

# Application of BIM in Architectural Design, Project Construction, and Project Management

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**Abstract:** The construction quality and efficiency of construction engineering are directly related to people's daily life. Therefore, construction enterprises must keep pace with the times and actively introduce advanced technical means into architectural design, project construction, and management, so as to ensure the quality and safety of construction to the maximum extent. The application of BIM not only improves the efficiency of construction and construction quality, but also realizes the control of construction cost. This study explores and analyzes the advantages of BIM as well as proposes application strategies of BIM in architectural design, project construction, and management, hoping to contribute to the smooth construction of construction engineering.

**Keywords:** BIM; Architectural design; Project construction; Project management

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## 1. Introduction

Building Information Modeling (BIM) is a new technical means that has the advantages of visibility, optimization, coordination, simulation, and relevance. Hence, this technical means can be widely used and promoted in the field of construction<sup>[1]</sup>. In construction engineering, construction enterprises must realize the application of BIM in architectural design, project construction, and management as well as strengthen the study of BIM, so as to give full play to the application of BIM and its advantages to effectively control the construction cost while ensuring the construction quality and the completion of construction engineering<sup>[2]</sup>.

## 2. BIM

BIM is used to present the various components of building engineering through the application of digital building components, so as to reflect the entire construction cycle of construction engineering. The application of BIM in the construction is to intuitively present data and information about the building through the use of computer software to compare and analyze it, so as to timely identify the differences between the data and information<sup>[3]</sup>. The application of BIM in architectural design can ensure the rationality of architectural design through simulation and analysis, as well as prevent the poor progress of subsequent construction in view of unreasonable architectural design.

## 3. Advantages of BIM

### 3.1. Visual advantage

In construction engineering, it is difficult to describe the construction content and construction technology

clearly and comprehensively only with plane drawings and texts. With the application of BIM, the structure and size of the construction project can be shown from a three-dimensional level. It not only presents three-dimensional architectural drawings, but also construction contents through the establishment of three-dimensional models, which helps construction personnel to accurately and comprehensively interpret the drawings, so that the data information related to construction engineering can be accurately grasp. The establishment of three-dimensional models can enhance the visual experience of construction personnel as well as assist them in identifying the existing problems in the construction process and solve them in a timely manner <sup>[4]</sup>.

### **3.2. Optimization and coordination advantages**

The application of BIM has shown much benefits in problem handling, especially for complex construction projects. Through the application of BIM, complex construction contents can be sorted out and analyzed; in addition, the loopholes in project management can be identified in a timely manner <sup>[5]</sup>. It is also possible to realize smooth communication between departments, prevent information asymmetry between departments, as well as ensure that all departments and staff are able to grasp correct information and cooperate well, so as to improve the effectiveness and efficiency of each construction communication link, form departments, significantly enhance the coordination ability of the staff, and eventually improve the construction quality of construction engineering. Therefore, the application of BIM in the construction field has the advantages of optimization and coordination <sup>[6]</sup>.

### **3.3. Simulation advantage**

Construction has the characteristic of continuity. If there are mistakes in the early stage of construction, it is bound to affect the smooth progress of subsequent construction. In order to prevent engineering changes in subsequent construction, it is important to conduct simulation experiment to fully prepare for engineering construction. Before construction, all kinds of factors affecting the quality and safety of construction are concealed. BIM uses existing construction engineering information to analyze and predict subsequent construction. It also simulates specific construction situations, so as to identify problems, effectively improve and optimize the construction plan, as well as contribute to the reasonability of the emergency construction plan <sup>[7]</sup>.

### **3.4. Affiliate advantage**

The application of BIM in construction engineering projects aids in presenting all the information about construction engineering through various parameters established by engineering models. The data information carries the characteristic of integration; hence, the logical relationship of the data information is more ideal. For different parts of the construction project, the parameters of the corresponding model also vary, but there is a certain correlation among these parameters <sup>[8]</sup>. Therefore, when information changes, it is necessary to modify the corresponding parameters in the construction engineering model, so that the other parameters will be automatically adjusted, and the construction engineering model will also change accordingly. With that, the information change is more efficient.

## **4. Application of BIM in architectural design**

### **4.1. Using animation to display architectural renderings**

Through research, one of the obvious characteristics of BIM is diversity. The application of BIM in architectural design not only establishes corresponding models according to the architectural design, but also renders and analyzes the construction design scheme. It can be expressed through the establishment of three-dimensional models; hence, BIM is widely used in architectural design. Compared with three-

dimensional models, two-dimensional models are generally more abstract. When browsing the two-dimensional mode, only professional technicians can clearly understand the content, and in the establishment of three-dimensional building models, even non-professional technical personnel can easily grasp the content. This is also an advantage in the application of BIM in architectural design. In addition, BIM is relatively simple to operate, and with only a few simple steps, the architectural design effect map can be shown through animation <sup>[9]</sup>.

## **4.2. Collaborative architectural design using BIM**

Architectural design involves a lot of content, and these contents are complex, usually requiring mutual cooperation and communication between various departments. With the rapid social and economic development, people's living standards have improved significantly, and at the same time, the requirements for construction projects are constantly expanding. Construction engineering not only requires the function of living, but also some other functions <sup>[10]</sup>. When using BIM for collaborative architectural design, the organic integration of BIM with other disciplines is crucial to reduce the construction cost. In the past, CAD is commonly used in architectural design. Although it meets the basic requirements of architectural design, problems gradually arise with the development of the construction industry, especially with the advent of information age. In the field of construction, BIM is widely used, with good development prospective. The application of BIM in architectural design can realize the collaborative design between multiple parties.

## **4.3. Visual architectural design scheme**

The application of BIM in architectural design can visualize the architectural design scheme through the establishment of virtual models <sup>[11]</sup>. In the past, the architectural design scheme is static and flat, but through the application of BIM, the architectural design scheme is more dynamic and intuitive using simulated systematic architectural design models. The main purpose of architectural design scheme is to meet the needs of customers. The application of BIM in architectural design aids in presenting the design of various details in an ideal manner, especially in terms of lights and colors. This greatly strengthens customers' subjective feelings toward the architectural design, thus contributing to user satisfaction <sup>[12]</sup>.

## **5. Application of BIM in construction projects**

### **5.1. Application of BIM in cost control**

Through the application of BIM, the cost of a construction project can be determined through preliminary calculations. It relieves the accounting pressure of the staff and formulates budgets more accurately. The construction settlement is usually sorted out according to the different stages of the construction. The application of BIM assists construction personnel in calculating the number of raw materials and equipment, so as to ensure the proper use of raw materials and construction equipment purchase or lease. This not only ensures that the construction materials and equipment can be used at the construction site to promote progress, but also prevents the waste of raw materials and equipment <sup>[2]</sup>. In addition, the implementation of relevant policies and local climate conditions may affect the construction project <sup>[13]</sup>. For example, during winter, it is chilly and snowy in northern China, thus posing a challenge to construction projects. The application of BIM aids in updating settlement reports based on the construction results of the project.

### **5.2. Application of BIM in the inspection of collisions**

With the continuous development of the society and the accelerating pace of urban construction, the area available for construction in the city is decreasing. In the future, the buildings in the city will mostly be super high-rise and high-rise buildings, in which their structures will be more diverse and complex <sup>[14]</sup>. Since each element and the pipelines are interlaced, it is a challenge to conduct a comprehensive inspection

of the construction project using the traditional three views. Therefore, the application of BIM should be considered, in order to strengthen the inspection of the collision in the construction, such as whether there is a collision between different construction processes, different pipelines, different steel bars, etc. In addition, it is necessary to carefully check for any collisions in the gap between the entities. The application of BIM not only helps in identifying collisions systematically and automatically, but also in generating collision inspection reports after the inspection. In that way, architectural designers can make timely corrections to the design scheme based on the collision inspection report.

### **5.3. Application of BIM in previewing the construction process**

Through the application of BIM, virtual building models can be established according to certain proportions, and the whole construction process can be rehearsed on this basis<sup>[16]</sup>. BIM can dynamically and repeatedly simulate each construction process and the important parts of construction to form virtualized animations and images. Through these models, the appearance of the building can be examined, and the internal structure of the building can be presented accurately. According to research, the accuracy of the establishment of the simulated model directly affects the accuracy of the rehearsal of the construction link. By previewing the construction process through BIM, construction personnel will be able to accurately grasp each link of the construction process, construction quality, and construction requirements, so as to avoid substandard construction quality and inconsistencies with the construction requirements and rework in view of insufficient standard operating procedures<sup>[16]</sup>. In addition, through the BIM preview virtual construction, it is possible to bring more real experiences to businesses, and project construction leaders can also use this opportunity to perform technical disclosure to the construction personnel, so as to help them understand the construction needs and the importance of emphasizing safety measures.

## **6. Application of BIM in building management**

### **6.1. Application of BIM in construction progress management**

An indispensable part of building management is construction progress management. In some construction project management, it is difficult to control the construction progress of construction projects because there is no in-depth analysis of the construction progress or strict construction progress control scheme. Once there is a progress delay, beyond the specified construction cycle, it is bound to lead to an increase in construction cost, thus causing an adverse impact on the benefit of the construction project<sup>[17]</sup>. Based on the actual situation of the construction site, models can be established with the use of BIM. In that way, construction police uniforms can be planned more reasonably, and supervision of the construction site can be done via the installation of cameras. This will help construction management personnel to timely grasp the actual situation of the construction site, identify hidden factors that might affect the construction progress, and carry out effective measures to eliminate these factors in a timely manner. The application of BIM in construction progress management not only ensures the completion of the construction project on time, but also modifies the construction progress plan for those unfinished construction parts in accordance with the architectural design scheme.

### **6.2. Application of BIM in construction quality management**

The construction quality of construction projects is not only related to the safety of the construction, but also the benefits of the construction projects, including both economic benefits and social benefits. Therefore, in the process of construction management, it is crucial to focus on strengthening the management of construction quality, so as to avoid the impact on people's normal production and life. It is also important to follow the development of the times and strengthen the application of BIM in construction quality management. In construction, a large number of construction materials are required, and the quality

of these materials directly affects the construction quality. With the help of relevant data and information, the specifications, quantity, and quality requirements of construction materials required for construction can be clarified <sup>[18]</sup>. The management of construction equipment and personnel should also be strengthened through the application of BIM. In addition, BIM can also be used to establish simulation projects and prefabricate construction schemes, so that more scientific and reasonable decisions can be made to further ensure the quality of construction.

### **6.3. Application of BIM in construction safety management**

There are many unforeseeable factors in construction projects. Even a slight negligence is likely to result in unforeseen circumstances or even potentially endanger the lives and safety of construction personnel. Therefore, it is necessary to strengthen the safety management of construction projects throughout the entire process. In order to achieve a more ideal safety management effect, the application of BIM in construction safety management should be encouraged <sup>[19]</sup>. First of all, through the application of BIM, construction projects can be simulated. In that way, the safety hazards concealed in the construction site can be determine, thus reducing the occurrence of safety accidents in the formal construction process. Second, through the application of BIM, hidden dangers can be intuitively presented in front of the construction personnel, so as to strengthen their safety consciousness. This can be carried out in strict accordance with the construction process, construction specifications, and construction requirements. Finally, certain monitoring equipment can be used to monitor the situation of the construction site in real time, so as to identify the factors that may cause safety accidents and eliminate them in time <sup>[20]</sup>.

## **7. Conclusion**

In conclusion, architectural design, project construction, and project management are the key links in any construction project. They do not only affect the construction quality of construction projects, but also the benefits of construction projects. The application of BIM in construction design, project construction, and project management has shown many benefits. Therefore, construction enterprises must vigorously promote the use of BIM to improve the scientificity and rationality of architectural design, enhance the visual experience of the architectural design scheme, strengthen the management of the construction links in construction projects, as well as clarify the construction process, construction standard, and construction quality of each construction link through the establishment of simulation models.

## **Disclosure statement**

The author declares no conflict of interest.

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