Archives Management Evaluation of Colleges and Universities based on Fuzzy Mathematics

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In colleges and universities, it is inevitable to evaluate archives management which is the focus of daily operation. This paper first confirms the indicators of the archives management evaluation index system for colleges and universities and then utilizes AHP to confirm their weights and fuzzy mathematical method to establish the evaluation model. The model gives results of the evaluation as 5 levels: very high, high, medium, low and very low. Expert judging method is utilized to judge all secondary indexes and level judging vectors are then acquired. Finally the evaluation level is confirmed based on maximum principle.

1. Introduction

Archives management is a very complicated job, especially in colleges where talents are cultivated. Archives management, in general, is divided into five parts: documents, educational archives, student records, scientific research records, and honors and awards. Currently, without unified management, archives management in colleges is relatively disordered. Therefore, archives management evaluation is an urgent job.

2. Establishing an Archives Management Evaluation Indicator System for Colleges and Universities

An archives management evaluation indicator system for colleges and universities is established based on a large amount of related readings and telephone interviews to several colleges in Shandong Province. It is scientific, reasonable and feasible. The system contains three primary factors: technical indicator A (infrastructure A_1; archives collection A_2; archives management A_3; archives query A_4; archives statistics A_5; archives security A_6), human indicator B (number of staff B_1; quality of staff B_2; professional ability B_3; staff turnover B_4) and environmental indicator C (archives location C_1; priority given by leadership C_2; investment by the school C_3; attention from teachers C_4).

3. Analytic Hierarchy Process Method and Fuzzy Mathematics Method

3.1 Analytic hierarchy process method
Analytic hierarchy process method is an issue processing method to combine, systematize and layering qualitative and quantitative analyses of practical issues, which is abbreviated as AHP. AHP method divides the practical issues into several layers and compares the indicators layer to layer and further analyses, solves and predicates the issues. The process has 4 steps:

1. Based on archives management evaluation indicator system for colleges and universities, analyze the relationships between all factors and establishes the hierarchical chart of the system;

2. Compare the primary and secondary factors of archives management of colleges and universities and construct a comparative matrix of primary indicators. In comparison 1-9 scale values are normally adopted. Table 1 shows the values.

Table 1: 1-9 scale values of analytic hierarchy process method

Scale a_{ij}	1	2	3	4	5	6	7	8	9
Comparison of I and j	Same		Slightly stronger		Strong		Obviously strong		Absolutely strong

3. Utilize geometric method to calculate relative weight vectors of primary and secondary factors of archives management of colleges and universities. The calculation has three steps which are:

(1) Calculate the product of every line of factors in the comparative matrix, acquire vector α;

(2) Conduct n-order extraction calculation to vector α to acquire vector β;

(3) Conduct normalization processing to vector β to acquire index weight vector γ.

4. Conduct consistency check to the comparative matrix and maintain it within specified error range due to the existence of subjective factors. The checkout procedure has three steps which are:

(1) Calculate coincident indicators of the comparative matrix $CI = \dfrac{\lambda_{\max} - n}{n-1}$. $\lambda_{\max} = \dfrac{1}{n}\sum_{i=1}^{n}\dfrac{\sum_{j=1}^{n}a_{ij}r_j}{r_i}$ is the maximum eigenvalue of the comparative matrix;

(2) Confirm random coincident indicators according to the value of n. Specific values are shown in Table 2;

Table 2: Random coincident indicators of the comparative matrix

n	1	2	3	4	5	6	7	8	9	10	11	12
RI	0	0	0.58	0.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51	1.54

(3) Calculate consistency ratio of the comparative matrix $CR = \dfrac{CI}{RI}$, when $CR < 0.10$, the matrix passes the consistency check.

3.2 Fuzzy mathematics method

Fuzzy mathematics method is commonly used in fuzzy decision issue. It is a key to make reasonable and comprehensive evaluation to a practical problem that is affected by various index factors. This method mainly adopts the membership degree theory of fuzzy mathematics. Based on confirming the evaluation factor sets and judgement sets of archives management of colleges and universities, it constructs a judgment matrix of the secondary factors and finally confirms the evaluation level of archives management.

1. Confirm the evaluation factor sets $P = \{p_1, p_2, \cdots, p_n\}$ of archives management of colleges and universities. The evaluation object has n factors;

2. Confirm the judgment sets $V = \{v_1, v_2, \cdots, v_5\}$ of archives management of colleges and universities. All secondary factors are divided into 5 levels;

3. Confirm the fuzzy evaluation matrix $R = (r_{ij})_{n \times 5}$ of archives management of colleges and universities, the process has two steps:

(1) Generate an evaluation $f(p_i)$ for each factor p_i ($i = 1, 2, \cdots, n$), acquire a fuzzy reflection map f (P to V):

$$f : P \to F(P), p_i \to f(p_i) = (r_{i1}, r_{i2}, \cdots, r_{im}) \in F(V)$$

(2) Induce fuzzy relation $R_f \in F(P \times V)$ from fuzzy reflection map f:

$$R_f(p_i, v_i) = f(p_i)(v_i) = r_{ij}, \; i = 1, 2, \cdots, n; \; j = 1, 2, \cdots, m,$$

Then finally fuzzy judgment matrix $R = (r_{ij})_{n \times m}$ is acquired.

4. According to the weight vectors of each level of factors of archives management of colleges and universities, the comprehensive judgment vectors $w = \gamma^T R$ are calculated by matrix multiplication.

4. Building an Archives Management Evaluation Model for Colleges and Universities

4.1 Adopt layer comparison method to confirm the weights of each factor of archives management of colleges and universities.

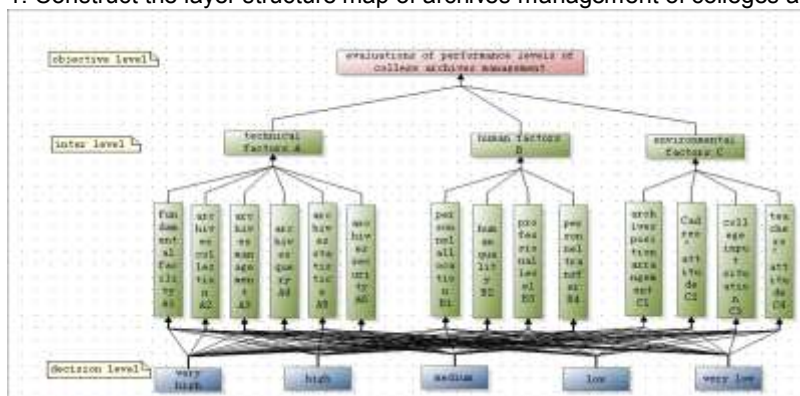1. Construct the layer structure map of archives management of colleges and universities (Figure 1).

Figure 1: Layer structure map

2. Adopt expert judgment method to construct a comparative matrix of primary factors and secondary factors of archives management of colleges and universities.

10 experts are invited to score the importance level of each level of factors of archives management of colleges and universities. After averaging the scores, the impact levels of each factor and the comparative matrix are confirmed: P, A, B, C, D, and E.

3. Calculate the weight vectors of each level of factors of archives management of colleges and universities.

Results acquired are: γ_P, γ_A, γ_B, γ_C, γ_D,

4. Conduct consistency check, make sure that $CR < 0.10$.

4.2. Building an archives management evaluation model for colleges and universities based on fuzzy mathematics method

1. Put all of 14 secondary factors into the factor sets $P = \{p_1, p_2, \cdots, p_{14}\}$ of archives management of colleges and universities;

2. Construct the evaluation sets $V = \{v_1, v_2, \cdots, v_5\}$ of archives management of colleges and universities, dividing its performance into 5 levels: very high, high, medium, low and very low. Specific levels are shown in table 3:

Table 3: Level evaluation sets of secondary factors of archives management of colleges and universities

Secondary factors	Evaluation levels				
infrastructureA_1	Very good	Good	Medium	Low	Very low
archives collection A_2	Very good	Good	Average	Low	Very low
archives management A_3	Very good	Good	Average	Low	Very low
archives queryA_4	Very good	Good	Average	Low	Very low
archives statistics A_5	Very good	Good	Average	Low	Very low
archives security A_6	Very good	Good	Average	Low	Very low
number of staffB_1	Very good	Good	Average	Low	Very low
quality of staff B_2	Very good	Good	Average	Low	Very low
professional ability B_3	Very good	Good	Average	Low	Very low
staff turnover B_4	Very good	Good	Average	Low	Very low
archives locationC_1	Very good	Good	Average	Low	Very low
priority given by leadership C2	Very good	Good	Average	Low	Very low
investment by the school C 3	Very good	High	Average	Low	Very low
attention from teachersC 4	Very good	Good	Average	Low	Very low

3. Confirm the fuzzy evaluation matrix $R = (r_{ij})_{n \times m}$ of archives management of colleges and universities and then use expert judgment method to conduct level evaluation to secondary factors y of archives management of colleges and universities. 10 experts are invited to do so:

$$R_A = \begin{bmatrix} r_{11}^{(A)} & r_{12}^{(A)} & \cdots & r_{15}^{(A)} \\ \cdots & & \cdots & \cdots \\ r_{41}^{(A)} & r_{42}^{(A)} & \cdots & r_{45}^{(A)} \end{bmatrix}, \quad r_{ij} = \frac{number\ of\ experts\ who\ give\ level\ of\ j}{10},$$

R_B, R_C, R_D, R_E are acquired in line with this formula.

4. According to the weights of each secondary factor of archives management of colleges and universities, the fuzzy evaluation matrix of 3 primary factors are acquired as:

$$R_P = \begin{pmatrix} \gamma_A^T R_A & \gamma_B^T R_B & \gamma_C^T R_C & \gamma_D^T R_D & \gamma_E^T R_E \end{pmatrix}^T,$$

Lastly the level evaluation vectors of archives management of colleges and universities are calculated according to the weights of the primary indexes: $w = \gamma_P^T R_P$,

Based on the maximum principle, the level that corresponds to the maximum vector w is the evaluation level of archives management of colleges and universities.

5. Model Calculation and Application

5.1. By means of expert interview (10 experts) and questionnaire investigation, the comparative matrix of archives management of colleges and universities is confirmed. Specific results are listed in table 4-7:

Table 4: Comparative matrix and inspection results of archives management of colleges and universities

Objective level	Evaluation of archives management of colleges and universities P				Maximum eigenvalue	Consistency ratio
Primary factors	technical indicator A	human indicator B	environmental indicator C	Weight		
technical indicator A	1	7	9	0.7928		
human indicator B	1/7	1	2	0.1312	3.0217	0.0209
environmental indicator C	1/9	1/2	1	0.0760		

Table 5: Comparative matrix and inspection results of technical indicator A

Primary factors	technical indicator A							Maximum eigenvalue	Consistency ratio
Secondary factors	Infrastructure A_1	archives collection A_2	archives management A_3	archives query A_4	archives statistics A_5	archives security A_6	weight		
infrastructure A_1	1	3	2	7	4	1/4	0.2155		
archives collection A_2	1/3	1	2	5	3	1/7	0.1227		
archives management A_3	1/2	1/2	1	6	2	1/3	0.1156	6.4324	0.0686
archives query A_4	1/7	1/5	1/6	1	1/3	1/9	0.0274		
archives statistics A_5	1/4	1/3	1/2	3	1	1/5	0.0625		
Primary factors	technical indicator A								
archives security A_6	4	7	3	9	5	1	0.04563		

Table 6: Comparative matrix and inspection results of technical indicator B

Primary factors	human indicator B					Maximum eigenvalue	Consistency ratio
Secondary factors	number of staffB_1	quality of staff B_2	professional ability B $_3$	staff turnover B $_4$	weight		
number of staffB_1	1	1/3	1/6	5	0.1179		
quality of staff B $_2$	3	1	1/3	7	0.2642	4.1851	0.0693
professional ability B $_3$	6	3	1	9	0.5794		
staff turnover B $_4$	1/5	1/7	1/9	1	0.0385		

Table 7: Comparative matrix and inspection results of technical indicator C

Primary factors	environmental indicator C					Maximum eigenvalue	Consistency ratio
Secondary factors	archives locationC_1	priority given by leadership C_2	investment by the school C_3	attention from teachers C_4	weight		
archives locationC_1	1	1/8	1/6	1/3	0.0485		
priority given by leadership C_2	8	1	3	6	0.5815		
investment by the school C_3	6	1/3	1	3	0.2627	4.1037	0.0388
attention from teachers C_4	3	1/6	1/3	1	0.1073		

5.2. Invite 10 experts to conduct level judgment to the secondary factors of archives management of one college. Results are shown in table 8:

Table 8: Level judgment results of secondary factors of archives management of one college

Secondary factors	Level judgment results				
infrastructureA_1	3	5	1	1	0
archives collection A_2	1	3	5	1	0
archives management A_3	2	4	4	0	0
archives queryA_4	5	3	2	0	0
archives statistics A_5	0	2	5	2	1
archives security A_6	0	1	7	1	1
number of staffB_1	0	2	6	2	0
quality of staff B $_2$	1	2	4	2	1
professional ability B_3	4	5	1	0	0
staff turnover B $_4$	2	4	3	1	0
archives locationC_1	4	3	3	0	0
priority given by leadership C_2	1	2	4	3	0
investment by the school C $_3$	0	2	6	1	1
attention from teachers C $_4$	1	3	5	1	0

5.3. The evaluation vector of archives management level of this college is calculated as:

$$w = \begin{pmatrix} 0.1318 & 0.2378 & 0.2239 & 0.0669 & 0.0140 \end{pmatrix},$$

According to the maximum principle, the evaluation level of archives management of this college is: high.

6. Conclusions

Evaluation research of archives management of colleges and universities are relatively few and that there are still many problems in archives management for colleges. Problems to be solved include: lack of unified management mechanism, low facility updating, low level of human resource and lack of funds. Evaluation of

archives management is able to urge colleges and universities to pay more attentions to it by increasing funds, updating facility, speeding up digitalization process and enhancing level of human resource. These mentioned above are of far-reaching significance for archives management of colleges and universities.

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