The Use of BIM Information Building Models in Environmental Protection

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Abstract. In order to explore the application of BIM (Building Information Model) technology in environmental protection, the BIM technology method was used to study the protection & regeneration of the environment and the application of BIM from the ecological perspective. Also, the design stage based on the information model, the optimization stage of the urban overall protection & regeneration, performance simulation evaluation stage, and the implementation stage of the multi-information platform collaborative management were elaborated in detail. It is concluded that the application mode of BIM technology in environmental protection is to change the design and management style based on 2D drawings to the one that takes 3D models as the core in order to make the traditional protection methods more scientific and sophisticated.

1. Introduction
With the development of China’s sustainable development strategy, the urban reconstruction based on environmental protection and regeneration has received increasing attention. In the process of reconstruction, factors such as climate, population density, and environmental quality have undergone tremendous changes, so the environmental protection and regeneration must be commensurate with it. The amount of information is also increasing with the increase of design requirements, and the traditional information technology based on CAD+GIS cannot meet the requirements any longer [1]. In recent years, with the rapid development of information technology, BIM technology has been promoted. It integrates plenty of information into a visualized 3D model and performs dynamic simulation and analysis in order to provide precise data reference and interaction platform for designers in the design of building life cycle [2]. Against this background, this article attempts to explore the application of BIM technology in environmental protection in order to provide a more sophisticated and rational optimization program for the protection and regeneration of the environment.

2. Related theory
2.1. The definition of BIM
There are various versions of the definitions or interpretation of BIM. In 1975, the “Father of BIM”, Professor Chunk Eastman of Georgia Tech University, first conceived the concept of a “building information model” in his curriculum, proposing the use of an integrated model to convey and express building-related information. Eastman’s vision opened the way for the development of building information and laid the foundation for the future development of BIM [3]. To this day, research on
BIM has mainly gone through three major stages: germination, production and development. The original concept of BIM originated from the global oil crisis in 1973, the time of the Great Depression in the United States, and the whole industry was hoping to find a way to improve the efficiency of the industry. In 1975, Professor Eastman put forward a “computer-based architectural description” in his project “Architectural Description System”, using the advanced technology of the computer to realize the visualization of the construction project and quantitatively analyse the data generated in the project process, so as to improve the efficiency of the project construction. Thus, he is known as the “Father of BIM” by later generations [4]. In 2009, McGraw-Hill made a simple definition of BIM in the market research report named “BIM Business Value” and thought that “BIM is the process of designing, constructing, and operating of projects by using digital models.” In comparison, the definition of BIM is relatively complete in the U.S. National BIM Standard pointed out: “A Building Information Model (BIM) is a digital representation of physical and functional characteristics of a facility. As such it serves as a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle from inception onward. A basic premise of BIM is collaboration by different stakeholders at different phases of the lifecycle of a facility to insert, extract, update or modify information in the BIM process to support and reflect the roles of that stakeholder. And the BIM is a shared digital representation founded on open standards for inter-operability” [5].

As can be seen from the national BIM standards of the United States, BIM technology is based on the computer information architecture model, focusing on the entire life cycle from the concept design of the building to the operation and maintenance of the building. To sum up, BIM is a shared digital model based on public standardization collaborative operation. It can provide faster interactive experience and a more intuitive management model for the project throughout its life cycle. It can be foreseen that BIM technology will be the main application technology in the field of architecture and planning design in the future.

2.2. The impact of BIM technology on design

Impact before the start of the design phase:
Prior to the establishment of the architectural detail model, the development programme model can be used to evaluate the proposed scheme more carefully to determine whether it meets the functional and sustainable needs of the building. The use of analysis and simulation software to evaluate the initial design plan can improve the overall quality of the building. When the owner uses the integrated project delivery method for project procurement, the project team can use BIM at the beginning of the design to improve their understanding of project requirements and avoid written communication and related delays [6].

Impact on the design phase of the project:
In the design process, the visualization of the design can be realized earlier and be more refined. The 3D model generated by BIM software is designed directly by software instead of multiple 2D views, so it can be visualized at any stage of the process, and the size of each view of the building can be consistent. When the design needs to be changed, the software can automatically make simple corrections. If the designed object is controlled by parametric rules to ensure that the alignment of the object is correct, the 3D model will not cause errors in geometry, alignment, and spatial coordination, which can reduce the need for users to manage design changes.

Impact on construction and processing:
BIM technology can use the design model as the basis of the prefabricated original. If the design model is transferred to a BIM production tool and detailed to the extent of making the object, it will accurately present the object of the building for production and construction. The accuracy of BIM makes it possible to produce larger originals designed in different places than 2D drawings. This feature can respond to possible changes in the construction site as well as the situation where the exact size of the other items can be obtained only after the completion of other projects.

Impact after the completion of the project:
BIM technology can improve the debugging and handover of facility information. During the construction period, the general contractor and the division contractor will collect the information about the installed materials as well as maintenance information related to the building system. This information can be connected to the object of the building model to be transferred to the owner for the use of the facility management system.

### 3. Methods

#### 3.1. BIM Cloud Platform

The cloud platform is the integration of resources to build up a group of servers with a strong computing performance and graphic processing ability. It can greatly save the time of data analysis and calculation, improve the efficiency of data application, and ensure that every BIM user can get the best computing and graphic processing service. In addition to supporting BIM applications, the BIM cloud platform can also support the operation of other applications according to requirements.

**Figure 1. BIM cloud platform framework**

#### 3.2. Project planning — to combine the regional features and highlight the design focus

BIM technology coordinates the rich simulation and meteorological information such as geographical information and regional analysis, and can accurately and objectively evaluate the climate conditions, characteristics, and suitability of the technology in the region. In the early stage of the plan, the BIM information model can be introduced into the environment regeneration design, and the collected regional information can be used to establish the city information model hierarchically by making use of the collected GIS geographic information, local climate information and external environmental information. The simulation analysis of the local human settlement environment parameters makes the initial design direction clearer and provides an effective basis for follow-up design.
3.3. Plan evaluation — to evaluate environmental performance and improve design strategy
BIM technology takes the 3D information model as the core. Visualization technology has changed the traditional methods of spatial cognition and interpretation, and has enriched and improved design methods. BIM is based on three-dimensional space. It establishes the urban space model and starts with it to carry out the program design from the initial stage of the design. BIM technology senses urban spatial patterns in motion in a three-dimensional and realistic manner, and can observe the city at a specific angle. Real-time comparison of multiple schemes and real-time editing of urban design elements can be achieved. In the design process, any angle can be selected as the viewpoint to observe, evaluate and modify the building’s shape, the combination of building group, and a certain area of a city until the final plan is determined. Moreover, according to the BIM visibility analysis, it is possible to analyse the visibility of regional landscapes or landmark buildings, enhance their accessibility, and avoid design errors caused by subjective judgments instead of actual situations in the design process, and adopt more scientific methods in establishing a visual form for urban space forms. Urban spatial form establishes visual form. BIM performance simulation can carry out sunshine, ventilation, thermal, noise, and disaster emergency simulations for the building and even its historical area, providing a scientific basis for the following design work.

3.4. Program Optimization – to optimize the overall structure and improve design quality
The concept of an ecologically sustainable urban environment requires a combination of external environmental resources, spatial comfort requirements, and urban design. Therefore, this article attempts to construct a systematic design method that can closely connect the use of environmental resources with the environment in the process of environmental regeneration in order to provide architects with design methods that can adjust the impact of climate and environment and meet the thermal comfort of the human body when designing buildings in certain areas. The BIM information model is introduced into the environmental protection and regeneration of the city design. Constructing building information models at different levels according to the requirements can simulate the development process of the city and the change process of the physical environment resulting from the change of the space form, and evaluate the performance of urban spatial form to determine the optimal design for local climate and environment. The BIM application visualized data feedback to conduct a comprehensive evaluation of the plan, providing parameter descriptions and trait summaries for the optimization of the urban design plan, so as to achieve urban space ecological design in the real sense.

Figure 2. Ecological simulation evaluation of BIM
3.5. Project implementation — to build a resource platform and realize data exchange

The implementation of the urban design scheme relies on urban design guidelines. In addition to drawings and texts, the BIM-based urban design guidelines also have data and visual digital information. Various kinds of information can be effectively managed and applied. Through the use of BIM technology, the originals can be constructed by groups and uploaded to the “cloud” technology platform so as to facilitate designers in different fields to find the corresponding information quickly, realizing the sharing of resources. It can also ensure the authenticity and immediacy of the project data. Thus, the efficiency of information utilization is improved and the sustainability of the scheme is guaranteed.

![BIM implementation flow chart](image)

**Figure 3. BIM implementation flow chart**

4. Results

For BIM, it is not only a tool to assist in design, but also a change in design thinking and management mode. The integration of BIM and environmental protection & regeneration revealed hidden information (historical information, climate information, humanistic information) through information models, and transformed the traditional design and management that based on 2D drawings into the ones based on 3D models. In addition, BIM’s performance simulation technology made it possible to carry out environmental protection and regeneration from the perspective of performance enhancement.
and optimization. This greatly improved the efficiency and scientific level of environmental protection work, and promoted comprehensive information and modernization of environmental protection. Thus, it has great application value and broad application prospects. It is believed that with the development of BIM technology, more types of BIM applications will surely emerge, and the methods for environmental protection and regeneration design will continue to be expanded.

Figure 4. Implementation diagram of BIM information architecture model in environmental protection

5. Conclusion
BIM emphasizes the concept of the whole life cycle, and it has vast potential for application space. Its application width as well as the depth of its application should be expanded. This study attempts to introduce the BIM concept and technology into environmental protection and regeneration research, and put it into actual use. Through research and practice, it is believed that the protection of the environment should not be limited to the preservation of the environment. Instead, we should meet the requirements of the development of the times and consider how we can revive the vitality of the urban environment and meet the needs of people living in it.

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