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Digital Campus Synthetic Evaluation Based on Analytic Hierarchy Process

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Abstract: Good Evaluation index and method are essential for smooth development of the construction of Digital Campus. Taking scientific approaches to evaluate and optimize will promote the construction of Digital Campus. This study constructed an AHP (Analytic Hierarchy Process) evaluate model which consisted of the following five first-grade indices: Infrastructure construction (A1), database construction (A2), administration (A3), application (A4) and operation guarantee (A5). Then judgment matrix was built to computer index weight. The result showed that the decreasing order of the weight of each influential factor of the quality of Digital Campus was A4 (0.43)>A1 (0.25)>A2 (0.16)>A5 (0.10)>A3 (0.06). Finally, a practical multilayer evaluate model was built . This model helps to evaluate digital campus construction in a faster, more accurate and scientific manner. This study also brings promotional values to similar multifactorial evaluation.

Key words: Institutions of higher learning, digital campus, analytic hierarchy process, fuzzy mathematics

INTRODUCTION

Digital campus construction is an important work for schools and part of school construction and talent cultivation. It is significant to improvement of school teaching, scientific research, administration and service. Digitalization at institutions of higher learning achieves higher education by making use of new technical power. Digitalization is a necessary demand for high stage of informationization and indicates transition from technology level to idea level for informationization innovation power. It's the core and important result for college informationization. At present digital campus construction is a major indicator of comprehensive quality, image and status for colleges. Some colleges and universities at home have been preparing or implementing digital campus construction and made certain achievements. How to properly evaluate the results is not only a concern for these colleges but also evaluation experts of Department of Education.

In recent years, digital campus construction has begun to take shape, along with which comes evaluation study on digital campus construction result. Yan *et al*. (2004) analyzed characteristics of teaching quality evaluation and provided a solution for teaching quality evaluation system based on campus network by combining dynamic web technology. Zhu *et al*. (2004) discussed theories and practices concerning digital campus construction which are very helpful to digital campus construction evaluation. Wang and Mu (2012), from the perspectives of intention and need of students, teachers, administration personnel and social employees, analyzed the components and indices for evaluating digital construction of senior professional institutes. Zhou *et al*. (2006) and Cai and Yang (2005) also proposed an index system for evaluation of digital campus which, however, lightened the weight of main factors due to excessively detailed consideration to factors and too many layers of system. Such evaluation result seems deviated. Jiao (2007) conducted study on benefit of digital campus construction according to cost-benefit theory. This can guide construction of digital campus to some extent but it's not representative enough by only providing three schools as examples.

In this study, a practical multilayer evaluation model is established on the basis of college digitalization evaluation system by using analytic hierarchy process (Hu, 2010) and fuzzy mathematic theory (Tao *et al*., 2009). This model and evaluation method can fully represent the main features of human decision-making thinking. Qualitative analysis and quantitative analysis are integrated to describe information as it really is, making learning evaluation scientific and simple.

MATERIALS AND METHODS

Step 1: Build evaluation index hierarchy model Selecting a Template. Digital campus (Zhou *et al*., 2006) is virtual education environment based on digital information and network for collecting, processing, integration, storage, transmission and application of information concerning teaching, scientific research, administration, technological service, life-support services through computer and network, so as to make the best of digital resources.

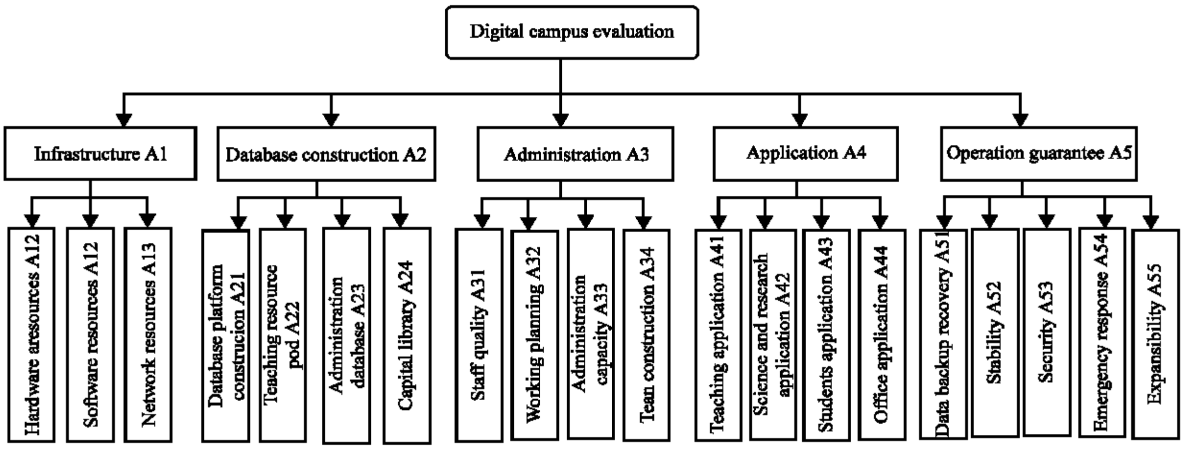

Fig. 1: Digital campus evaluation indices

A digital space is established through digitalization from environment and resources to application, improve operation efficiency of traditional campus, expand functions, finally realize comprehensive informationalization of education process. For establishing comprehensive administration platform, it is necessary to adhere to guidance of unified planning, implementation by steps, enforced application, resource integration and data share (Tan and Wang, 2011; Tang, 2010). Based on consideration of China Information Development Report, the writer classifies evaluation index system for digital campus into five aspects, namely infrastructure construction, database construction, administration, application and operation guarantee. In this study AHP is used to build hierarchy as shown in Fig. 1.

This model consists of three layers, first, second and third layers are respectively objective layer(digital campus evaluation), standard layer (first-level index), including infrastructure, database construction, administration, application and operation guarantee, indicated, respectively by A(i) (i = 1, 2, 3, 4, 5) and index layer (second-level index), indicated by Aij (i = 1, 2, 3, 4, 5; j = 1, 2, 3, 4, 5).

Step 2: Building of judgment matrix. Building of judgment matrix is a key step for AHP (Cheng and Li, 2010). The process of building is actually a pairwise comparison of elements on the same hierarchy with respect to their priority in sequence. First, compare elements on the criteria hierarchy to one another two at a time and build relative importance judgment matrix; second, compare index factors under each criteria hierarchy to one another two at a time and build relative importance judgment matrix. In order to compare the elements to one another two at a time to get a judgment matrix, Satty's 1-9 scale method (Saaty, 1994) is going to be used for grading. As a result, primary and secondary judgment matrixes are built, as shown in Table 1-6.

Table 1: Digital campus evaluation indices primary index judgment matrix G

G	A1	A2	A3	A4	A5
A1*	1	2	5	1/3	3
A2*	1/2	1	3	1/3	2
A3*	1/5	1/3	1	1/5	1/2
A4*	3	3	5	1	3
A5*	1/3	1/2	2	1/3	1

*A1-A5 are respectively first-grade index infrastructure, database construction, administration, application and operation guarantee

Table 2: Judgment matrix for factors of second-grade index infrastructure (A1)

A1	A11	A12	A13
A11*	1	2	1/2
A12*	1/2	1	1/3
A13*	2	3	1

*A11-A13 are second-grade indices under first-grade index infrastructures

Table 3: Judgment matrix for factors of second-grade index Database construction (A2)

A2	A21	A22	A23	A24
A21*	1	2	3	4
A22*	1/2	1	3	2
A23*	1/3	1/3	1	1/2
A24*	1/4	1/2	2	1

*A21-A24 are second-grade indices under first-grade index Database construction

Table 4: Judgment matrix for factors of second-grade index Administration (A3)

A3	A31	A32	A33	A34
A31*	1	1/2	1/3	2
A32*	2	1	1/2	4
A33*	3	2	1	5
A34*	1/2	1/4	1/5	1

*A31-A34 are second-grade indices under first-grade index Administration

Table 5: Judgment matrix for factors of second-grade index Application (A4)

A4	A41	A42	A43	A44
A41*	1	4	3	2
A42*	1/4	1	1/2	1/3
A43*	1/3	2	1	1/2
A44*	1/2	3	2	1

*A41-A44 are second-grade indices under first-grade index application

Table 6: Judgment matrix for factors of second-grade index operation guarantee (A5)

A5	A51	A52	A53	A54	A55
A51*	1	1/2	1/3	2	3
A52*	2	1	1/2	3	4
A53*	3	2	1	3	4
A54*	1/2	1/3	1/3	1	2
A55*	1/3	1/4	1/4	1/2	1

*A51-A55 are second-grade indices under first-grade index Operation guarantee

Table 7: Random consistency index RI

n*	1	2	3	4	5
RI	0.00	0.00	0.58	0.90	1.12
n*	6.00	7.00	8.00	9.00	
RI	1.24	1.32	1.41	1.45	

*n: Order of matrix

Table 8: Synthetic weight for digital campus evaluation indices

Index hierarchy	A1 0.25	A2 0.16	A3 0.06	A4 0.43	A5 0.10	Synthetic weight
A11	0.2970					0.075140
A12	0.1634					0.041351
A13	0.5396					0.136539
A21		0.4687				0.074833
A22		0.2787				0.044496
A23		0.1028				0.016414
A24		0.1497				0.023907
A31			0.1547			0.009066
A32			0.2879			0.016874
A33			0.4765			0.027924
A34			0.0810			0.004744
A41				0.4668		0.198799
A42				0.0953		0.040580
A43				0.1603		0.068247
A44				0.2776		0.118207
A51					0.1655	0.017028
A52					0.2720	0.027990
A53					0.3893	0.040053
A54					0.1067	0.010973
A55					0.0664	0.006835

Step 3: Solve judgment matrix by using MATLAB software. In this study, MATLAB program is used to accurately complete these calculations in a short period of time. Consistency index CI, random consistency index RI and consistency ratio CR are introduced.

The calculation formula is as follows:

Consistency index:

$$CI = \frac{\lambda_{max} - n}{n - 1} \quad (1)$$

where, n refers to order of matrix.

Consistency ratio:

$$CR = \frac{CI}{RI} \quad (2)$$

The judgment matrix is fully consistent when CR = 0; satisfactory when CR<0.1; the consistency is extremely satisfactory when CR>=0.1. The values of RI are given in Table 7 (Zhang *et al*., 2011).

Take judgment matrix G as an example, use MATLAB program to calculate the value as follows:

In the judgment matrix G, W = $(0.25, 0.16, 0.06, 0.43, 0.10)^T$, CI = 0.04, CR = 0.04<0.1, all of which meet consistency requirement. The weight of the five factors on the criteria hierarchy is W = $(0.25, 0.16, 0.06, 0.43, 0.10)^T$. The result corresponding to the matrix on the criteria hierarchy can be calculated as follows:

- **A1-matrix:** W = $(0.2970, 0.1634, 0.5396)^T$, CI = 0.0046, CR = 0.0051<0.1
- **A2-matrix:** W = $(0.4687, 0.2787, 0.1028, 0.1497)^T$, CI = 0.032093, CR = 0.035659<0.1
- **A3-matrix:** W = $(0.1547, 0.2879, 0.4765, 0.0810)^T$, CI = 0.007034, CR = 0.007816<0.1
- **A4-matrix:** W = $(0.4668, 0.0953, 0.1603, 0.2776)^T$, CI = 0.01033, CR = 0.01147<0.1
- **A5-matrix:** W = $(0.1655, 0.2720, 0.3893, 0.1067, 0.0664)^T$, CI = 0.028608, CR = 0.025543<0.1

Step 4: Calculation of synthetic weight.With the above calculations, it can obtain the weight of criteria hierarchy to target hierarchy and weight of index hierarchy to criteria hierarchy. The equation for weight of various index hierarchies to target hierarchy is:

$$Wi = A(i) \times w(Aij) \quad (3)$$

where, A(i) stands for weight of various factors on the criteria hierarchy to target hierarchy; w(Aij) stands for weight of various factors on the index hierarchy to criteria hierarchy (Chen and Chen, 2012). The specific weight for each index is shown in Table 8.

RESULTS

It can be obtained from Table 8 that the decreasing order of the weight of each influential factor is A4 (0.43)>A1 (0.25)>A2 (0.16)>A5 (0.10)>A3 (0.06). During the construction of Digital Campus, application and infrastructure construction are priorities.

The comprehensive evaluation value of digital campus construction can be calculated by the following equation: The equation for primary index evaluation is:

$$G = \sum A_i W_i$$

in which A_i stands for evaluation grade of various indices on the criteria hierarchy and W_i stands for absolute weight of various indices.

The equation for secondary index evaluation is:

$$A_i = \sum A_{ij} W(A_{ij})$$

where, A_{ij} stands for grade for indices corresponding to criteria hierarchy to A_i .The full grade is 100. $W(A_{ij})$ stands for weight of the index correspond to A_{ij} (Wang and Tan, 2007).

CONCLUSION

This study uses Analytic Hierarchy Process (AHP) to build a practical multi-hierarchy evaluation model and MATLAB software to solve matrix with better efficiency. It helps to evaluate digital campus construction result of a certain university more quickly, accurately and scientifically.

REFERENCES

Cai, H. and K. Yang, 2005. Determiuing the evaluation criterion weight of digital Campus based on AHP. J. Changsha Aeronautcal Vocational Tech. Coll. J., 6: 58-63.

Chen, W. and S. Chen, 2012. Research on quality evaluation of academic thesis based on AHP. J. Zhejiang Univ. Technol., 4: 222-225.

Cheng, H. and T. Li, 2010. Research on AHP model application in on-line course evaluation system. J. Hainan Normal Uni. Nat. Sci., 9: 351-354.

Hu, B., 2010. Fuzzy Theory. Wuhan University Press, Wuhan, China.

Jiao, Z., 2007. Benefit analysis and evaluation of digital campus in colleges and universities. J. E-Educ. Res., 12: 47-52.

Saaty, T.L., 1994. How to make a decision: The analytic hierarchy process. Interfaces, 24: 19-43.

Tan, J. and Z. Wang, 2011. Strategy of digital campus construction in polytechnic college. J. Software Guide, 8: 3-5.

Tang, M., 2010. The research on Hunan University Digital Campus construction planning design and realization. Master Thesis, Hunan University, Hunan, China.

Tao, L., Q. Wang and J. Ding, 2009. Evaluation model of on-line learning based on fuzzy mathematics. J. Shanxi Electr. Technol., 6: 48-50.

Wang, W. and G. Tan, 2007. Digital campus fuzzy synthetic evaluation based on AHP. J. Shenzhen Inst. Inform. Technol., 2: 73-77.

Wang, Y. and J. Mu, 2012. Explore and Analyse the evaluation contents and index of digital campus in higher vocational college-based on the users' perspective. J. Mod. Educ. Technol., 9: 57-60.

Yan, J., L. Yao and Z. Jiang, 2004. Campus network-based solution for teaching quality assessment system. J. Guangzhou Maritime Coll., 23: 36-38.

Zhang, T., Y. Xu, Z. Li and Z. Lin, 2011. A method of digital imagingand image processing for detection data based on fuzzy mathematics. J. Projectiles Rockets Missiles Guidance, 2: 27-29.

Zhou, H.X., K.G. Yu and M. Zhong, 2006. Study on E-campus estimating indices system. J. Zhejiang Water Conserv. Hydropower Coll., 1: 41-44.

Zhu, Y., Y. Cao and G. Yin, 2004. Digitized campus construction theory and practice. J. Exploring Educ. Dev., 9: 101-105.