Architectural Design of Building Information Model Technology in Internet Age

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Abstract. As a revolutionary technology to realize the construction industry information, BIM technology has been vigorously developed in China in recent years. The whole life cycle of a construction project includes planning stage, design stage, construction stage, operation and maintenance stage, with many participating units. This paper mainly studies the architectural design of building information model technology under the Internet era. This paper analyzes and combs the traditional structural design process, and summarizes the problems and defects existing in the traditional structural design process. Combined with the characteristics of BIM technology application, the BIM technology is combined with the traditional structural design process. Taking Project A as an example, the causality analysis, the analytic hierarchy process and the fuzzy comprehensive evaluation method are used. The architectural design quality of Project A based on BIM technology is evaluated, and the effect of adopting BIM technology in the design of Project A is compared and analyzed.

Keywords: Internet Era, Building Information Model, Architectural Design, Design Quality Evaluation Model

1. Introduction
The 21st century is an era of interweaving and integration of information and technology. With the vigorous development of national society and economy, human society has stepped into a new historical period. At the same time, great changes have taken place in people's pursuit of spiritual life and material living standards. In the pursuit of low pollution, low energy consumption, green under the strategic policy of sustainable development, people are not limited to the requirement of building housing in its function and space, due to the diversity of people's life and work and repeatability, the functional requirement of the building also will become complex and diverse, so that more should be people-oriented, people and buildings, and man and nature in harmony and form whole [1]. For the construction of our country is in the high speed development stage, on the one hand, the resulting environmental pollution and resource waste problems emerge in endlessly, the grim reality of how to implement intensive of resource utilization, environment friendly type mode of sustainable development of sexual health, how to improve the production efficiency of the construction industry, meet the requirements of green building, on the other hand, the development of society makes
architecture diversified in its function, form, technology and environment, which increases the difficulty in the design process. Designers will also have to overcome many design challenges and difficulties, and all kinds of contradictions are the focus of general attention in the construction engineering field [2]. In recent years, the market of the domestic construction industry has entered a new historical period under the in-depth study and extensive promotion and application of the emerging technology tool BIM technology. It provides a new direction for the development of the construction industry in the whole life cycle of the building. All information in the life cycle of the building is recorded in a digital way to realize the transmission and sharing of data and information in the whole life cycle of the project [3-4].

At present, the theoretical research of BIM technology has already taken the lead in the UK, the United States, Japan and South Korea and other countries, which is mainly reflected in the improvement of BIM technology in internal system standards, mature technology application, policy support and continuous innovation and supplement of talent echelon. At the beginning of the 21st century, the federal government of the United States launched the 3D and 4D construction management plan method based on BIM theory and technology, and subsequently drafted the implementation and application guidelines and standards of BIM technology among related professions in the field of construction in succession [5]. At present, in Japan, the application of BIM technology in engineering projects has been continuously expanded nationwide, and under the guidance and incentive of the government, it has reached a steady development level [6]. In addition to the above countries, in some extremely cold or hot regions of Northern Europe, due to the long-term impact of natural climate, traditional outdoor operations cannot be carried out normally, so prefabrication based on component factories is particularly important, which also greatly promotes the application development of BIM technology in this region [7].

In this paper, the basic connotation of BIM technology as the basis for analysis, combined with the birth background, characteristics and functions of BIM technology, actively explore the actual application of BIM technology, and finally carry out the prospect of the application of BIM technology in the engineering design stage.

2. Construction Design Based on BIM

2.1. Engineering Design Phase BIM Application Related Technology

(1) Collaborative working mode

To carry out collaborative design with the help of BIM technology, in general, will make the information and data always maintain a good correlation, and the consistency is also widely recognized by people, which can enhance the effectiveness of data sharing and realize the full use of information. Therefore, in this case, the requirements of the mode in terms of BIM model management are very strict, usually much higher than the traditional requirements. If the actual work is performed only with the help of manual management, the specified tasks cannot be successfully completed [8]. At this time, it has become a general trend for relevant design units to complete the designated work with the help of collaborative platform, and it is also the key condition of BIM technology development. With the help of the BIM collaborative platform, scientific data management can be carried out in relevant BIM projects, and the integrity of data storage can be enhanced by the collaboration between BIM designs, so as to further realize timely and accurate transmission. In essence, from the perspective of synergistic effect of BIM, the platform can also create more comfortable working links for architectural engineering design, construction and suppliers, so as to promote the uniformity and accuracy of building information and improve design quality [9].

(2) Analysis of working standards

In order to implement the collaborative model to some extent, the relevant staff must develop a specific work template. Then on this basis, all parties of the building will effectively choose the modeling software according to the design requirements at that time, and carry out the work in combination with the design method and the relevant design process. Specifically, we should
scientifically choose the mainstream software of this major, treat it as the core software, and carry out real-time adjustment and supplement with the needs of the project. In the actual application of the software, the staff must also be on the software data exchange standards for further analysis, especially to pay attention to software file format compatibility, so that it meets the requirements of the regulations. With the help of BIM design units can accumulate relatively rich components, and then form resources that can be reused under the premise of processing. At the same time, qualified architectural design units will also promote the rational development of component resource pool, ensure that component resources can be fully developed, so that the design cost can be greatly reduced, and the value of BIM technology can be enhanced [10].

(3) Model classification standards
In the process of implementing the hierarchical division of BIM model, relevant staff should first process from the integrated model architecture, and define the resource data, professional model objects and family model objects. The resource data in the hierarchical classification should conform to the characteristics of information description and can reflect the correlation of model objects. As the necessary model objects that must be used in different stages of construction project implementation cycle, family model objects are composed of professional model resource information and generic information, which can fully express the related attributes and actual correlation between different models. For professional model objects, when the actual integration work is carried out, attention should be paid to the change of the model system, and a comprehensive model in line with the development of life cycle should be built. Starting from the content of resource data, it should include relevant data described by geometric information, cost information and material information. In terms of the contents contained in family model objects, they usually contain contents such as relational elements, shared components and attribute elements [11-12].

2.2. Design Quality Evaluation Model Based on BIM
There are many kinds of evaluation methods of project design quality, which are not enumerated here. And for the purpose of this study, there is no need to use multiple evaluation methods for comparative evaluation. In view of the definite factors and fuzzy factors in the quality evaluation index system of the project, it is necessary to adopt the practical analysis method. Due to the opinions of the internal audit expert group and other parties of the project in the process of evaluation, it is necessary to use the method of fuzzy comprehensive evaluation to determine the indicators of each factor in the process of analysis and balance of these factors, so as to evaluate the design quality of the project as a whole, objectively and accurately.

(1) Analytic Hierarchy Process
Analytic Hierarchy Process (AHP) establishes a quantitative assessment model through the interrelation and analysis of each factor and index in the whole evaluation system. The specific implementation steps of AHP include the following three steps:

According to the basic theory of analytic hierarchy process, the two indexes in the evaluation system are compared and judged.

According to the value of the evaluation index, calculate the weight $W_i$ of the standardized index according to the following formula:

$$W_i = \frac{\prod_{j=1}^{5} a_{ij}}{\sum_{i=1}^{5} (\prod_{j=1}^{5} a_{ij})^{1/5}}$$

(2)

Consistency test is carried out for indicators, and the formula for consistency test is as follows:

$$\lambda_{max} \approx \frac{1}{n} \sum_{i=1}^{n} (Aw)^i \frac{(Aw)^i}{W_i}$$

(2)

(2) Steps of fuzzy comprehensive evaluation
Establishment of evaluation index set: major index set $U$={early scheme design stage, preliminary design stage, construction drawing design stage, later coordination stage}={U1,U2,U3,U4}
Individual index set of early planning $U_1=\{\text{output quality of the scheme, the situation that the scheme meets the target of Party A, the rationality of the scheme, and the evaluation of the scheme effect}\} = \{U_{11}, U_{12}, U_{13}, U_{14}\}$

Similarly, the single index set of the last three design stages can be similarly obtained by this method.

Establish the weight set:

Weight set of major indexes:

$$A = \frac{a_1}{u_1} + \frac{a_2}{u_2} + \frac{a_3}{u_3} + \frac{a_4}{u_4} = (W_1, W_2, W_3, W_4) \quad (3)$$

Pre-planned single item weight set:

$$A_1 = \frac{a_{11}}{u_{11}} + \frac{a_{22}}{u_{22}} + \frac{a_{33}}{u_{33}} + \frac{a_{44}}{u_{44}} = (W_{11}, W_{22}, W_{33}, W_{44}) \quad (4)$$

Build a review book

Comment set is a collection of various evaluation results used to judge an object.

In this paper, the project design quality evaluation is divided into four levels, namely excellent, good, qualified and unqualified.

The fuzzy evaluation matrix $R$ was used to establish the evaluation matrix of design quality.

In order to solve the fuzziness of evaluation indicators in the model, in the first-level fuzzy comprehensive evaluation, we will comprehensively consider each evaluation level of each indicator, and give the single-factor evaluation data according to the results.

Second level fuzzy comprehensive evaluation. Here, the evaluation matrix should be comprehensively evaluated according to all the influence indexes, and then the two-level fuzzy comprehensive evaluation matrix can be obtained.

Determine the rating level. This is the last step of fuzzy comprehensive evaluation. In this step, the concrete work is to carry on the comprehensive evaluation to the final quality of the design results. According to the specific evaluation index data results, the design quality of the evaluated project is evaluated at four levels: excellent, good, qualified and unqualified. Here, you can also process the evaluation results if you want to divide the design quality of the evaluated items into percentages. That is, according to the quality of excellent, good, qualified and unqualified respectively corresponding to 90, 80, 70, 60 scores.

3. Application of Evaluation Model of Architectural Design Quality

Based on BIM technology, this paper applies the fuzzy comprehensive evaluation method for the design quality management of the project. After analyzing the influencing factors of the project design quality and the expert group evaluation, the quality evaluation result $S$ of the whole project is finally obtained. In this section, this model is used to compare the number of project design problems and errors before and after the application of BIM technology. In view of the important and difficult points in the application of BIM technology, the advantages of BIM technology in the application of the project are finally summarized, and effective suggestions are provided for the specific application, so as to maximize the value of the application of BIM technology in the project quality management.

In order to analyze the specific application of BIM technology in this project, this paper selects the construction drawing design stage in which collaborative design is most widely applied to make a comparative analysis of the design quality effect before and after the application of BIM technology in Project A.

100 samples were selected from the construction drawings before and after the application of BIM technology for inspection and statistics. For the positions corresponding to the four types of secondary indicators of the 100 samples, whether they are qualified and the corresponding secondary inspection indicators were checked.
4. Application of Evaluation Model of Architectural Design Quality

4.1. A Project Use BIM Pre-Project Design Quality Issues

Table 1. A statistical table of design quality problems before using BIM technology in the project

| Check the indicator                  | Occurrences | Frequency  |
|-------------------------------------|-------------|------------|
| 1 Drawing quality                   | 11          | 39.29%     |
| 2 Coordinate error                  | 6           | 21.43%     |
| 3 Civil engineering error itself    | 5           | 17.86%     |
| 4 Mechanical and electrical error   | 6           | 21.43%     |

As shown in Table 1 and Figure 1, before the application of BIM technology, the problems in the model mainly focus on indicators 1 and 2. After analysis, the reason is that quality problems existing in some drawings cannot be directly expressed and reflected by traditional two-dimensional software, which leads to many design quality problems. For example, the construction drawing design is difficult to avoid the incongruity between civil engineering and mechanical and electrical design, including the incongruity of the plane, vertical and section in the drawing, and the problems of various details cannot be found in time.
As shown in Figure 2, the above table is the statistical table of design quality problems after the use of BIM technology in Project A. It can be concluded from the table that the qualified rate has increased significantly after the use of BIM technology. 1 or 2 problems that appeared most before the application of BIM technology were significantly reduced after the use of BIM technology; at the same time, in the civil engineering and mechanical and electrical specialty, the error frequency of its own has been greatly reduced. These results fully demonstrate that the use of BIM technology can significantly improve the design quality, and avoid the mistakes caused by various coordination problems in the design stage being left over to the construction stage, resulting in irreversible results.

5. Conclusions
In recent years, with the rapid growth of the national economic level, the upgrading of high-tech new technology is accelerating, the construction industry based on the traditional operation mode is facing a very severe challenge, and it needs to continue to explore the reform and transformation of engineering technology. The birth of digital construction technology runs through the whole life process of engineering project from planning and design, construction management to operation and maintenance, which helps to change the traditional way, promote the traditional work efficiency and improve the traditional work quality. Based on the trend and prospect of the transformation and upgrading of the construction industry, the relevant departments attach great importance to the development and application of BIM technology and continue to increase the promotion and application efforts. The development and application of BIM technology will surely promote the transformation of construction engineering technology and bring huge benefits to the development of the construction industry in China. Some drawbacks in this article from the traditional structure design process, in order to realize the whole process structure professional BIM is designed as the goal, explores the construction design phase of the BIM process problems and BIM application process in the BIM application point under the condition of existing concrete realization method, and analyzes the various BIM application points in the design phase of application value.

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