Research on the Optimized Management and Control of Intelligent City Construction Project Management Based on BIM Technology

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Abstract: The proportion of science and technology in production is becoming more and more obvious. The powerful function of BIM technology can realize the simulation of building construction. From the implementation effect, compared with enterprises and institutions widely adopting new technologies, the government, as an important participant in the supervision and operation of smart city construction, still lacks the demonstration effect of using new technologies to supervise the whole process from the early stage of project construction and rely on collected data and information to enhance public service after project completion. From the point of view of project construction, this paper is based on the need of construction project information system construction. This paper makes a detailed and comprehensive study on the design, type selection, construction technology improvement and management method improvement of this large-scale construction project. With BIM technology as the basis for project management, BIM technology has a theoretical and practical basis for project schedule control. In the future, theoretical researchers and engineers should expand their application in the field of project management and achieve a qualitative leap in project management.

1. Introduction

With the integration and development of economic globalization and marketization, the proportion of science and technology in production is becoming more and more obvious [1]. As a trend of urbanization, the essence of smart city is to apply information technology to urban infrastructure, politics, economy, culture, social life and other fields, thus making the city more "smart" [2]. With the support of BIM technology, real-time information sharing can be realized, which effectively reduces the shortcomings in the traditional construction management process [3]. Thus, the cooperation between various departments and different specialties in the construction process has been realized [4]. For construction enterprises, whether it is the fierce market competition, the demand of self-management or the requirement of social responsibility, it is urgent to apply BIM technology [5]. It is necessary to make full use of information technology such as BIM and simulation to make the expected results of the design plan visible, the application scenario virtualization, the construction management operation and maintenance process simulation, and accuracy [6]. There is also a need to fully integrate the intelligent construction of infrastructure and the intelligent construction of intelligent systems [7]. Therefore, China's construction industry needs to accelerate the exploration of the application of applied information technology in the field of construction, rationally optimize the allocation of industrial resources, and improve the production efficiency of the construction industry as soon as possible [8].

The powerful features of BIM technology enable simulation of building construction. Various new technologies have also been further researched and applied, such as BIM, Internet of Things, VR virtual reality technology, etc. [9]. However, from the perspective of implementation effects,

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compared with the widespread adoption of new technologies by enterprises and institutions, the government, as an important participant in the supervision and operation of smart city construction, still lacks the use of new technologies to conduct full-process supervision from the initial stage of project construction and after completion of the project. Relying on the collected data and information to enhance the demonstration effect of public services [10]. These buildings have the characteristics of huge scale, high investment and high construction technology content [11]. The fragmentation of industry structure, the antagonistic relationship between participants, and the poor level of information management all result in the inefficiency of the construction industry to a certain extent [12]. The direct consequence is that in the construction of construction projects, such phenomena as unreasonable rework of scheme design, inefficient construction management, delayed construction period, and inadequate construction technology to meet the design requirements often occur [13]. There are some problems in the process of information sharing and transmission, which bring trouble to communication management and organization and coordination [14]. Construction management is of great significance, not only to ensure the smooth progress of the project, but also to improve the satisfaction of owners, and also to improve the construction efficiency [15].

The project schedule management based on BIM technology incorporates the owner, design unit, supplier, supervision unit and project management unit into the schedule management system. From the beginning of project design, relevant information including progress management information has been collected, collated and analyzed [16]. Some local governments have realized the lack of this key link and initiated related pilots and research. Since 2013, the use of open BIM technology to extract and generate construction progress has been studied [17]. Then, BIM asynchronous online collaboration based on hybrid client servers and P2P networks was published in the Journal of Construction Automation [18]. In 2015, a case study of residential renovation time/cost analysis based on a pre-built BIM database structure was proposed [19]. In 2017, some scholars studied the big data of large BIM based on cloud system framework to view, store and analyze [20]. BIM technology has changed the way information is transmitted during the life cycle of a construction project, effectively improving the efficiency of design and management [21]. All building model information can be applied to construction management and post-operational maintenance, improving the information sharing level of building information data and the efficiency of information use.

2. Materials and Methods

The information integration of BIM technology mainly reflects the integration of design process and integration of design information. The information model is the essential carrier of building information integration, that is, the information of each professional aspect is input into a model, and the traditional CAD software is only a simple information representation of building components. Quality problems often occur during the construction process, such as common defects and omissions. If these quality problems cannot be effectively taken to prevent them, it may be difficult to meet the standards of engineering design, and eventually there will be problems such as rework. Not only does it cause economic losses, but it also affects the progress of the process, etc. [22]. In the process of the previous design, the design of the drawings is generally presented in the form of 2D, so its subjectivity is relatively large [23]. By using BIM technology, data can be input into the model, thus establishing a virtual model. For large-scale projects invested by the government, Congress is responsible for formulating national development policies and investment plans, while the federal government and its subordinate general offices are responsible for investment plans, the preparation and allocation of annual budgets, and the supervision and implementation of federal laws. At the state level, the state legislature is responsible for budget allocation and state legislation. State professional departments are responsible for planning, construction, operation and maintenance, and manage federal and state funds. Figure 1 is the BIM construction optimization model.

In the aspect of structural calculation, the calculation and analysis of the overall structure is carried out, and the elastic time history analysis under multiple earthquakes is performed according to the

artificial seismic wave parameters. Table 1 shows the relevant parameters such as the maximum acceleration value and duration of the seismic wave.

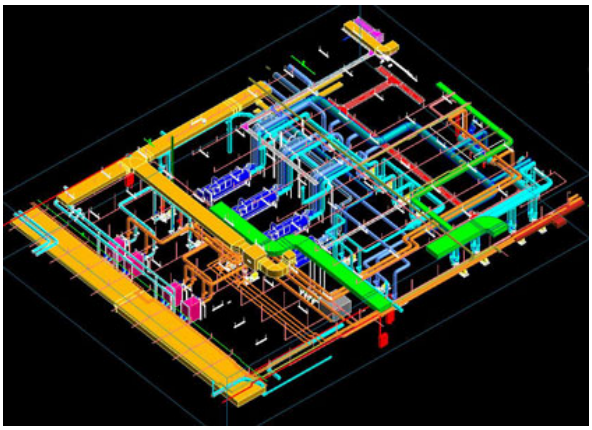

Figure 1 BIM architectural engineering optimization model

Table 1 Relevant parameters such as maximum acceleration value and duration of seismic waves

Adaptation	Maximum acceleration (cm/s^2)	Duration(s)	Number of waves	Time Step(s)	Effective duration(s)
Artificial seismic wave	80	35	1700	0.03	27.48
Natural seismic wave	75	50	1850	0.03	38.96

The training and learning process of the BIM model is the process of gradually decreasing the error value between the output value and the expected value of the network until the error meets the requirements. Definition error:

$$P_{t+\Delta t} = p_t\left(1+\Delta tu_t(y)\right) + p_t\left(1+\Delta tu_t(y')\right) \tag{1}$$

Apply it to the optimization of housing layout. As follows:

$$s_{t+\Delta t}(y) = \frac{p_{t+\Delta t}}{P_{t+\Delta t}} = \frac{p_t + \Delta tp_t(y)}{p_t\left(1+\Delta tu_t(y)\right) + p_t\left(1+\Delta tu_t(y')\right)} \tag{2}$$

Through the process analysis of the standard BIM algorithm, we use the phenomenon of switching between the continuous exclusion operation and the attraction operation in the natural food foraging process to improve the standard BIM algorithm and propose an improved BIM model. The particle speed is updated as follows during the run:

$$s_{t+\Delta t}(y) = \frac{p_{t+\Delta t}}{P_{t+\Delta t}} = \frac{s_t(y)\left(1+\Delta tu_t(y)\right)}{s_t(y)\left(1+\Delta tu_t(y)\right) + s_t(y')\left(1+\Delta tu_t(y')\right)} \tag{3}$$

Under the framework of a smart city, we should pay attention to the integration of governance system construction, intelligent system construction, and information resource system construction, especially focusing on the construction of information resource system throughout the data life cycle, and mining data utilization value. In collaborative design, designers from all disciplines can participate in the integration of the design process. The building information database based on computer is the core content of BIM technology. The building information model contains various geometric information such as the spatial relationship of the building structure and the size of some components. With the support of BIM technology, problems can be discovered as early as possible, thus avoiding quality problems. For example, in the design stage, construction drawings can be continuously deepened and optimized, so as to achieve the goal of engineering design. Analytic Hierarchy Process (AHP) is used to judge the impact of each sub-project on the cost importance of the two-storey underground project. As shown in Table 2 and Figure 2, the budgetary amounts of

materials for the project are presented.

Table 2 Project material budget

Project name	Budget (10,000 yuan)
Civil engineering	926.5
Plumbing project	147.6
Decoration engineering	98.5
Electrical installation engineering	123.4

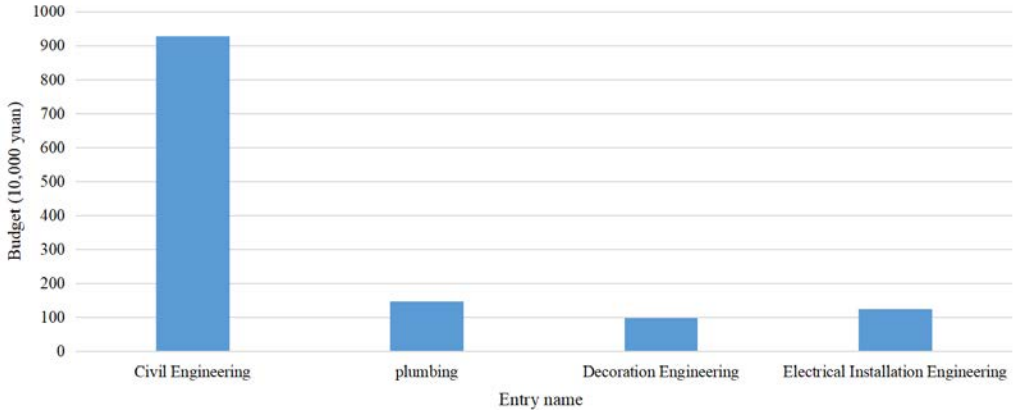

Figure 2 Project budget amount of each project

Planning and planning stage, survey and design stage, construction and supervision stage, operation and maintenance stage, and transformation and demolition stage. Building information models can be built, shared and applied at all stages of the project's life cycle and can be coordinated. From 2004 to 2017, the average annual growth rate of China's real estate investment is much higher than the growth rate of GDP. With the increase in sales volume, the annual sales of real estate also rose sharply, as shown in Figure 3 is the growth trend of national real estate investment. During this period, the trend of China's real estate development scale is shown in Figure 4.

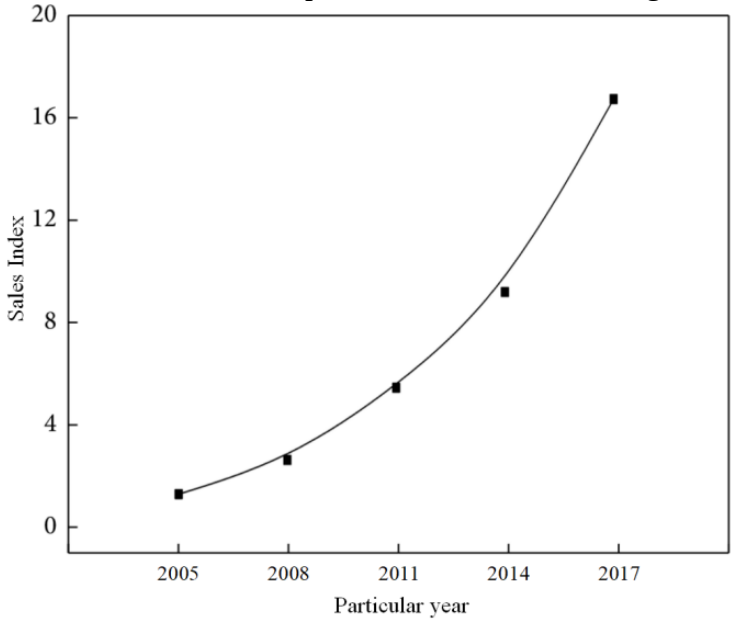

Figure 3 National real estate investment growth trend

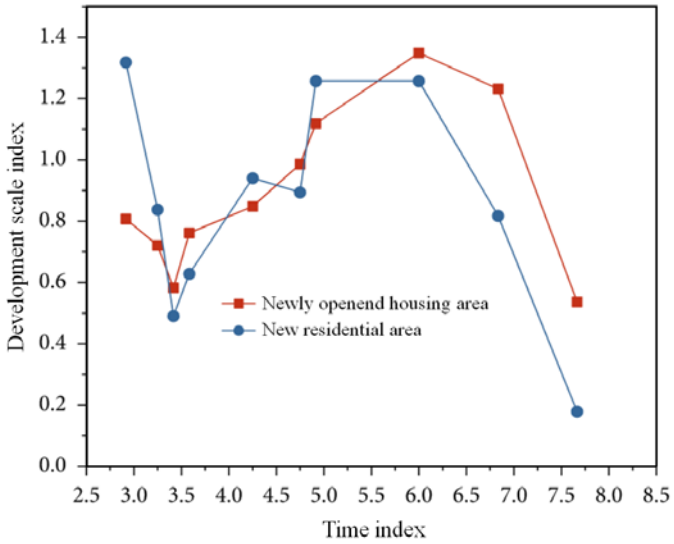

Figure 4 Trends in the scale of real estate development

The trend of the scale of real estate development in China is due to the fact that the government has more departments involved in the examination and approval at this stage, and the supervision mode is single, which puts high demands on the construction unit. Especially in the engineering project approval and design approval stage, involving a large number of relevant government departments, involving a large number of approval points, the engineering construction approval work volume is very large. Component attribute information is mainly divided into creation, positioning, geometric expression and association, etc. It can not only describe its own attribute information but also describe the relationship with the outside world. It can be passed and shared in different professional models and at different stages. In the traditional design scheme, it is difficult to predict and judge the safety factors in the construction process in advance, which brings about the safety problems in the design. Using the corresponding BIM software, the design of building, structure, equipment and other links can be carried out directly. In the design, the three-dimensional design model can be established, and the data of the three-dimensional design model can be shared among the links. BIM technology design process integration and design information integration have been based on data information, abandoning the traditional CAD drawing mode, especially in the design aspect has obvious substantive effect. It can realize the integration of data and information, thus eliminating the relevant design schemes which are not conducive to safety in advance, thus achieving the optimization of construction safety.

In order to determine the circumstances under which exclusion and attraction operations are performed, we introduce a diversity control method:

$$s_{t+\Delta t}(y) - s_t(y) = s_t(y)\frac{\Delta tu_t(y) - \Delta t\overline{u}_t^{\,p}}{1+\Delta tu_t} \tag{4}$$

The termination condition of iteration is usually chosen as the maximum iteration number or the optimal position searched by PSO so far to satisfy the predetermined minimum adaptive threshold. Change the position and velocity of each particle according to the following formula:

$$S = 2L + W = \frac{c}{2f\sqrt{\varepsilon_{eu}}} \tag{5}$$

The choice of parameters in the BIM system is critical to whether the algorithm converges. According to the initial conditions of BIM, for the convenience of analysis, only in discrete time. Can be derived:

$$ES_i = \sum_j (1 - \sum_q p_{iq} m_{jq}), q \neq i, j \tag{6}$$

3. Result Analysis and Discussion

Virtually build the entire project or building using BIM software and 3D design model data completed during the design phase. After the design party completes the model establishment according to the requirements of Party A, it can be transferred to the structural designer to enter the structural design data on the original model, and then transferred to the equipment design engineer to enter the data information of the equipment design, etc., to avoid repeated data entry. For the safety problems that occur in the field, not only can it be prevented in advance, but also can be effectively controlled, thus ensuring the safety of building construction personnel and buildings. The basic attribute information is a description of the geometric attributes, physical attributes, and functional attributes of the component primitives. It is a feature of the primitive model itself, and does not change with time and changes in the external environment. All mandatory requirements that affect public safety and public interests are subject to the approval model of professional departments. When it comes to normative requirements, we can inform them beforehand, implement them by the five main bodies responsible for the construction process and submit digital documents for the record, while government supervision can improve the efficiency of examination and approval by means of intelligent comparison and spot check. The results of bottom shear calculation under different calculation parameters are shown in Table 3.

Table 3 Bottom shear of structures with different calculation parameters

Direction	Standard seismic parameter calculation	Calculation of Safety Assessment Report Parameters
X	35107kN	35742kN
Y	29186kN	32179kN

Visualization is "what you see and what you get". For the construction industry, visualization was first applied in architectural design and achieved great benefits. The special software of BIM technology can automatically check whether the design conforms to the specifications or import the data of the three-dimensional design model into various analysis software. The BIM model based on IFC standard can integrate all kinds of extension information related to the model and form a complete and unified BIM model, which greatly improves the application scope and value of BIM. The competent departments of local construction industry at all levels shall establish and improve the enterprise information integrity archives and practice insurance system in the construction industry, and formulate an effective corporate credit evaluation system.

The measurement relationship is also widely used in the planning results for the area statistics of the planned land, the calculation of the floor area ratio of different land types, the height and density of the buildings, and the minimum distance between buildings at different heights. The relationship between road width and building area is shown in Figure 5.

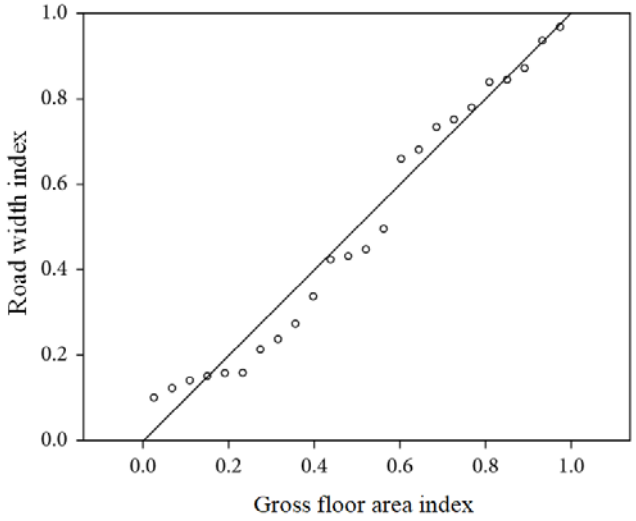

Figure 5 Relationship between road width and building area

The extended attribute information is to describe the technical attributes, economic attributes and management attributes of the component model. This kind of information is the information associated with the component model attached to the construction engineering management process, and it has the characteristics of independence [25]. In the building information model, extraction and conversion are performed based on specific information formats to realize data docking and sharing of different professional software. Dimensionless processing of comparison series and reference series. In this paper, the mean method is used:

$$AE_i = ES_i / S_i = \sum_j (1 - \sum_q p_{iq} m_{jq}) / \sum_j \tag{7}$$

Difference sequence:

$$CI_i = \frac{\sum_j (\frac{C_{ij}}{C/N}) \ln(\frac{C_{ij}}{C/N})}{N \ln(N)} \tag{8}$$

Find the maximum difference and the minimum difference between the two poles:

$$P_i = \frac{f_i}{\sum_{i=1}^{N} f_i} \tag{9}$$

In the model, the topological relationship between the two objects is characterized by whether the inner, outer and outer subsets of the objects intersect, expressed as:

$$Y_j(t) = \phi\left(\sum_{i=1}^{n} w_{ji} x_i - \theta_j \right) \tag{10}$$

The BIM model based on real work tasks can be built by collision detection and other forms, aiming at the design problems and quality problems that may arise in advance. Fully forecast the urban residential, industrial, warehousing and other land use, and rationally arrange the phased supply of urban land. The optimization performance parameters of residential layout before and after optimization are shown in Table 4. The simulation comparison of topology reliability optimization is shown in Figure 6.

Table 4 Performance parameters of residential layout optimization topology before and after optimization

	Before optimization	After optimization
Row number	26	35
Column number	18	22
Monitoring points	468	770

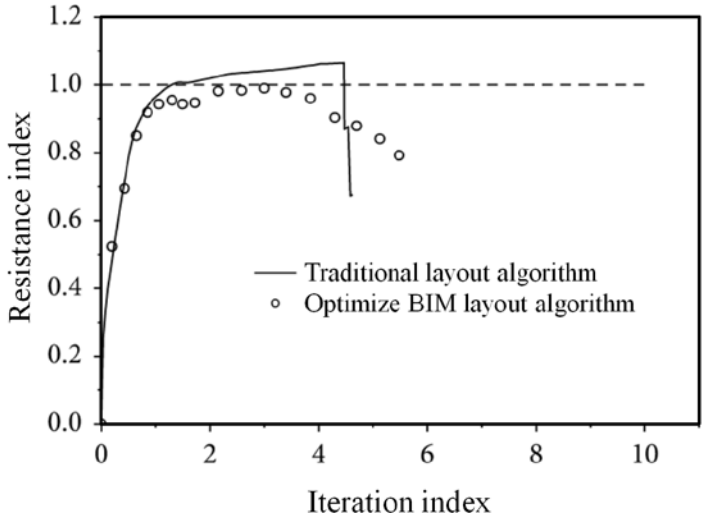

Figure 6 Comparison of residential layout optimization topology reliability optimization simulation

A building information model database built on specific standards and rules can export various forms of data and information. According to the specific conditions of the construction project, it can be decomposed into three parts: civil engineering, structural engineering and electromechanical engineering. In the process of applying BIM technology, the building model can be first created, and the structural and electromechanical models can be further improved. Achieve the effect of information sharing. A unified S-dimensional model is established, and each engineering staff and unit can directly use or edit the model to generate a view model that is compatible with its management objectives. Discover problems, communicate problems, feedback, and solve problems with view models. Then feedback to the original model to optimize or modify the model. Conduct differentiated management through data comparison and analysis. Plane, elevation and section drawings can be extracted directly from BIM model, and data output types of various forms or documents, such as reserved opening drawings of building structures, comprehensive mechanical and electrical pipeline drawings, collision detection reports, material and equipment tables, bill of quantities, and so on, can also be derived. Collision detection will be carried out by importing model information data from all specialties into professional collaborative design and construction simulation software to reduce design changes in the construction process.

4. Conclusions

With the continuous introduction and improvement of the relevant policies for the promotion and application of national BIM, the application of BIM in the construction industry will be more and more extensive. Through building models, collision detection, virtual simulation and other means to complete the construction project life cycle project management in order to ensure the quality of the project. It saves manpower, material resources and time, and improves work efficiency. From the point of view of project construction, this paper is based on the need of construction project information system construction. This paper makes a detailed and comprehensive study on the design, type selection, construction technology improvement and management method improvement of this large-scale construction project. With the rapid development of information technology and the change of life by science and technology, information and technology have spread all over every corner of our daily life, which has a tremendous impact on the whole society. The application of BIM technology has improved the production efficiency and management level in the design and construction phases of construction projects, with the continuous development of the construction industry and the increasing complexity of construction projects. With the advancement of construction project management concepts and the maturity of BIM technology, BIM technology has a theoretical and practical basis for project schedule control. In the future, theoretical researchers and engineers should expand their application in the field of project management and achieve a

qualitative leap in project management.

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