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Research Article

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Study on performance evaluation of digital resources in college library based on fuzzy analytic hierarchy process

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ABSTRACT

The digital resources construction of college library is important for the development of college, therefore it is necessary to evaluate it base on an effective evaluation method, and the application of fuzzy analytic hierarchy process on it is studied in depth. Firstly, the meaning of performance evaluation of digital construction of college library is discussed; Secondly, the digital resource performance evaluation index system is constructed; Thirdly, the analysis procedure of fuzzy analytic hierarchy process and confirming model of index weight based on fuzzy analytic hierarchy process are given. Finally, a cased study is carried out, results show that the fuzzy analytic hierarchy process is an effective method for performance evaluation of digital resources of college library.

Key words: performance evaluation; digital resources; college library; fuzzy analytic hierarchy process

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INTRODUCTION

College library is an important is an important place where the teachers and students in colleges and universities can obtain the information and strengthen the study. With the wide application of network and multimedia technology, the college library digitization process is accelerated. The digital resources construction is the focus of library construction, library should understand correctly the function of digital resources, and evaluate the construction state of digital library. Because the barrel spending of library is limited, then it is necessary for library to use the funds rationally and get the high construction benefit [1]. In recent years, the performance evaluation of digital resources in college library lacks quantitative analysis, and the reasonable index system and evaluation model have not been established, the evaluation work exists certain blindness. The effective evaluation method should be applied in quantitative evaluation of digital resources construction. The fuzzy analytic hierarchy process is a comprehensive evaluation method based on fuzzy mathematics. This method can transfer the qualitative evaluation to quantitative evaluation. It has the character of clear results and strong system, which can solve the fuzzy and less quantifiable problem, and be suit for dealing with non-deterministic problem. The funds of college library can produce the biggest effect in digital construction of college library, and amend the service level of library, then achieve the maximum performance of college library.

Meaning of performance evaluation of digital construction of college library

In recent years, there is a misconception for college library during the procession of digital construction. Although the funds of constructing the digital resources are limited, but some colleges library are in blind pursuit of capacity of digital resources, and overlook utilization of digital resources. If the performance evaluation is introduced into the digital construction of college library, the current misconception can be avoided, and the redundant low-level development can be reduced, the maximum digital resources utilization can be achieved [2].

With the increasing of the demands for digital resources by college students, the proportion of input in the digital resources construction for the whole funds is increasing constantly. Whether the funds invested are reasonable or not,

and an important guidance is the performance evaluation results of digital resources construction. The college library should increase the funds with good performance evaluation results and decrease the funds with poor evaluation results. The performance evaluation on the digital construction of college library can understand the library collection of college library in time, and distinct the merits digital resources, then the whole structure of digital resources of library collection can be regulated in time, therefore the performance evaluation of digital resources of college library can ensure the sustainable development of digital construction of college library [3].

In addition, the performance evaluation of digital construction of college library is a important method that can measure the serve quality ability to provide service for the teaching and scientific research, and it is also a means to measure the quality of information service. Therefore the performance evaluation of digital construction of college can improve the information service quality and satisfaction of teachers and students.

Construction of digital resource performance evaluation index system

The digital resources play an important role on the library development. The performance evaluation of digital resources can make college obtain the maximum benefit. The performance evaluation content of college library concludes following contents: conformity degree of teaching and scientific research development, quality of digital resources, function of digital resources, service quality [4]. The performance evaluation index system of college library digital resources is shown in table 1.

Table 1 Performance evaluation index system of college library digital resources

First grade index	Second grade index
conformity degree of teaching and scientific research development (A_1)	conformity degree of college-running aim (A_{11})
	conformity degree of subject construction (A_{12})
	target audience of digital resources (A_{13})
	conformity degree of Library goal (A_{14})
quality of digital resources (A_2)	size of digital resources (A_{21})
	quality of digital resources (A_{22})
	trial results of digital resources (A_{23})
	characteristic digital resources (A_{24})
function of digital resources (A_3)	searching interface (A_{31})
	searching technique and method (A_{32})
	procession of search results (A_{33})
	searching efficiency (A_{34})
service quality (A_4)	quality of management information system (A_{41})
	added value of digital resources (A_{42})
	technical guidance of digital resources (A_{43})
	service provided by publisher (A_{44})
	cost accounting of digital resources (A_{45})

Analysis procedure of fuzzy analytic hierarchy process

The procedure of fuzzy analytic hierarchy process is a method combining the fuzzy theory and analytic hierarchy process, according to the features of performance evaluation of digital resources of college library, the fuzzy analytic hierarchy process based on triangular fuzzy number is applied in this research, and the weight of performance evaluation index of digital construction of college library, the procedure of fuzzy analytic hierarchy process is listed as follows [5]:

Step 1: analyze the comparison between different indexes, and construct the Hierarchical model.
Step 2: Compare the evaluation index of the same hierarch with the importance of a principle of top hierarch.
Step 3: Carry out consistency check for fuzzy judge matrix, and regulate the fuzzy matrix that does not satisfy the consistency, and ensure the consistency.
Step 4: Calculate the relative weight of the evaluation index of next grade to principle of last level, and calculate the weight of elements of different grades to performance evaluation of digital resources of college library.

Confirming model of index weight based on fuzzy analytic hierarchy process

According to the actual situation of digital construction of college library, the performance evaluation system of it is established, and the evaluation index system is constructed, the evaluation principle and basis are put forward, the theory model of fuzzy analytic hierarchy process is constructed.

Constructing the fuzzy judging matrix is an important part of fuzzy analytic hierarchy process. During the procession of constructing the fuzzy judging matrix, the formula of fuzzy judging matrix is different when the evaluation scale selected is different. Considering the uncertainty and fuzziness in the procession of evaluation, the triangular fuzzy number is used as the evaluation scale of constructing the fuzzy judging matrix.

The triangular fuzzy number is the fuzzy $\tilde{M}$ on discourse domain R, and the membership function of it is expressed as follows [6]:

$$\mu = \begin{cases} \dfrac{x-1}{m-l}, l \le x \le m \\ \dfrac{x-u}{m-u}, m \le x \le u \\ 0, other \end{cases} \quad (1)$$

where, l is the up bond of $\tilde{M}$, u is the bottom bond of $\tilde{M}$, m is the median that the membership is equal to 1, and the corresponding curve is shown in figure 1.

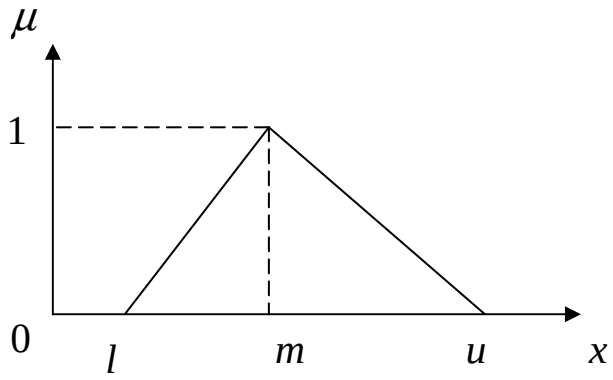

Figure 1 Membership function curve of triangular fuzzy number

The triangular fuzzy number is generally defined to denote the semantics, such as better, normal, poor and so on. The calculation method of triangular fuzzy number is listed as follows:

The fuzzy judging matrix $A = (\tilde{a}_{ij})_{m\times n}$ is given, the fuzzy weight vector is defined as $W = (\tilde{w}_{ij})_{1\times n}$, and the formula of calculating the score vector is expressed as follows:

$$\vec{R} = \vec{A} \otimes \vec{W} \quad (2)$$

where, $\vec{R} = [\tilde{r}_1 \quad \tilde{r}_2 \quad \cdots \quad \tilde{r}_m]'$, $\tilde{r}_i = \tilde{a}_{i1} \otimes \tilde{w}_1 \oplus \tilde{a}_{i2} \otimes \tilde{w}_2 \oplus \cdots \oplus \tilde{a}_{in} \otimes \tilde{w}_n$, $\vec{A}$ is fuzzy judging matrix, and the corresponding expression is listed as follows [7]:

$$\vec{A} = \begin{pmatrix} \tilde{a}_{11} & \tilde{a}_{12} & \cdots & \tilde{a}_{1n} \\ \tilde{a}_{21} & \tilde{a}_{22} & \cdots & \tilde{a}_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \tilde{a}_{m1} & \tilde{a}_{m2} & \cdots & \tilde{a}_{mn} \end{pmatrix} \quad (3)$$

where $\tilde{a}_{ij}$（$i = 1,2,\cdots,m; j = 1,2,\cdots,n$）, m is the number of samples, n is the number of evaluation indexes. $W = (\tilde{w}_j)_{1\times n}$, $\tilde{w}_j$ is the weight of evaluation index, which can be obtained through expert evaluation.

The triangular fuzzy number can be sorted based on mean value and standard deviation. When the mean value is bigger and standard deviation is smaller, the fuzzy number is bigger, the mean value and standard deviation of triangular fuzzy number can be calculated by the following expressions [8]:

$$\bar{x}(\tilde{r}_i) = \frac{1}{4}(a + 2b + c) \quad (4)$$

$$\sigma(\tilde{r}_i) = \frac{1}{80}(3a^2 + 4b^2 + 3c^2 - 4ab - 2ac - 4bc) \quad (5)$$

RESULTS AND DISCUSSION

The aim of performance evaluation for digital resources is to improve the collection of college library according to the demands of teachers and students in college, and ensure the development of digital resources construction. The effectiveness of evaluation method is verified through the case study. And six college libraries are chosen in this research and the library employees, teachers and students are used to respondents, and 1200 questionnaires are issued, and the 1200 questionnaires are recovered.

The membership degree of evaluation index can be described by the triangular fuzzy number, and the fuzzy judging vector can be obtained, then the fuzzy judging matrix can be constructed finally, the definition of importance of triangular fuzzy number is shown in table 2.

Table 2 Corresponding relationship between triangular fuzzy number and importance

triangular fuzzy number	importance
$\tilde{1}$	Importance of indexes 1 and 2 is same
$\tilde{2}$	Index 1 is slightly more important than index 2
$\tilde{3}$	Index 1 is obviously more important than index 2
$\tilde{4}$	Index 1 is very more important than index 2
$\tilde{5}$	Index 1 is especially more important than index 2
$\tilde{2},\tilde{4},\tilde{6},\tilde{8}$	The importance lies somewhere between the two accounts

The characteristic function of triangular fuzzy number is shown in table 3.

Table 3 Characteristic function of triangular fuzzy number

triangular fuzzy number	Membership function
$\tilde{1}$	(1,1,3)
$\tilde{x}$	$(x-1, x, x+1)$, $x = 2,3,4,5,6,7,8$
$\tilde{9}$	(7,7,9)

The membership degree of second grade evaluation index can be calculated according to formula (1), the membership of first grade evaluation index is the mean value of second grade evaluation index, the corresponding calculating results for six college libraries are shown in table 4.

Table 4 Membership of first grade evaluation index for six college libraries

Order number of college library	Membership			
	A_1	A_2	A_3	A_4
1	0.35	0.57	0.65	0.43
2	0.41	0.56	0.73	0.82
3	0.37	0.65	0.64	0.72
4	0.55	0.87	0.92	0.86
5	0.39	0.63	0.72	0.66
6	0.55	0.73	0.58	0.70

According to the relationship between the membership degree and triangular fuzzy number, the membership degree can be transfer into the corresponding triangular fuzzy number, and the fuzzy judging matrix can be obtained finally.

$$A=\begin{bmatrix} \tilde{5} & \tilde{6} & \tilde{5} & \tilde{4} \\ \tilde{6} & \tilde{6} & \tilde{7} & \tilde{5} \\ \tilde{7} & \tilde{8} & \tilde{5} & \tilde{6} \\ \tilde{6} & \tilde{8} & \tilde{9} & \tilde{5} \\ \tilde{6} & \tilde{7} & \tilde{8} & \tilde{7} \\ \tilde{7} & \tilde{6} & \tilde{5} & \tilde{8} \end{bmatrix}$$

Through expert review, the weight of every first grade index can be confirmed finally, which is listed as follows:

$$W=\begin{bmatrix} \tilde{6} & \tilde{7} & \tilde{5} \end{bmatrix}$$

And the score vector can be calculated according to the formula (2), which is shown as follows:

$$R=\begin{bmatrix} (75,96,120,134) \\ (112,135,142,154) \\ (115,132,151,164) \\ (129,152,174,185) \\ (105,124,143,163) \\ (99,121,136,154) \end{bmatrix}$$

The defuzzification operation is carried out for the performance evaluation system of digital resources, and the performance level of six college libraries can be sorted according the sorting rules, the corresponding results are shown in table 5.

Table 5 Sorting results of performance level for six college libraries

sequence	Order number of college library	Mean value	standard deviations
1	6	112.5	105.2
2	4	92.3	105.2
3	3	84.5	103.1
4	2	82.1	116.7
5	5	75.4	129.5
6	1	69.5	115.2

As seen from table 5, considering the performance evaluation level of digital resources, the college library 6 is best, and then is college library 4, college library 3, college library 2, college library 5, the college library 1 is poorest. Therefore the college library with poor performance of digital resources can benefit from the experience of college library with good performance level of digital resources, they can amend the digital resources construction form the aspects of conformity degree of teaching and scientific research development, quality of digital resources, function of digital resources, service quality.

CONCLUSION

With the growing expansion of recruitment scale, the demand for the digital resources is developing; the college library should strengthen the construction of digital resources, and make the information service of library work smoothly. The performance evaluation of digital resources construction is important for improve the whole level of college library. Cased study shows that the fuzzy analytic hierarchy process is strong operational, it can obtain the effective evaluation results. The reliable evaluation system of digital resources of college library can be established based on fuzzy analytic hierarchy process. According to the evaluation results, the college library can find out the disadvantages in constructing the digital resources, and take measures to construct the characteristic database, and improve the applied value of digital resources.

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