency three larger influence factors are energy saving and environmental protection design, business activity and recreational activity, and make consistency test through hierarchical single arrangement and whole system. Analytic hierarchy process possesses less data information requests, qualitative analysis and quantitative analysis combination advantages that can further apply in similar fields.

Key words: Analytic hierarchy process, large-scale gymnasium, after competition operation use, influence factor

---

INTRODUCTION

National swimming center is main swimming pool that constructed in Beijing Olympic Games, 2008 that gathers Olympic Games water sports swimming, synchronized swimming as well as diving competition and other competitions' main stadium, is also one of landmark buildings in 2008 Beijing Olympic Games [1-3]. National swimming center water cube planning construction area is 62.95 thousand m^2, overall construction area is 65-80 thousand m^2 [4-6]; total construction charge is 1.02 billion Yuan, and the water cube every year internal and external stadium equipment facilities maintain and repairmen expense is around 9.6 million Yuan, stadium administration expense is around 4.2 million Yuan more, stadium working staff wages and welfare are around 4 million Yuan more, stadium water, electricity as well as fuel and other expense need nearly more than 40 million Yuan [7-9]. From these data, it is clear that China establish large-scale competition stadium no only needs high expense, but also is a large expense on stadium facilities maintaining and administration and other aspects payments after competition, therefore it has a important significance to make research on after competition Olympic Games stadium water cube operation use influence factors, which can provide some reference values for future establishing stadium and establishing stadium after competition operation when other countries hold large-scale activities in the future [10-13].

This research according to consulted information established operation use and each influence factor relationships, systematically analyze each factor influences sizes on them that are weight values. Use mathematical thinking converting complicated influence system into simple mathematical relationships, combining qualitative analysis and quantitative analysis; further solve main influence factors that affect after competition large-scale gymnasium.

GYMNASIUM OPERATION INFLUENCE FACTOR ANALYTIC HIERARCHY PROCESS MODEL

Construct hierarchical structure

Through consulting relative established Olympic Games stadiums operation use information and data after Olympic Games ending, it can get that main factors affect Olympic Games stadium the water cube after competition operation use are stadium design, after competition management main body and after competition operation contents[3-6]. In each influence factor, there are lots of small factors restrict stadium operation use. Stadium design including energy saving and environmental protection design, after competition reconstruction design, stadium scale design as well as stadium appearance design and other aspects; after competition management main bodies divide into government and enterprises cooperative management, completely government management and enterprise independent management these management plans; after competition operation contents are continuous organizing sports activity, or hold large-scale business activity and public service activity and open courts establish them into recreation grounds holding recreational activities. Establish them and decision-making performance hierarchical structure through analysis as Figure1 shows.

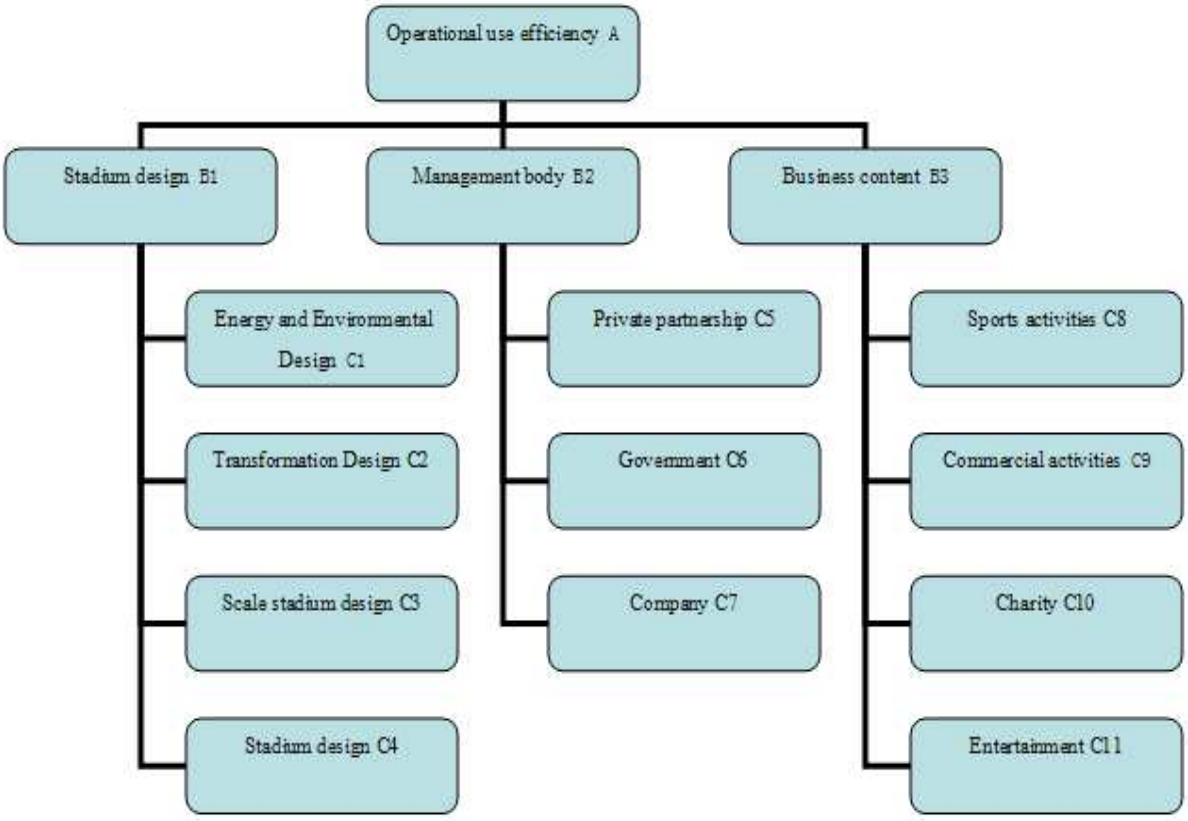

Figure 1: Large-scale gymnasium water cube operation use influence factors

But criterion layer's each criterion weight covers the targets measurement is not always the same.

Construct judgment matrix

Hierarchical structure can clearly reflect relations among each element, but criterion layer's each criterion weight covers the targets measurement is not always the same. When one element has more influence factors, directly consider what influence extent that each factor affects the element, it will appear data that thinks important extent is not coherent, causing error. Therefore, this paper adopts establishing paired comparison matrix method on factor B to carry out paired comparison. Which is taking two factors B_i and B_j every time，with a_{ij} representing B_i and B_j affect A ratios, whole comparison result use matrix $M=(a_{ij})_{n\times n}$ to express，it called M as $A-B$ paired comparison judgment matrix, it is called judgment matrix for short. It is clear that if B_i and B_j influence ration on A is a_{ij} , then B_j and B_i influence ration on A should be $a_{ji}=\frac{1}{a_{ij}}$. Adopt similar method to compare each C factor，establish $B-C$ comparison matrix.

For a_{ij} defined value，Saaty and others suggest to quote number $1\sim9$ and their reciprocal as scale. Table 1 lists out 1-9 scales definitions:

Table 1: 1-9 scale a_{ij} definition

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 importance ratio between element i and element j is a_{ij} , then importance ratio between element j and element i is $a_{ji}=1/a_{ij}$

According to consulted information and data, make comparison between each factor, it can get judgment matrix as following table forms and list it out:

Establish water cube operation use efficiency A and influence factor stadium design B_1 , after competition management main body B_2 , after competition operation content B_3 comparison matrix $A-B$ as following Table 2 shows:

Table 2: Operation use efficiency A and influence factor comparison matrix $A-B$

A	B_1	B_2	B_3
B_1	1	$\frac{5}{2}$	$\frac{5}{6}$
B_2	$\frac{2}{5}$	1	$\frac{1}{3}$
B_3	$\frac{6}{5}$	3	1

Establish stadium design B_1 and influence factor energy saving and environmental protection design C_1, after competition reconstruction design C_2, stadium scale design C_3, stadium appearance design C_4 comparison matrix B_1-C as following Table 3 shows:

Table 3: Stadium design B_1 and influence factor comparison matrix B_1-C

B_1	C_1	C_2	C_3	C_4
C_1	1	$\frac{7}{5}$	$\frac{7}{4}$	$\frac{7}{2}$
C_2	$\frac{5}{7}$	1	$\frac{5}{4}$	$\frac{5}{2}$
C_3	$\frac{4}{7}$	$\frac{4}{5}$	1	2
C_4	$\frac{2}{7}$	$\frac{2}{5}$	$\frac{1}{2}$	1

Establish after competition management main body B_2 and influence factor government and enterprise cooperation C_5 , government C_6 , enterprise C_7 comparison matrix B_2-C as following Table 4 shows:

Table 4: Management main body B_2 and influence factor comparison matrix $B_2 - C$

B_2	C_5	C_6	C_7
C_5	1	$\frac{3}{2}$	2
C_6	$\frac{2}{3}$	1	$\frac{4}{3}$
C_7	$\frac{1}{2}$	$\frac{3}{4}$	1

Establish after competition operation content B_3 and influence factor sports activity C_8, business activity C_9, public service activity C_{10}, recreational activity C_{11} comparison matrix $B_3 - C$ as following Table 5 shows:

Table 5: Operation content B_3 and influence factor comparison matrix $B_3 - C$

B_3	C_8	C_9	C_{10}	C_{11}
C_8	1	$\frac{4}{7}$	$\frac{4}{3}$	$\frac{4}{6}$
C_9	$\frac{7}{4}$	1	$\frac{7}{3}$	$\frac{7}{6}$
C_{10}	$\frac{3}{4}$	$\frac{3}{7}$	1	$\frac{1}{2}$
C_{11}	$\frac{6}{4}$	$\frac{6}{7}$	2	1

Hierarchical single arrangement and consistency test

Judgment matrix corresponds to maximum feature value $\lambda_{\max}$ feature vector W, it is the priority weight of same hierarchy corresponding elements that is relative important to last hierarchy some element after normalization, the process is called hierarchical single arrangement.

Consistency indicator:

$$CI = \frac{\lambda - n}{n - 1} \tag{1}$$

When $CI = 0$, C is consistency matrix，the larger CI is, the more seriously inconsistency extent C would be. Random consistency indicator RI values as Table 6 shows:

Table 6: Random consistency indicator RI

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

For $n \geq 3$ paired comparison matrix M, it is called its consistency indicator and same order (refers to n is the same)random consistency indicator RI ratio as consistency ratio CR formula(2), when formula (2)is true, it is thought that M inconsistency extent is within permissible range, it can use its feature vector as weight vector.

$$CR = \frac{CI}{RI} < 0.1 \tag{2}$$

Use Matlab calculating each matrix maximum feature value $\lambda_{\max}$ as well as CI, and judge consistency whether is passed or not， result as Table 7 shows:

Table 7: Consistency test result

Judgment matrix	Weight vector W	Maximum feature value	CI	RI	CR
$A-B$	$(0.385,0.154,0.461)$	3	0	0.58	0
B_1-C	(0.389,0.278,0.222,0.111)	4	0	0.9	0
B_2-C	$(0.461,0.308,0.231)$	3	0	0.58	0
B_3-C	$(0.2,0.35,0.15,0.3)$	4	0	0.9	0

From Table 7, it is clear that each judgment matrix maximum feature all is the same as its matrix orders, and its consistency indicator CI value all is 0, indicates each judgment matrix is consistency matrix, so it passes consistency test. According to random consistency indicator RI values calculation, it gets that consistency ratio CR value is 0, because $0<0.1$, it is thought that M inconsistency extent is within permissible range, it can use its feature vector as weight vector.

Hierarchical whole system and consistency test

In above test, it gets a group of factors weight vectors on last hierarchy some elements; in order to get each element influence weight for water cube operation efficiency, it should compound bottom hierarchy each element weight with last hierarchy element weight on top hierarchy efficiency.

In hierarchy B, it has B_1, B_2, B_3 three influence factors，their weights on A are respectively: 0.385, 0.154, 0.461. In hierarchy C, it has 11elements C_1, C_2, C_3, C_4, C_5, C_6, C_7, C_8, C_9, C_{10}, C_{11}, their weights on hierarchy B are respectively:0.389, 0.278, 0.222, 0.111, 0.461, 0.308, 0.231, 0.2, 0.35, 0.15, 0.3 (when C_i and B_j are uncorrelated，$c_{ij}=0$).Solve hierarchy C each element total weight on operation efficiency A，which is to solve hierarchy C each element whole system weight， utilize formula(3):

$$c_i=\sum_{j=1}^{m}c_{ij}b_j, i=1,2,\cdots,11 \tag{3}$$

Utilize above formula solving hierarchy C each element weight as Table 8 shows:

Table 8: Each element total weight on operation use efficiency

Element	C_1	C_2	C_3	C_4	C_5	C_6
Weight	0.150	0.107	0.085	0.043	0.071	0.047
Element	C_7	C_8	C_9	C_{10}	C_{11}	
Weight	0.036	0.093	0.161	0.069	0.138	

Weight whole system consistency test

C hierarchy elements correlated to B_j established comparison judgment matrix passes consistency test in hierarchical single arrangement, and it has already solved consistency indicator $CI(j)$ and its corresponding random consistency indicator $RI(j)$, then C hierarchy whole system random consistency proportion by formula(4)it gets.

$$CR=\frac{\sum_{j=1}^{m}CI(j)b_j}{\sum_{j=1}^{m}RI(j)b_j} \tag{4}$$

When $CR<0.10$, hierarchical whole system result passes consistency test, and result is relative precise. By testing， C hierarchy correlated to B_j elements get that $CI(j)$ is 0， so hierarchy whole system random

consistency CR passes testing.

To sum up, it can get energy saving and environmental protection design, after competition reconstruction design, stadium scale design, government and enterprise cooperation, government, enterprise, sports activity, business activity, public service activity, recreational activity these factors after competition operation use efficiency weights on Olympic Games stadium water cube are respectively0.150 0.107 0.085 0.043 0.071 0.047 0.036 0.093 0.161 0.069 0.138. By data comparative analysis, it gets operation use efficiency three larger influence factors are energy saving and environmental protection design, business activity and recreational activity.

CONCLUSION

Utilized analytic hierarchy process model systematically analyzing multiple elements influences on large-scale gymnasium after competition operation efficiency, and made quantization from Olympic Games stadiums design to application as well as management each aspect influence extent, by mathematical analysis, it established each element and large-scale gymnasium after competition operation efficiency mathematical relationships, further solved main factors that affected after competition stadiums operation efficiency were energy saving and environmental protection design, business activity and recreational activity. The conclusion provided an effective reference for current stadiums after competition operation use problems and unfounded stadiums design.

The utilized analytic hierarchy process model skillfully combining qualitative analysis with quantitative analysis, systematically divided complicated operation use elements into different aspects, structure was clear so that helpful for converting complicated problems into relative simple mathematical calculation, the gained results were simple and clear, it provided references and suggestions for decision-makers. In analytic hierarchy process, lots of data wasn't needed, less digital information was required, more qualitative analysis was requested than normal quantitative analysis, by qualitative analysis and converting elements whole aspects judgment into each element weight, finally got uppermost influence factors, it provided references for decision makers.

REFERENCES

[1] Huo Jian-xin; Li Fu. *Ournal of Beijing Sport University*, **2007**, 30(5), 612-614.
[2] Zhang Chunyu; Feng Xinxin. *Journal of Shenyang Sport University*, **2012**, 31(4), 38-42.
[3] Zhou Liang-jun; Tan Jian-xiang. *Journal of Shanghai Physical Education Institute*, **2009**, 33(2).
[4] Zhang B.; Zhang S.; Lu G.. *Journal of Chemical and Pharmaceutical Research*, **2013**, 5(9), 256-262.
[5] Wu Yi-gang; Shen Jia. *Journal of Shanghai Physical Education Institute*, **2007**, 31(6):16-20.
[6] Chen Yuan-xin; Huang Ai-feng; WANG Jian. *Journal of Shanghai Physical Education Institute*, **2007**, 31(1), 30-34, 43.
[7] Lin Xian-peng. *Journal of Beijing Sport University*, **2005**, 28(11), 1441-1444.
[8] Yuan Guang-feng. *Journal of Capital College of Physical Education*, **2006**, 18(1), 23-25, 50.
[9] Tan Cheng-wei; LIn Yong-hu. *Journal of Shenyang Sport University*, **2007**, 26(1), 26-28.
[10] Xiaomin Zhang. *Journal of Chemical and Pharmaceutical Research*, **2013**, 5(12), 8-14.
[11] Wang Bo; Zhao Yulin. *Journal of Chemical and Pharmaceutical Research*, **2013**, 5(12), 21-26.
[12] Mingming Guo. *Journal of Chemical and Pharmaceutical Research*, **2013**, 5(12), 64-69.
[13] Bing Zhang. *Journal of Chemical and Pharmaceutical Research*, **2014**, 5(2), 649-659.