Research on Influencing Factors of Teaching Quality of BIM Bidding Course of Engineering Cost Specialty based on AHP

Hui Lu

School of civil engineering, Xi'an Traffic Engineering Institute, Xi'an, Shaanxi, China
e-mail: luhuijn@163.com

Abstract
With the development of BIM technology, the integration of BIM technology into curriculum teaching becomes more and more important. In order to effectively evaluate the teaching quality of BIM courses and clarify the influencing factors of curriculum teaching quality and the weight of each factor, this paper analyzes and studies the influencing factors of teaching quality of BIM bidding course of Engineering Cost specialty based on analytic hierarchy process, establishes a hierarchical structure model, constructs judgment matrix and determines the weight of each factor, an example is given to verify it. The analysis shows that among the factors at the criterion level, students account for the largest weight, followed by teachers. The mastery of students' professional basic knowledge and teachers' mastery of BIM bidding software at the scheme level are the key factors.

Keywords: *Teaching quality; Analytic hierarchy process; influence factor*

1 INTRODUCTION

Building information model (BIM) can help realize the integration of building information. BIM three-dimensional model database can integrate the whole process information of building design, construction, operation and later maintenance. Personnel from all parties involved in the project can work together based on BIM, which improves work efficiency and promotes sustainable development. With the development of BIM Technology, BIM Technology teaching has attracted more and more attention.

Engineering cost specialty is a kind of interdisciplinary discipline involving engineering technology, economy, management, law and other knowledge categories. Internationally, it has formed a talent training system of engineering cost higher education integrated with the practice qualification system [1]. It is a discipline in the category of management science and engineering specialty, which aims to cultivate innovative talents who understand technology and management. Mastering BIM technology is not only the need for industry development, but also the need for employment and self-development for engineering cost graduates. In the process of training engineering cost talents, it is necessary to integrate BIM Technology with engineering project management, engineering cost management, engineering bidding, engineering measurement and pricing and other courses. "Classroom teaching" is still the lifeline of college education and the main way to achieve the objectives of college education and teaching. Therefore, the evaluation of teachers' classroom teaching quality is the core content of the college teaching quality assurance system [2]. Taking the engineering bidding course as an example, this paper analyzes the factors affecting the teaching quality of BIM bidding course.

The teaching process of BIM bidding is restricted by many factors, and the quality is questioned. Only by effectively identifying various factors affecting teaching, finding out the key factors and scientifically and objectively evaluating the teaching quality of the course, can we help teachers improve teaching methods and promote the teaching quality of BIM bidding.

2 HIERARCHY MODEL

2.1 *Analytic hierarchy process*

American operations research scientist Saaty T. L. proposed an effective method to deal with such problems, called the Analytic Hierarchy Process (AHP), which is a combination of qualitative and quantitative, highly logical, systematic, simple, flexible and practically effective methods to solve multi-level and multi-objective planning and decision-making problems [3].

2.2 *Analytic hierarchy process steps*

This paper will use AHP to classify and sort out the factors affecting BIM bidding teaching, form an interrelated and orderly level, then calculate and analyze the relative importance and rank, and find out the key

B. Fox et al. (Eds.): IC-ICAIE 2022, AHCS 9, pp. 1492-1497, 2023.
https://doi.org/10.2991/978-94-6463-040-4_223

factors affecting teaching quality. The AHP method is divided into four steps:

2.2.1 Establishment of hierarchical structure model

Analyze the objectives, identify the influencing factors, divide the indicators and all factors into different levels such as target level, criterion level and scheme level, and use the hierarchical model diagram to represent the subordinate relationship between the indicators and various factors.

2.2.2 Construction of judgment matrix

The judgment matrix is the premise and basis of weight ranking, which affects the final total ranking and weight score of decision-making [4]. Each element on the same level as compared with each other to construct a judgment matrix to judge the relative importance of element I and element J and expressed with corresponding scales. The relative importance scale is shown in Table 1.

Table 1 Scale of relative importance of two elements

B_{ij}	1	3	5
Comparison between Bi and B_j	Before and after factors are equally important	The former is slightly more important than the former	The former is obviously important compared with the former
7	9	2 , 4 , 6 , 8	1/n,n=1,2,...,9
The former is more important than the latter	The former is extremely important compared with the former	The former and latter factors are more important in the middle of the two	If the importance ratio of factor Bi to factor $B_j$is B_{ij}, the importance ratio of factor Bi to factor B_j is B_{ij} = 1/ B_{ji}

2.2.3 Hierarchical single ranking and consistency test

Solve the eigenvalue of judgment matrix A, normalize its corresponding eigenvector and record it as w. the elements of W are the ranking weights of the importance of the elements of the same level relative to the elements of the previous level. Let the maximum eigenvalue of judgment matrix a be λ_{Max}, according to the matrix theory, the necessary and sufficient condition for the consistency of an n-order reciprocal matrix A is its maximum eigenvalue $\lambda max=n$ [5]. To ensure that the maximum eigenvalue can truly represent the relative importance of each factor, the average random consistency index RI is used for the consistency test.

2.2.4 Hierarchical total sorting

After completing the single ranking and consistency inspection of this level, the total ranking of the level is carried out by calculating the weight of the relative importance of all factors of a level to the highest level.

3 ANALYSIS OF INFLUENCING FACTORS OF TEACHING QUALITY OF BIM BIDDING COURSE OF ENGINEERING COST SPECIALTY BASED ON AHP

3.1 *Establishment of hierarchical structure model*

According to the actual teaching situation of the BIM bidding course of engineering cost specialty, through interviewing 9 relevant experts, including 3 enterprise experts and 6 University experts, the index system is constructed as follows:

The target layer is the teaching quality of the BIM bidding course, represented by A;

The four indicators B_i (i = 1,2,3,4) of the criterion layer are teachers, students, schools and enterprises respectively;

The scheme level is the mastery of J1-BIM bidding software: teachers have a good grasp of bidding software, and can flexibly use the corresponding knowledge to explain in class. On the contrary, it will lead to classroom teaching jams, slow progress and other phenomena.

J2-BIM bidding course design: teachers need to prepare lessons before teaching. The instructional design can make clear the course teaching ideas, contents, teaching points, teaching methods and time;

J3-Classroom Management: in the classroom teaching organization, only appropriate management measures can ensure the course teaching order and enable students to complete the learning of course knowledge in a good atmosphere;

J4-Teaching attitude: Teachers' attitudes towards classroom teaching, students and psychology in class will affect the quality of curriculum teaching;

S1-Learning interest: only when students have enough interest in the course can promote students' active learning and actively master the knowledge elements and logical structure of the course;

S2-Mastery of theoretical knowledge: the mastery of basic knowledge of construction technology, housing architecture, engineering economics, engineering project management, engineering contract management and other courses will have an impact on the study of bidding;

S3-Hands-on operation ability: the learning of the BIM bidding course needs to operate the corresponding software and prepare the corresponding bidding materials. It has strong hands-on operation ability and can ensure the learning of practical operation part;

S4-Cooperation ability: the bidding course needs to simulate the bidding process and prepare bidding documents. The learning of these contents requires group teaching and requires students to have good teamwork ability;

X1-BIM Technology Publicity: the school's news reports and academic lectures on BIM Technology will imperceptibly promote students' understanding of BIM Technology and improve their interest in learning BIM Technology;

X2-Experimental Teaching fund support: the strong investment in an experimental teaching fund can ensure the construction of experimental environment and the purchase of experimental equipment;

X3-BIM bidding software configuration: the new version of the BIM bidding software can ensure the better completion of the practical teaching of BIM bidding course;

Students will be required to devote more time to BIM technical courses if they have higher requirements for BIM technical ability;

Q2-BIM bidding competition: enterprises hold BIM bidding competition. Students can increase their weight for employment and promote students' learning of BIM bidding.

The hierarchical model is established according to the relationship between indicators, as shown in Figure 1.

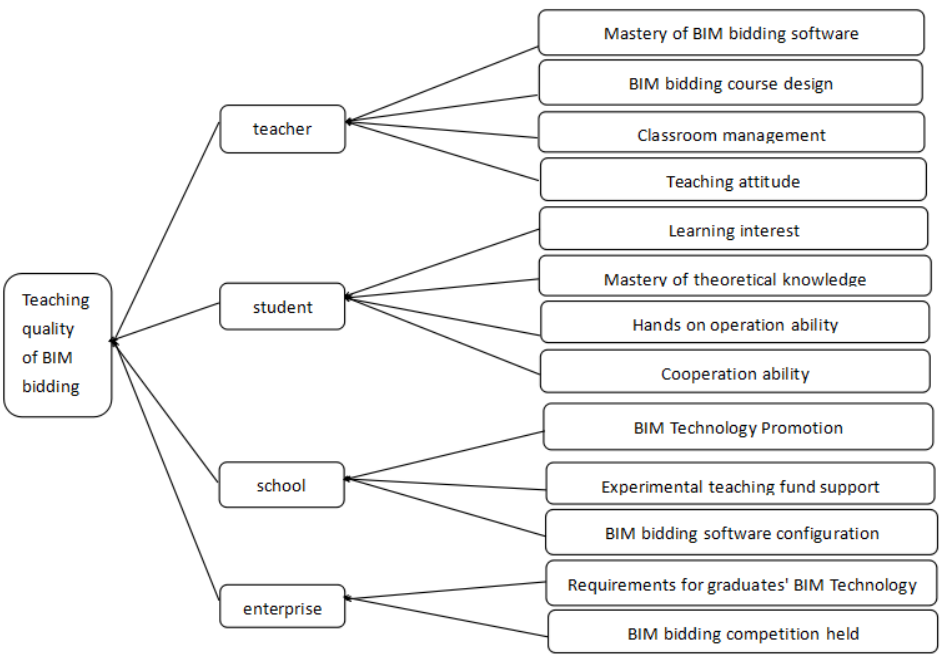

Figure 1 Hierarchical model of influencing factors on teaching quality of BIM bidding course of Engineering Cost Specialty

3.2 *Construction of judgment matrix*

AHP is used to empower teachers, students, schools and enterprises. Since the four indicators of teachers, students, schools and enterprises have an impact on A, the results of the pairwise comparison are represented by matrix $B = b_{ij}$. The factors at all levels are compared with each other by expert consultation method, and the judgment matrices A, B1, B2, B3 and B4 are constructed through mutual comparison, in which: $A = (a_{ij})4\times4, B1 = (bi_j)4\times4,$ $B3 = (b_{ij})3\times3$、$B4 = (b_{ij})2\times2$, calculate the corresponding eigenvector ω，$\omega1$，$\omega2$，$\omega3$，$\omega4$. The judgment matrix is as follows:

$$A=\begin{bmatrix} 1 & 1/2 & 5 & 7 \\ 2 & 1 & 7 & 8 \\ 1/5 & 1/7 & 1 & 4 \\ 1/7 & 1/8 & 1/4 & 1 \end{bmatrix}$$

$$Bl=\begin{bmatrix} 1 & 3 & 7 & 5 \\ 1/3 & 1 & 5 & 3 \\ 1/7 & 1/5 & 1 & 2 \\ 1/5 & 1/3 & 1/2 & 1 \end{bmatrix}$$

$$B2=\begin{bmatrix} 1 & 1/6 & 3 & 3 \\ 6 & 1 & 5 & 7 \\ 1/3 & 1/5 & 1 & 1/2 \\ 1/3 & 1/7 & 2 & 1 \end{bmatrix}$$

$$B3=\begin{bmatrix} 1 & 1/5 & 1/7 \\ 5 & 1 & 1/3 \\ 7 & 3 & 1 \end{bmatrix}$$

$$B4=\begin{bmatrix} 1 & 6 \\ 1/6 & 1 \end{bmatrix}$$

3.3 *Hierarchical single ranking and consistency test*

The weight vector of the judgment matrix and the corresponding maximum eigenvalue are calculated by the sum-product method λ_{max}。The consistency test is carried out according to the average random consistency index RI, $CI=\frac{\lambda_{max}-n}{n-1}$, Consistency ratio $CR=\frac{CI}{RI}$.

The average random consistency index RI is shown in Table 2:

Table 2 Average random consistency index RI

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

Through calculation, the weight, maximum eigenvalue and consistency ratio of the hierarchical single ranking of the judgment matrix are shown in Table 3.

Table 3 Judgment matrix weight, eigenvalue and consistency ratio of hierarchical single ranking

	weight	Maximum eigenvalue λ_{max}	Hierarchical single sort consistency ratioCR
A	1.0000	4.1993	0.0746
B1	0.3302	4.2195	0.0822
B2	0.5287	4.2608	0.0977
B3	0.0981	3.0649	0.0624
B4	0.0431	2.0000	0.0000

According to the above table, the single sorting consistency ratios of matrices A, B1, B2, B3 and B4 are 0.0746, 0.0822, 0.0977, 0.0624 and 0.0000 respectively, which are less than 0.1, meeting the consistency requirements.

3.4 *Hierarchical total sorting*

Complete the single level ranking and consistency test, and further calculate the weight of the relative importance of all factors at the same level to the highest target level. The ranking weight of the elements of the scheme layer to the overall goal is shown in Table 4, and the ranking weight of the elements of the criterion layer to the decision-making goal is shown in Table 5.

Table 4 Ranking weight of each element of the scheme layer to the overall goal

Scheme level elements	weight	sort
Mastery of BIM bidding software	0.186411	2
BIM bidding course design	0.088826	4
Classroom management	0.029548	9
Teaching attitude	0.025366	11

learning interest	0.097824	3
Mastery of professional basic knowledge	0.343633	1
Hands on operation ability	0.038543	7
Cooperation ability	0.048695	6
BIM Technology Promotion	0.007055	12
Experimental teaching fund support	0.027362	10
BIM bidding software configuration	0.063672	5
Requirements for graduates' BIM Technology	0.036912	8
BIM bidding competition held	0.006152	13

According to the analysis results, the ranking weight of each element of the scheme layer to the overall goal is as follows: mastery of professional basic knowledge, mastery of BIM bidding software, learning interest, BIM bidding curriculum design, BIM bidding software configuration, cooperation ability, hands-on operation ability, requirements for graduate BIM Technology, classroom management, experimental teaching fund support, teaching attitude, BIM Technology Publicity and BIM bidding competition.

Table 5 ranking weight of criteria level elements to decision objectives

Criteria layer elements	weight	sort
teacher	0.330151	2
student	0.528695	1
school	0.098089	3
enterprise	0.043064	4

It can be seen from table 5 that teachers and students have a great impact on decision-making objectives.

3.5 *Teaching quality evaluation of BIM bidding course*

In the teaching process of the BIM bidding course, score each element, calculate the final score according to the weight, summarize the total score and evaluate the teaching quality of the course.

To verify the effectiveness of the analysis model of influencing factors of online teaching quality based on AHP, the quality scoring data of five classes of BIM bidding course in a university in Xi'an are analyzed. The school indicators of the five classes are consistent with the enterprise indicators, and the calculation results are shown in Table 6.

Table 6 Analysis of teaching quality of BIM bidding course in a university

	Class 1	Class 2	Class 3	Class 4	Class 5
J1	90	92	95	93	95
J2	85	86	90	87	88
J3	83	87	79	80	83
J4	80	89	91	93	87
S1	86	85	70	78	90
S2	87	85	83	80	89
S3	89	93	90	80	85
S4	80	85	87	75	83
X1	85	85	85	85	85
X2	85	85	85	85	85
X3	85	85	85	85	85
Q1	80	80	80	80	80
Q2	75	75	75	75	75
score	86.20	86.62	85.17	83.39	88.64

4 CONCLUSION

According to the analytic hierarchy process, this paper analyzes and studies the factors affecting the teaching quality of BIM bidding course, and obtains the weight of each factor relative to the target layer. According to the analysis results, the mastery degree of j1-bim bidding software, j2-bim bidding course design, J3-classroom management, J4-teaching attitude, S1-learning interest, S2-theoretical knowledge, S3-hands-on operation ability, S4-cooperation ability, X1-bim technology publicity X2-Experimental Teaching fund support, X3-bim bidding software, Q1-Requirements for graduates' BIM Technology, Q2-bim bidding competition, among the 13 factors, the most important is the mastery of professional basic knowledge, accounting for 34.36%, followed by the mastery of BIM bidding software, accounting for 18.64%. Among the four elements of teachers, students, schools and enterprises in the standard level, students account for the largest weight, 52.87%, followed by teachers 33.02%, schools and enterprises 9.81% and 4.31% respectively.

REFERENCES

[1] Dehai Xing, Xuyuan Dong.Application of AHP method in network-based teaching quality evaluation system [J].Computer engineering and application,2006(21): 207-209 + 219.

[2] Zhan Gao, Zhihai Suo. Design and implementation of classroom teaching quality evaluation system in Colleges and universities[J]. Modern electronic technology, 2015,38 (22): 41-43 + 47.

[3] Yongli Xing, Guannan Sun, Guangdong Huang. Research and application of analytic hierarchy process in undergraduate teaching evaluation[J]. Journal of higher education, 2021,7 (14): 50-53 + 58.

[4] Cancan Liu, Xiukui Yue, Zhiping Wu, Mingyu Xu. Application of analytic hierarchy process in asset evaluation -- A Case Study on the evaluation of technical intangible assets[J]. China asset appraisal, 2019 (02): 49-55.

[5] Jian Yan, Rong Chen, KeYue Zhang, Qunyi Huang, Yuanfu Li. Curriculum system of "double first-class" Engineering Cost Specialty in Colleges and universities with transportation characteristics [J]. Construction economy, 2021,42 (04): 102-107.