Ways to Improve the Efficiency of Construction Engineering Management Based on BIM Technology

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Abstract: At present, the country has higher and higher requirements for the transformation and upgrading of the construction industry. The traditional extensive construction methods can no longer meet the requirements of the transformation and upgrading of enterprises. Industrialization and greening have become the new direction of the development of the construction industry in the future. The purpose of this paper is to study the ways to improve the efficiency of construction engineering management based on BIM technology. This article uses three data exchange methods to test and evaluate the corresponding plug-ins. Data conversion tests were performed on structural analysis models established by more than 60 different software. According to the results of quantitative analysis and comparison, specific suggestions on how to select reasonable data exchange methods in specific situations such as the use of different later models were given. This paper uses BIM technology to achieve 4D construction simulation verification, assists in project schedule management, improves management efficiency, uses BIM technology to assist in optimizing the design of the project construction organization plan, and formulates the optimal construction organization plan. Improve the quality management of engineering design data and realize BIM-based three-dimensional proofreading. And through the analysis of the above-mentioned problems of the M project, and put forward feasible management optimization suggestions, and finally achieve the purpose of helping the construction enterprise to improve the management efficiency and level. At the same time, it can also provide assistance and reference for other similar companies in the same industry. Research has shown that it is not conducive to use this method when the possibility of interface component omission and information deviation in the secondary development of API is 50%, 40%, and 30% respectively, and it performs well in importing structural information parameters. This method is preferred.

Key words: BIM Technology, Implementation Group Design, Schedule Management, Management Improvement
1. Introduction

With the rapid development of the industry, the competition in the construction engineering industry has become increasingly fierce [1-2]. Under such a market situation, engineering companies need to strengthen cost control and achieve internal refinement and information management in order to improve and maintain their own core competitiveness [3-4]. BIM technology, as a hot emerging technology in the current engineering industry informatization construction, has become the best choice for many engineering companies [5-6]. Through BIM technology, visualized management and monitoring of engineering projects are realized, helping construction projects to achieve cost reduction and efficiency enhancement and safe production [7-8].

In the research on ways to improve the efficiency of construction engineering management based on BIM technology, many scholars have studied it. For example, in order to reduce the risk of project management decision-making in construction enterprises, Zhang L can improve the new projects of construction enterprises through the use of knowledge resources of old projects. Various decision-making provide reference basis, improve the efficiency and accuracy of decision-making, and avoid the occurrence of blind decision-making [9]. Kang T W expands the role of BIM in construction companies, not only allows project management itself to use BIM, but also allows senior management to use BIM to make management decisions, thereby actively promoting the application of BIM technology in the entire enterprise [10].

This article proposes the establishment of BIM modeling system requirements and standards to guide the modeling work of M project. It can also guide a certain bureau to use BIM model results to carry out innovative requirements such as "errors, omissions, and deficiencies" on engineering design results, improve engineering design review efficiency and design data quality, reduce project rework, and control construction costs.

2. Ways to Improve Construction Management Efficiency Based on BIM Technology

2.1 BIM Modeling Efficiency Evaluation and Prompt Information Recognition Theory

(1) Basic concepts of DEA theory

1) Decision-making unit

A production process can be regarded as an activity in which a unit inputs a certain number of production factors and produces a certain number of products within a certain possible range. Although the content of the activities is different, the purpose is to obtain the maximum benefit.

2) Production function and returns to scale

Define the set \( L(y) = \{x \mid (x, y) \in T\} \) as the possible input set for \( y \), and \( P(x) = \{y \mid (x, y) \in T\} \) as the possible output set for \( x \). Suppose \((x, y) \in T\), if \((x, y') \in T\) does not exist, and \( y \leq y' \), then \((x, y)\) is called effective production activity. For the production possible set \( T \), the hypersurface \( y = f(x) \) in the \( R^{m+s} \) space formed by all effective production activities \((x, y)\) is called the production function. It can be seen from this that the function represents the relationship between any set of input and maximum output under certain conditions.

Let \((x, y) \in T\), let

\[
 a(\beta) = \max\{a | \beta x, ay \in T, \beta \neq 1\} \quad (1)
\]

\[
 \rho = \lim_{\beta \to 1} \frac{a(\beta)^{-1}}{\beta^{-1}} \quad (2)
\]

If \( \rho > 1 \), the DMU corresponding to \((x, y)\) is called an increasing return to scale, otherwise it is decreasing. When \( \rho = 1 \), the return remains unchanged.
(2) Basic principles of Logistic regression analysis

In the analysis of the prompt information field based on the BIM model system in this article, the value of the input variable whose value is within the real number range needs to be transformed into the target probability value, and then regression analysis is performed. Therefore, using the above-mentioned Logistic nonlinear regression theory, first perform the following two-step processing on the objective function, as shown in formulas (3) and (4).

\[ \Omega = \frac{p}{1-p} \]  

\[ \ln(\Omega) = \ln \left( \frac{p}{1-p} \right) \]  

Among them, \( \ln(\Omega) \) is called Logit\( P \). The above two steps are called logit transformation. After transformation, the relationship between Logit \( P \) and \( \Omega \) is still increasing or decreasing, and the value is between \(-\infty\)~\(+\infty\), which is consistent with the value of the output variable of the general linear regression equation.

2.2 Engineering Problem Diagnosis and Management Improvement

The introduction of BIM is to optimize and adjust the current management methods, and use the software system developed based on BIM technology to land and solidify the optimized results, so as to achieve project transparency and refined management based on 3D BIM models. A huge improvement in management methods unimaginable by any engineering company.

(1) Research on improvement of project schedule management

Using BIM technology to assist M project schedule management is to make full use of the comprehensive and highly relevant characteristics of BIM model information, combined with traditional project management theories and ideas, and finally achieve the goal of BIM assisting M projects to achieve the best project management.

By relying on the BIM platform, the M project schedule (WBS) data, contract data, engineering quantity data, cost data, labor, engineering data, design models, engineering breakdown structure (PBS) and other data associations are established, Form a unified engineering data center. Through this BIM data center of the M project, all project related parties and participants can access the data support required in the management, so as to realize centralized, structured, and visual project management in the entire life cycle of the M project.

(2) Research on the establishment of M project schedule management system

Most of the current M project schedule management work is done manually, and the related software (project, office) schedule control function is relatively simple, but the project department schedule manager is responsible for manually collecting, updating data and publishing information. Project participants complete project work independently, the system cannot provide support and functional assistance, and information transmission is lagging, which affects the sharing of project information among various units.

In the new project schedule management framework system combined with BIM technology, the requirements of project management theory for project work breakdown structure, requirements for project schedule control, etc., are combined with the BIM3D model. Therefore, on the basis of the original plan schedule management, based on the BIM model of the project, it integrates the construction site management, resource management, schedule management, and cost management to realize the 4D simulation preview and simulation verification of the construction schedule, so that the project schedule
arrangement is more reasonable. At the same time, in the actual execution process, real-time progress data collection can be used to track the execution of the project, and it can be fed back to the system for multiple simulations, so as to adjust the plan in a timely and flexible manner.

3. Experimental Research on Ways to Improve Construction Management Efficiency Based on BIM Technology

3.1 Experimental Method
Based on the data exchange test of more than 40 models, this article summarizes the various data exchange problems that appear in the process and defines them as influencing factors when selecting data conversion methods, so as to evaluate the data conversion methods. The specific indicators are: Structural analysis software does not support IFC format, successfully imported structural information parameters, no suitable version interface, large-scale component omission, component information deviation, successful import of non-structural component information, software crashes, low conversion efficiency, etc. The conversion efficiency is the ratio of the number of components to the conversion time; the structural information parameters include component section information, material information, load information, boundary conditions, etc., and non-structural components include railings, handrails, ceilings, curtain walls and other auxiliary components.

3.2 Indirect Data Exchange Using Plug-Ins
The indirect data exchange method using intermediary software involves the secondary conversion of the model, so compared to the direct use of plug-ins for indirect data exchange, the method of using intermediary software is more complicated. At present, there are quite a few plug-ins on the market, and these plug-ins have similar functions but differ in some cases. In this paper, the use of plug-in indirect data exchange is tested and researched, and the domestic representative PDST plug-in version is selected for testing.

4. Experimental Research and Analysis of Ways to Improve Construction Management Efficiency Based on BIM Technology

4.1 Data Exchange Efficiency Analysis
As there is no evaluation standard to follow for each index in the factor set, this paper selects ABAQUS, Midas, YJK, PKPM, SAP and other software to perform data conversion results, and determines the evaluation set according to the probability of each influencing factor. The experimental results are shown in Table 1.

| Evaluation index               | Unlikely | Likely | Possibility |
|-------------------------------|----------|--------|-------------|
| No suitable version interface | 0.5      | 0.2    | 0.1         |
| Component information deviation | 0.3      | 0.1    | 0           |
| Software crashes              | 0.6      | 0.4    | 0.3         |
| Low conversion efficiency     | 0.8      | 0.5    | 0.1         |

As shown in Table 1, the data conversion method based on the IFC standard format has little
possibility of component loss, information deviation, and low conversion efficiency. In 89% of the cases, no similar situation has occurred. Therefore, the method is in the conversion accuracy and There is a big advantage in conversion efficiency. There are fewer cases of not supporting the IFC format. This means that more than 66% of the commonly used structural design software supports the IFC format. This proportion will increase in recent years. Therefore, the results are consistent with the previous results. This method has a wide range of applications. But at present, the structural component information cannot be imported, so it is not suitable for structural design.

4.2 Single Factor Evaluation Efficiency Analysis Under the Data Exchange Method

The comment set of the evaluation index is V: V= {the possibility of conversion success is small, the possibility of conversion success is average, and the possibility of conversion success is high}. Through the statistics of the actual conditions of each factor in each data conversion situation, and the quantification of each factor, the single factor evaluation set under each data exchange method can be obtained as shown in Table 2.

### Table 2. Single factor evaluation set based on API secondary development interface

| Evaluation index                | Unlikely | Likely | Possibility |
|---------------------------------|----------|--------|-------------|
| No suitable version interface   | 0.6      | 0.3    | 0.2         |
| Component information deviation | 0.3      | 0.1    | 0           |
| Software crashes                | 0.4      | 0.5    | 0.7         |
| Low conversion efficiency       | 0.6      | 0.1    | 0.3         |

![Figure 1. Single factor evaluation set based on API secondary development interface](image)

As shown in Figure 1, the main problem of the API-based secondary development interface is whether there is a suitable version interface, component omission and information deviation. The possibility of 50%, 40%, and 30% respectively is not conducive to using this method. And it performs well in importing structural information parameters, and structural information can be imported. Therefore, this method can be preferred for structural design with interfaces.
4.3 Analysis of Risks and Influencing Factors

After understanding the risks and influencing factors of each method, choosing a suitable data exchange method and effectively completing the BIM application is the ultimate goal. This paper analyzes the data exchange of single-use plug-ins, and the experimental results are shown in Table 3.

| Evaluation index               | Unlikely | Likely | Possibility |
|-------------------------------|----------|--------|-------------|
| Component information deviation | 0.5      | 0.2    | 0.3         |
| Import component information  | 0.6      | 0.6    | 0.8         |
| Software crashes              | 0.4      | 0.2    | 0.3         |
| Low conversion efficiency     | 0.5      | 0.1    | 0.6         |

As shown in Table 3, due to the instability of the plug-in, software crashes and conversion efficiency problems are more prominent. This problem occurs in 58% of cases. Therefore, it is recommended to further improve the stability of the plug-in. Its versatility is strong. It has suitable plug-in interfaces for 78% of the software. The structural information is imported with good integrity, and it is suitable for structural design without special interfaces.

5. Conclusions

This article is based on the advantages and disadvantages of different data exchange methods, combined with the characteristics of different structural forms and structural design software, considering the different stages of structural design and the use of the corresponding BIM model. This article proposes different structural forms and different design software in structural design. The accurate and efficient data exchange method applied in the stage provides a reference for the promotion and application of BIM technology in structural design work.

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