Fuzzy Comprehensive Evaluation of Learning Organization Construction Under the Background of Big Data

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Abstract. The arrival of the era of big data brings new opportunities and challenges to the construction and development of learning organizations. Learning organizations should not only recognize the importance of information and data, but also learn to apply information and data to organizational construction and development. Based on the era background of big data, this paper selects relevant representative evaluation indicators, uses the analytic hierarchy process to calculate the weight of each indicator, and uses the fuzzy comprehensive evaluation method to evaluate the construction of learning organization. Finally, it is concluded that focusing on the application of big data can help learning organizations make better progress and make better decisions.

Keywords: Big Data · Learning Organization · Analytic Hierarchy Process · Fuzzy Comprehensive Evaluation

1 Introduction

The rapid development of information technology and the deep integration of disciplines have opened a new chapter in digital life, bringing people into the era of big data [1], and data has become an important resource. The big data revolution has prompted rapid business development and changes [2], making enterprises face more changing environments and more complex demands. A learning organization is different from a traditional organization in that it has better integration and learning ability, which can make the enterprise develop for a longer time. The arrival of the era of big data has brought new opportunities and challenges to the construction and development of learning organizations. Learning organizations need to develop themselves in the context of the era of big data, and regard big data as an asset [4]. On the basis of the meaning of big data characteristics, it can efficiently and dynamically mine and utilize the value of data [3]. Not only to recognize the importance of information and data, but also to learn to apply information and data to organizational construction.

In the era of big data, the primary task of learning organization is to identify the positive influence of big data on their learning and development, as well as the practical impact of big data on enterprise construction. When evaluating the construction of a learning organization, the era background of big data should be integrated into it, so that the construction of a learning organization and big data can be integrated.

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2 Evaluation Model

2.1 Build a Hierarchical Hierarchy Model

By studying the literatures, this paper synthesizes the characteristics of big data and learning organizations, and adopts the method of gradually refining each indicator according to the principles of scientificity, typicality and operability. First, the learning organization construction *A* is called the target layer. Then three aspects of personnel learning B_1, policy formulation B_2 and organization construction B_3 are selected as the criterion layer, and the criterion layer is referred to as the first-level index layer. Finally, the scheme layer is obtained according to the actual characteristics of the three aspects in the first-level index layer, and the scheme layer is referred to as the second-level index layer. The constructed evaluation hierarchy model of learning organization construction under the background of big data contains 3 first-level indicators B_k (k = 1, 2, 3) and 15 s-level indicators C_l (l = 1, 2, …, 15), as shown in Fig. 1.

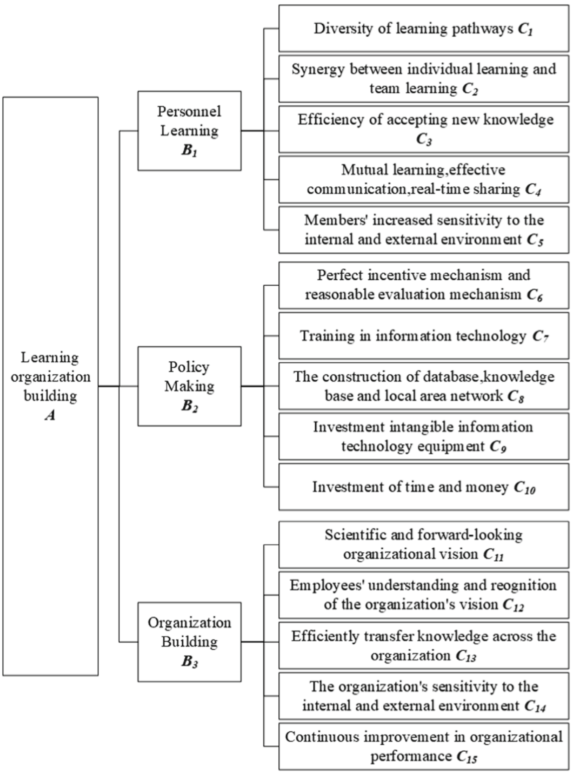

Fig. 1. Hierarchical structure model of learning organization construction evaluation

2.2 Construct Judgment Matrix and Check Consistency

(1) Construct Judgment Matrix
According to the scale of 1 to 9, the experts compare, evaluate and score the factors of each layer in the model, and test the obtained results. According to the expert scoring method, the comparison judgment matrix $\mathbf{R_A}$ between the three indicators in the first-level index and the target layer, and the comparison and judgment matrix $\mathbf{R_{B1}}$, $\mathbf{R_{B2}}$, $\mathbf{R_{B3}}$, between all the indicators in each second-level index layer and the corresponding first-level indicators are designed.

$$\mathbf{R_A} = \begin{bmatrix} 1 & 2 & 3 \\ \frac{1}{2} & 1 & 2 \\ \frac{1}{3} & \frac{1}{2} & 1 \end{bmatrix} \quad \mathbf{R_{B1}} = \begin{bmatrix} 1 & 2 & 4 & \frac{1}{2} & \frac{1}{2} \\ \frac{1}{2} & 1 & 3 & \frac{1}{3} & \frac{1}{3} \\ \frac{1}{4} & \frac{1}{3} & 1 & \frac{1}{5} & \frac{1}{4} \\ 2 & 3 & 5 & 1 & 1 \\ 2 & 3 & 4 & 1 & 1 \end{bmatrix}$$

$$\mathbf{R_{B2}} = \begin{bmatrix} 1 & \frac{1}{3} & \frac{1}{2} & 3 & 2 \\ 3 & 1 & 2 & 5 & 6 \\ 2 & \frac{1}{2} & 1 & 4 & 5 \\ \frac{1}{3} & \frac{1}{5} & \frac{1}{4} & 1 & \frac{1}{2} \\ \frac{1}{2} & \frac{1}{6} & \frac{1}{5} & 2 & 1 \end{bmatrix} \quad \mathbf{R_{B3}} = \begin{bmatrix} 1 & \frac{1}{2} & \frac{1}{4} & \frac{1}{6} & \frac{1}{3} \\ 2 & 1 & \frac{1}{3} & \frac{1}{5} & \frac{1}{2} \\ 4 & 3 & 1 & \frac{1}{3} & 1 \\ 6 & 5 & 3 & 1 & 2 \\ 3 & 2 & 1 & \frac{1}{2} & 1 \end{bmatrix}$$

(2) First-Level Index Layer-Level Single Sorting
From $|\lambda\mathbf{E} - \mathbf{R_A}| = 0$ ($\mathbf{E}$ is a unit matrix of order 3), calculate the maximum eigenvalue $\lambda = 3.0092$.

The corresponding eigenvectors are:

$$\boldsymbol{\omega}_\mathbf{A} = [\omega_{B1}\omega_{B2}\omega_{B3}]^T = [0.5390\ 0.2973\ 0.1638]^T.$$

The ω_{Bi} is the weight of the corresponding element single ordering.

Calculate the Consistency Index (CI) as:

$$CI_A = \frac{\lambda_{\max A} - n}{n - 1} = \frac{3.0092 - 3}{3 - 1} = 0.0046$$

The n is the order of the judgment matrix.

$$CR_A = \frac{CI_A}{RI_A} = \frac{0.0046}{0.52} = 0.0089 < 0.1$$

Among them RI is the average random consistency index, which is obtained by repeatedly calculating the characteristic root of the random judgment matrix and then calculating the arithmetic mean. By consulting the average random consistency index table, it can be known that when the order $n = 3$, $RI_A = 0.52$.

It can be seen that the consistency ratio of the judgment matrix $\mathbf{R_A}$ is less than 0.1, so the consistency of $\mathbf{R_A}$ is acceptable.

Table 1. B-C layer single sorting results

Judge matrix	λ_{max}	Eigen vectors ω_{Bi}	CI_{Bi}	CR_{Bi}
$\mathbf{R_{B1}}$	5.0850	$[0.1902\ 0.1176\ 0.0570\ 0.3234\ 0.3117]^T$	0.0213	0.0190
$\mathbf{R_{B2}}$	5.0550	$[0.1520\ 0.4305\ 0.2775\ 0.0851\ 0.0548]^T$	0.0138	0.0123
$\mathbf{R_{B3}}$	5.0727	$[0.0592\ 0.0934\ 0.2094\ 0.4432\ 0.1954]^t$	0.0182	0.0162

(3) Second-Level Index Layer-Level Single Ordering
Calculate the eigenvalues and eigenvectors of the judgment matrices $\mathbf{R_{B1}}$, $\mathbf{R_{B2}}$, $\mathbf{R_{B3}}$ respectively, and perform a consistency check. The calculation and test results are shown in Table 1.

It can be seen from the above that the consistency ratios of the judgment matrices $\mathbf{R_{B1}}$, $\mathbf{R_{B2}}$, $\mathbf{R_{B3}}$ are all less than 0.1, so the consistency of $\mathbf{R_{B1}}$, $\mathbf{R_{B2}}$, $\mathbf{R_{B3}}$ is acceptable.

(4) Overall Consistency Check
Through calculation, the consistency index of the second-level index layer as:

$$CI_B = \sum_{i=1}^{m} a_i CI_{Bi} = 0.0185$$

Where m is the number of indicators contained in the first-level indicator layer, and a_i is the weight of the ith first-level indicator in the target layer.

Finally, the consistency ratio of the second-level indicator layer relative to the first-level indicator layer is obtained as:

$$CR_B = \frac{CI_B}{RI_B} = 0.0165 < 0.1$$

Among them, $RI_B = \sum_{i=1}^{m} a_i RI_{Bi} = 1.12$.

From the above calculation, it can be concluded that the consistency ratio of the first-level index layer relative to the target layer CR_A and the consistency ratio of the second-level index layer relative to the first-level index layer CR_B are both less than 0.1. Therefore, the matrices in the AHP model established in this paper all reach the qualified standard. Continue to calculate the overall consistency ratio of the AHP model as:

$$CR^* = CR_A + CR_B = 0.0089 + 0.0165 = 0.0254 < 1$$

It can be concluded that the established AHP model has passed the consistency check as a whole. Therefore, the entire model established is qualified and can be used to analyze and deal with practical problems.

2.3 The Total Ranking Weight of All Levels of Indicators

Calculate the total ranking weights of all levels of indicators, and the results are shown in Table 2. The ranking results reflect the importance of each index for the evaluation of learning organization construction.

Table 2. Weights of indicators at all levels in the evaluation of learning organization construction

First-level indicators and their weights	Secondary Indicators	Weights	Sort
Personnel learning 0.5390	Diversity of learning pathways	0.1025	4
	Synergy between individual learning and team learning	0.0634	7
	Efficiency of accepting new knowledge	0.0307	11
	Mutual learning, effective communication, real-time sharing	0.1743	1
	Members' increased sensitivity to the internal and external environment	0.1680	2
Policy making 0.2973	Perfect incentive mechanism and reasonable evaluation mechanism	0.0452	8
	Training in information technology	0.1280	3
	The construction of database, knowledge base and local area network	0.0825	5
	Investment intangible information technology equipment	0.0253	12
	Investment of time and money	0.0163	13
Organization building 0.1638	Scientific and forward-looking organizational vision	0.0097	15
	Employees' understanding and recognition of the organization's vision	0.0153	14
	Efficiently transfer knowledge across the organization	0.0343	9
	The organization's sensitivity to the internal and external environment	0.0726	6
	Continuous improvement in organizational performance	0.0320	10

3 Final Evaluation Result

3.1 Survey Data Results

This paper conducts a questionnaire survey on a total of 102 senior leaders, middle-level leaders and ordinary employees of H company, and evaluates the above 15 secondary indicators. The evaluation level is set as V = {1: Great, 2: Good, 3: Average, 4: Poor, 5: Bad}, the converted points represent 100 points, 80 points, 60 points, 40 points, 20

Table 3. Statistical table of survey results of H enterprises' learning organization construction evaluation

Secondary indicators	Survey results				
	1	2	3	4	5
Diversity of learning pathways	15	35	28	10	2
Synergy between individual learning and team learning	22	42	18	7	1
Efficiency of accepting new knowledge	34	35	18	3	0
Mutual learning, effective communication, real-time sharing	17	29	30	10	4
Members' increased sensitivity to the internal and external environment	8	28	35	12	7
Perfect incentive mechanism and reasonable evaluation mechanism	11	36	29	11	3
Training in information technology	8	26	33	18	5
The construction of database, knowledge base and local area network	7	17	41	20	5
Investment intangible information technology equipment	21	39	23	6	1
Investment of time and money	12	28	34	12	4
Scientific and forward-looking organizational vision	16	33	25	14	2
Employees' understanding and recognition of the organization's vision	6	24	33	19	8
Efficiently transfer knowledge across the organization	15	31	28	13	3
The organization's sensitivity to the internal and external environment	10	29	32	13	6
Continuous improvement in organizational performance	19	32	27	10	2

points, respectively. Finally, 90 valid questionnaires were recovered, and the survey results are shown in Table 3.

3.2 Fuzzy Comprehensive Evaluation of Survey Results

By normalizing the data in the survey results in Table 2, the fuzzy comprehensive evaluation results of each indicator in the secondary indicator layer can be obtained.

Through the weighted average calculation and fuzzy calculation of the evaluation matrix, we can get the fuzzy comprehensive evaluation membership degree vector N_{Bi} of each index in the first-level index layer, the calculation formula is:

$$N_{Bi} = \omega_{Bi}^{T} \times R_{Bi\cdot S}, i = 1, 2, 3$$

Among them, ω_{Bi} is the weight vector of each index of the second-level index layer corresponding to the first-level index layer index R_{Bi}, and $R_{Bi\cdot S}$ is the fuzzy comprehensive evaluation matrix corresponding to the first-level index layer index B_i.

The membership vector obtained from the fuzzy comprehensive evaluation of personnel learning B_1 is:

$$N_{B1} = [0.171\ 0.352\ 0.323\ 0.110\ 0.044]$$

Table 4. Fuzzy comprehensive evaluation results of each index in the first-level index layer

First-level indicators	Evaluation results				
	Great (100)	Good (80)	Average (60)	Poor (40)	Bad (20)
Personnel learning B_1	0.171	0.352	0.323	0.110	0.044
Policy making B_2	0.106	0.292	0.376	0.179	0.048
Organization building B_3	0.142	0.331	0.332	0.145	0.051

Table 5. Fuzzy comprehensive evaluation results of target layer

Target layer	Evaluation results				
	100	80	60	40	20
Learning organization construction	0.147	0.331	0.340	0.136	0.046

The membership degree vector obtained from the fuzzy comprehensive evaluation of policy formulation B_2 is:

$$N_{B2} = [0.106\ 0.292\ 0.376\ 0.179\ 0.048]$$

The membership degree vector obtained from the fuzzy comprehensive evaluation of organization construction B_3 is:

$$N_{B1} = [0.142\ 0.331\ 0.332\ 0.145\ 0.051]$$

Through the above calculation and summary, the fuzzy comprehensive evaluation results of the three indicators in the first-level indicator layer can be obtained, as shown in Table 4.

3.3 Final Evaluation Result

Using the above formula, the membership degree vector obtained from the fuzzy comprehensive evaluation of the learning organization construction N_A can be calculated as:

$$\mathbf{NA} = \boldsymbol{\omega}\mathbf{A}^{\mathbf{T}} \times \mathbf{R}_{\mathbf{A \cdot S}} = [0.147\ 0.331\ 0.340\ 0.136\ 0.046]$$

Among them, $\boldsymbol{\omega}_{\mathbf{A}}$ is the weight vector of each index of the first-level index layer corresponding to the target layer A, and $\mathbf{R}_{\mathbf{A \cdot S}}$ is the fuzzy comprehensive evaluation matrix corresponding to the target layer A.

Through the calculation, the fuzzy comprehensive evaluation results of the target layer are obtained, as shown in Table 5.

Finally, the total score of the learning organization construction under the big data background of H enterprise is calculated as follows:

$$f = \begin{bmatrix} 0.147 & 0.331 & 0.340 & 0.136 & 0.046 \end{bmatrix} \begin{bmatrix} 100 \\ 80 \\ 60 \\ 40 \\ 20 \end{bmatrix} = 67.919$$

According to the score of f, it can be judged that the level of learning organization construction under the big data background of H company is generally better. In terms of policy formulation, it is necessary to make more efforts to improve, and it is necessary to pay attention to the construction of databases, knowledge bases and local area networks, and actively train employees in related technologies, and constantly strengthen the construction of learning organizations based on the background of the era of big data.

4 Conclusion and Outlook

Through the analysis and comparison of the existing literature and the evaluation model of learning enterprise construction under the background of big data constructed based on AHP, it can be found that "mutual learning, effective communication, real-time sharing", "members' increased sensitivity to internal and external environment" and "diversity of learning approaches" have a great influence on the evaluation of learning organization construction as always. The era background of big data makes "training in information technology" and "the construction of database, knowledge base and local area network" begin to occupy a relatively high weight in the evaluation of learning organization construction.

Focusing on the application of big data can help learning organizations make better progress and make better decisions. And big data facilitates the visibility of information, which can help employees enhance the ability to process information. Therefore, learning organizations should focus on the learning of information technology by members of the organization on the original basis, improve the construction of databases, knowledge bases and local area networks, and increase investment in tangible information technology equipment. In addition, learning organizations should also regard big data as a strategic business asset, use big data to improve cost efficiency, increase revenue and enhance the value of market competition, use big data to support prediction and decision-making behavior, and adapt to rapidly changing internal and external environments and increasingly complex real needs.

At present, the sensitivity of learning organizations to the era of big data is not very high, and the existing literature related to the study of learning organizations seldom takes the background of big data into account. Therefore, when scholars conduct research on learning organizations, they can combine the background of big data and strengthen practical research. In addition, companies can further explore the relationship between big data and the learning process so that the two can promote each other and ultimately achieve improved performance.

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