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The Application of AHP in Electric Resource Evaluation

Chunlan Qiu & Yonglin Xiao
Library of Jiangxi Science and Technology University
Ganzhou 341000, China
E-mail:jxust@163.com

Abstract

This article utilizes the analytic hierarchy process (AHP) method to study and establish the hierarchy model and its evaluation system for the electric resource evaluation.

Keywords: AHP, Electric resource, Evaluation system

1. Introduction

In recent years, with the continual increase of electric resource, the purchasing of electric resource has becoming the important part of the construction of library literature resource. The outlay used in electric resource in many libraries has exceeded 25%, so whether for purchasing new electric resource or continuing order and maintaining present electric resource, a new problem occurs, i.e. how to select and evaluate the electric resource, and how to enhance benefits and make the construction of electric resource more reasonable and scientific through the evaluation of electric resource?

However, present scholars' researches only focused on the evaluation of internet information resource or single database, and there are few researches to study the integrated evaluation to the collection of electric resource, and the evaluation and system are not perfect, the present evaluation methods include qualitative method and quantitative method. In this article, we will adopt the AHP method which combines qualitative analysis with quantitative analysis, and try to establish the electric resource evaluation system that can be applied in the pre-evaluation before purchasing and the after-evaluation in the purchasing.

The AHP method (Cai, 2005, p.58-63) was put forward by US famous operational research expert T. L Saaty in 1970s, which tried to simulate three human basic characters (i.e. decomposing, estimation and integration) to deal with complex problems through analytic hierarchy, quantitative analysis and standardization, and added statistical test in the whole process. It adapts to solve those decision problems that have complex structure and many decision rules and are difficult to be quantified.

The basic approach of AHP method include following steps. (1) Establish the concept of the complex problem and find out main factors involved in the study objective. (2) Analyze the association and subjection relationships among factors and establish orderly ladder hierarchy model. (3) Compare both relative essentialities of various factors on the same layer to the certain rule on the upper layer, and establish the evaluation matrix. (4) Compute the relative weight of the compared factor to the rule on the upper layer according to the evaluation matrix and implement the coherence test. (5) Compute the integrated weight of various layers to the total objective of the system and implement total compositor of the layers.

2. Establishment of electric resource evaluation system

2.1 Establishing hierarchy model

Base on many evaluation indexes of electric resource, we build a ladder hierarchy model (Xiang, 2004, p.26-29 & Wang, 2005, p.67-70 & Xiao, 2002, p.35-42) (seen in Figure 1, the 3rd index are not be concretely explained, which are seen in Table 4).

2.2 Constructing comparison evaluation matrix

We adopt the 1-9 standard degree method (seen in Table 1) to evaluate the relative essentialities of the indexes, and evaluate the proportion degree of the relative essentiality through both comparison among them.

For example, for electric resource, we think the content of database is comparatively more important than the searches system and function and endows it 3 points, and it is more important than the uses and endows it 4 points, and it is little more important than the cost accounting and endows it 2 points, and it is more important than the manufacturer than manufacturer service and endows it 4 points, and in this way, we can establish A-B evaluation matrix (seen in Table 2).

Analogously, we can establish evaluation matrixes B_1-C, B_2-D, B_3-E, B_4-F, B_5-G, C_1-P, C_2-P, C_3-P, C_4-P, C_5-P, C_6-P, C_7-P,

D_1-P, D_2-P, D_3-P, D_4-P, E_1-P, E_2-P, E_3-P, E_4-P, F_1-P, F_2-P, F_3-P, F_4-P, F_5-P, G_1-P, G_2-P, G_3-P, G_4-P, G_5-P.

2.3 Computing the weights W_I of various indexes

The information base of AHP is the evaluation matrix, and it utilizes the compositor principle to obtain the matrix compositor vector and compute the weight coefficients of various indexes. The computation approach (Li, 2004, p.75-78) includes following steps.

(1) Compute the product M_i of factors on every raw of the evaluation matrix B: $M_i=\prod_{j=1}^{n} b_j$, j=1, 2… n.

(2) Compute the root of n of M_i on every raw: $w_i=\sqrt[n]{M_i}$, i=1, 2… n, and n is the order number of the matrix in the equation.

(3) Implement normalized processing to $(w_l, w_2 ...wn)^T$, and make $W_I=\frac{w_i}{\sum_{j=1}^{n} w_j}$, so $W_I=[W1, W2, …Wn]^T$ are the eigenvectors, i.e. the weighted coefficients of various indexes.

The concrete evaluations of various layer index weights are seen in Table 4.

2.4 Implementing coherence testing to various evaluation matrix

Because of the complexity of things and human difference of objective evaluation, every evaluation can not achieve completely identical, and to ensure the rationality of the conclusion of AHP method, we need to implement coherence test to various evaluation matrix, so we introduce the negative square values of other latent roots except for the maximum latent root of the evaluation matrix in AHP method and take them as the deviation coherence index of the matrix departures, i.e. use $CI=\frac{\lambda_{\max}-n}{n-1}$ to test the coherence of the evaluation thinking. The maximum latent root $\lambda_{\max}=\sum_{i=1}^{n}\frac{(AW)_i}{nW_i}$.

To test whether different evaluation matrixes have satisfactory coherence, we must introduce the average random coherence index RI value of the evaluation matrix, and RI values of 1-9 order evaluation matrixes can be seen in Table 3.

To the 1st and 2nd evaluation matrixes, they always have satisfactory coherence, but the order number exceeds 2, the ratio of the coherence index CI with the some order random coherence index RI is called the random coherence ratio CR, and when $CR=\frac{CI}{RI} < 0.10$, we think this evaluation matrix has satisfactory coherence, i.e. the thinking on various layers is coherent, the conclusion obtained by the AHP is coherent, or else, the evaluation matrix should be adjusted to make it possess satisfactory coherence.

The maximum latent roots of the evaluation matrixes are obtained by the computer program, and according to them we can obtain the coherence index CI and random coherence ratio CR, and then we implement the coherence test, and the results are complete coherence or satisfactory coherence.

2.5 Integrated weight

Though above approach, we can only obtain the weighted vectors of a group of factor to the certain factor on its upper layer. To obtain the relative weights of various factors to the total objective, especially to obtain the compositor weights of various indexes on the lowest layer to the objective, i.e. "integrated weights", we need superincumbent computation and integrate weights under the single rule, and obtain the relative weight of every evaluation objective in the layer objective to the total objective and implement total evaluation coherence test layer by layer. Relative to the total objective, the integrated weights of various indexes can be denoted as $W=a_i a_{ij} a_{ijk}$, where a_i, a_{ij} and a_{ijk} respectively are 1st, 2nd and 3rd class index weight. Then we implement total compositor to the relative weights.

So we can obtain a clear evaluation index system of electric resource (seen in Table 4).

Though confirming the evaluation grading (seen Table 5), we can evaluate various indexes of the electric resource evaluation system, and the method is to use the weighted adding method, multiply the evaluation value of every evaluation index with the corresponding weight of this index, obtain the weighted evaluation value of the index, add these weighted evaluation values and obtain the total evaluation valves of the evaluation objective. The formula is $S=\sum W_i P_i$ (here, W_i is the integrated weight of the i'th index, P_i is the evaluation value of evaluated object on the i'th index, and i is the sequence number of the concrete index on the lowest layer in the evaluation model).

If the quantity of electric resources participated in the evaluation has Ql, Q2, Q3…Qn, we should adopt the AHP method. We respective establish evaluation matrixes aiming at 63 evaluation indexes, and obtain the compositor vectors of 63 evaluation matrixes. Multiply every compositor vector with weighted coefficient of corresponding index and add them, we can obtain the total compositor vector of Ql, Q2, Q3…Qn, and its result is also the compositor of the electric resources Ql, Q2, Q3…Qn.

3. Conclusions

The character of AHP is to combine qualitative analysis with quantitative analysis, which has high validity, reliability, conciseness and extensive applicability. But AHP still has limits, and its result only aims at the evaluation index in the rule layer, so the confirmation of evaluation index largely influences the system evaluation, in addition, human subjective evaluation has certain influence to the evaluation results of the system, so this method usually is combined with Delphi method to confirm the values of various indexes.

The evaluation of electric resources by AHP compensates human limit of subjective blur ability, which quantifies decision-makers' experiences and judgments, compares relative factors layer by layer, tests the rationality of comparison result layer by layer, avoids the subjective random of simple evaluation to make the result more exact and make the evaluation decision possess more objectivities and persuasions.

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Table 1. 1-9 standard degree method

Comparison between index A and index B	Extremely important	Very important	Important	Little important	equal	Little unequal	unimportant	Very unimportant	Extremely unimportant
Evaluation value of index A	9	7	5	3	1	1/3	1/5	1/7	1/9
Remark	Taking 8, 6, 2, 1/2, 1/4, 1/6, 1/8 as the middle values of above evaluations								

Table 2. Evaluation matrix

A	B_1	B_2	B_3	B_4	B_5
B_1	1	3	4	2	4
B_2	1/3	1	3	2	3
B_3	1/4	1/3	1	1/3	1
B_4	1/2	1/2	3	1	3
B_5	1/4	1/3	1	1/3	1

Table 3. RI values of evaluation matrix

Order number	1	2	3	4	5	6	7	8	9
RI	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45

Table 4. Evaluation index system table of electric resource

A electric resource	1st index (a_i)	2nd index (a_{ij})	3rd index (a_{ijk})	Integrated weight W
	Contents of database B_1 (0.41)	Embodied content C_1 (0.34)	Knowledge range P_1 (0.33)	0.0460
			Magazine sorts P_2 (0.17)	0.0236
			Article periodical proportion P_3 (0.17)	0.0236
			Nuclear periodical proportion P_4 (0.33)	0.0460
		Fixed number of year of data C_2 (0.09)	Database time limit P_5 (1.00)	0.0369
		Data type C_3 (0.23)	Article database P_6 (0.50)	0.0472
			Tabloid database P_7 (0.25)	0.0236
			Reality database P_8 (0.25)	0.0236
		Data repetition ratio C_4 (0.05)	≥30% P_9 (0.10)	0.0020
			10%~30% P_{10} (0.25)	0.0051
			≤10% P_{11} (0.65)	0.0133
		Data update/lag C_5 (0.15)	Daily update P_{12} (0.65)	0.0400
			Weekly update P_{13} (0.25)	0.0154
			Monthly update P_{14} (0.10)	0.0062
		Data source C_6 (0.09)	Data credibility P_{15} (0.50)	0.0184
			Information provider's reputation P_{16} (0.50)	0.0184
		Information resource organization C_7 (0.05)	Classifying according to topic and subject P_{17} (0.40)	0.0082
			Rationality of classification P_{18} (0.40)	0.0082
			Frame structure P_{19} (0.20)	0.0041
	Searches system and functions B_2 (0.24)	Searches function D_1 (0.35)	Browse searches P_{20} (0.10)	0.0084
			Simple searches P_{21} (0.16)	0.0134
			Second time searches P_{22} (0.28)	0.0235
			Checkable field P_{23} (0.46)	0.0386
		Searches technology D_2 (0.35)	Boolean searches P_{24} (0.20)	0.0168
			Truncate searches P_{25} (0.20)	0.0168
			Quotation searches P_{26} (0.20)	0.0168
			Clustering searches P_{27} (0.20)	0.0168
			Position logic P_{28} (0.10)	0.0084
			Weight searches P_{29} (0.10)	0.0084
		Searches results D_3 (0.19)	Completely exact P_{30} (0.43)	0.0196
			Output format P_{31} (0.27)	0.0123
			Hyperlink P_{32} (0.10)	0.0046
			Compositor mode P_{33} (0.10)	0.0046
			Marker P_{34} (0.10)	0.0046
		User service D_4 (0.11)	Help document P_{35} (0.37)	0.0100
			User training P_{36} (0.24)	0.0063
			Word and table tool P_{37} (0.15)	0.0040
			Adjustment of searches interface P_{38} (0.08)	0.0021
			Searches history record P_{39} (0.08)	0.0021
			Literature transfer service P_{40} (0.08)	0.0021
	Uses B_3 (0.08)	Entry time E_1 (0.12)	Database opened time P_{41} (1.00)	0.0096

		Searches time E_2 (0.23)	Searches mode used time P_{42} (1.00)	0.0184
		Download tabloid/entire article E_3 (0.23)	Article number downloaded to the client computer P_{43} (1.00)	0.0184
		User evaluation E_4 (0.42)	Easily using character P_{44} (0.33)	0.0111
			Practicability P_{45} (0.67)	0.0225
	Cost accounting B_4 (0.19)	Data base price F_1 (0.48)	Unit price of database P_{46} (1.00)	0.0912
		Searches cost F_2 (0.12)	Cost of database searches P_4 (1.00)	0.0228
		Entry cost F_3 (0.12)	Cost of database entry P_{48} (1.00)	0.0228
		Investment of hardware and software F_4 (0.21)	Cost to purchasing equipment and software P_{49} (1.00)	0.0399
		System maintenance F_5 (0.07)	Professional maintenance P_{50} (1.00)	0.0133
	Manufacturer services B_5 (0.08)	Data transfer mode G_1 (0.31)	International network P_{51} (0.16)	0.0040
			Special line mode P_{52} (0.30)	0.0074
			Local mode P_{53} (0.54)	0.0134
		Probation time G_2 (0.10)	Below 6 months P_{54} (0.54)	0.0043
			3~6 months P_{55} (0.30)	0.0024
			Below 3 months P_{56} (0.16)	0.0013
		Visiting mode G_3 (0.18)	Password entry P_{57} (0.40)	0.0058
			IP limit P_{58} (0.40)	0.0058
			Concurrent user P_{59} (0.20)	0.0029
		Technology support G_4 (0.31)	User service P_{60} (0.67)	0.0166
			Visiting purview P_{61} (0.33)	0.0081
		Relative document G_5 (0.10)	MARC record provision P_{62} (0.67)	0.0054
			ISSN, web address information provision P_{63} (0.33)	0.0026

Notice: The numbers in the bracket are the weights relative to superior indexes.

Table 5. Evaluation grading

Grading	good	comparatively good	general	comparatively bad	bad
Value interval	10-8	8-6	6-4	4-2	2-0

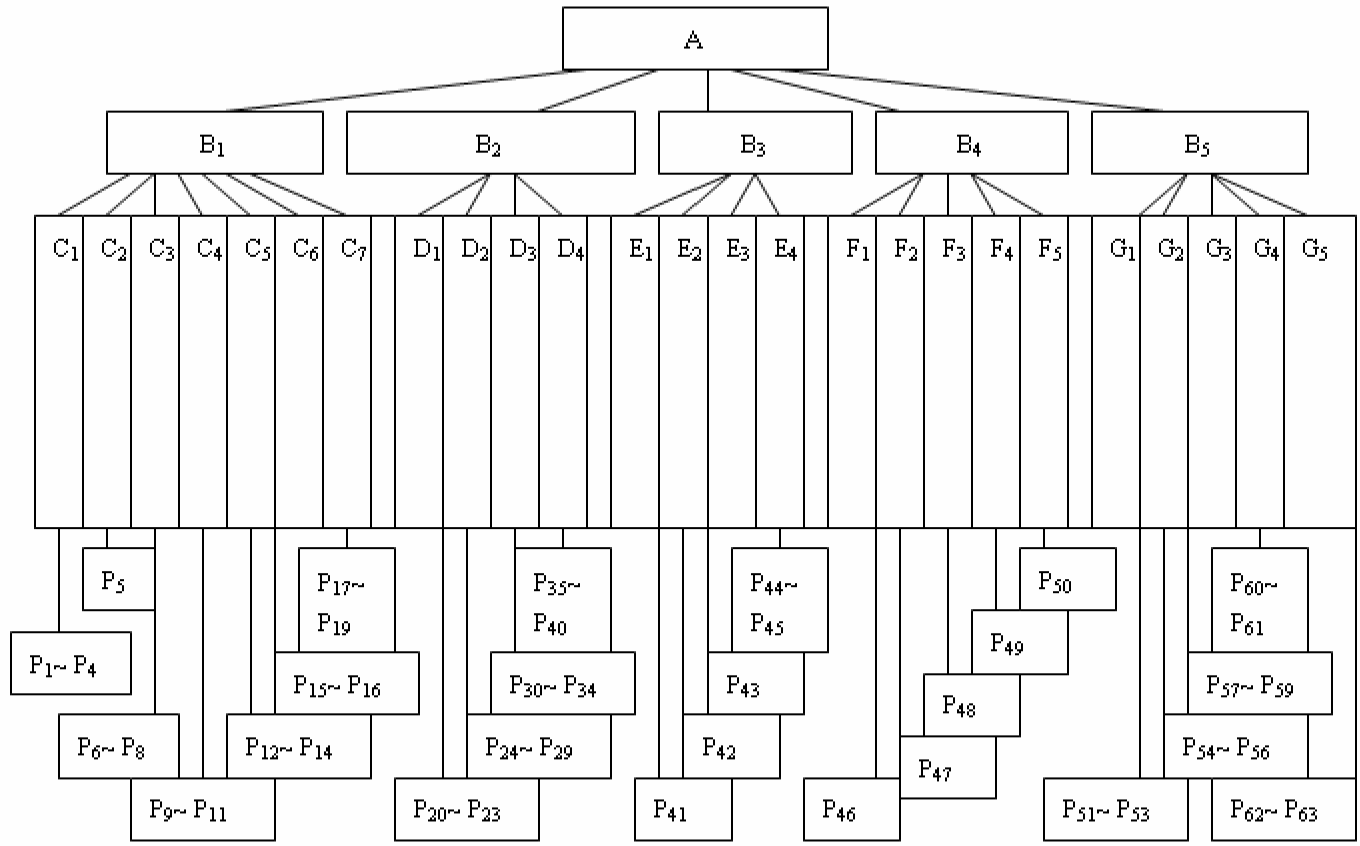

Figure 1. Ladder Hierarchy Model

Notice: A- the evaluation of electric resource, B_1- the contents of database, B_2- searches system and function, B_3- uses, B_4- cost accounting, B_5- manufacturer service, C_1- embodied content, C_2- fixed number of year of data, C_3- data type, C_4- data repetition ratio, C_5- data update/lag, C_6- data source, C_7- information resource organization, D_1- searches function, D_2- searches technology, D_3- searches results, D_4- user service, E_1- entry time, E_2- searches time, E_3- download tabloid/entire article, E_4- user evaluation, F_1- data base price, F_2- searches cost, F_3- entry cost, F_4- investment of hardware and software, F_5- system maintenance, G_1- data transfer mode, G_2- probation time, G_3- visiting mode, G_4- technology support, G_5- relative document.