

# BIM Implementation for Temporary Medical Facility: A Case Study in Huoshengshan and Leishengshan Hospital in Wuhan

Qi Hong<sup>1,\*</sup>

<sup>1</sup>ZJU-UIUC International Campus, Zhejiang University, Haining, Jiaxing, Zhejiang Province, China

\*Corresponding author. Email: Qi.18@intl.zju.edu.cn

## ABSTRACT

In response to the novel Coronavirus outbreak in Wuhan, China, in early 2020, two new hospitals, Huoshenshan and Leishenshan, were established. However, traditional construction methods cannot meet the requirements of building in a short time. The construction of these two hospitals adopts the design and construction mode of prefabricated buildings combined with BIM technology. Based on reviewing the literature on the combination of these two technologies in recent years, this paper analyzes the unique advantages of BIM technology in each stage of assembly building construction by taking the construction process of Huoshenshan Hospital as an example. The aim is to provide experience and reference for the construction of temporary medical facilities in other countries and regions also suffering from the epidemic.

**Keywords:** *Huoshenshan Hospital, Leishenshan Hospital, BIM technology, prefabricated building, Emergency Engineering Construction*

## 1. INTRODUCTION

With the Novel Coronavirus outbreak and its worldwide spread, the construction of emergency works such as temporary hospitals will become an urgent need. At the same time, the prefabricated building because it can shorten the construction period, reduce the advantages of construction is widely accepted and optimistic in the construction industry. Prefabricated buildings are therefore the first choice for temporary structures. However, the assembly building model also put forward higher requirements for the coordination and communication of various departments. Prefabricated buildings also require monitoring of the entire life cycle of the building. Traditional design and construction can hardly meet these requirements.

To solve these problems, the construction of Huoshenshan and Leishenshan Hospitals adopts the mode of combining assembled building and BIM technology. BIM technology can significantly strengthen the coordination and communication between various professions and can realize the monitoring of the whole life cycle of the building from the beginning to the end. Their successful experience has strong reference

significance for some countries and regions still suffering from the epidemic [1][2].



**Figure 1.** The construction site of Leishenshan Hospital

## 2. BRIEF INTRODUCTION OF PREFABRICATION BUILDING

### 2.1. Characteristics of Prefabrication Building

Prefabrication building is a kind of safe and efficient constructing technology. Prefabrication means producing components of a building in a factory. Then prefabrication components will be transported to the

construction site and get assembled. Compared with conventional construction practice, there are many advantages for prefabrication construction. Since the components are processed in the factory first, machines or molds that cannot be transported to the site can be used. Therefore, the processing of products will be easier, the quality and precision of products can be guaranteed and the workload of field operation can be reduced. These advantages illustrate the potential of prefabricated buildings. At the same time, prefabricated buildings put forward higher requirements for product standards and process management. If there is no uniform standard for the basic components, or the technical and management capacity of the prefabrication factory is insufficient, it will lead to a decrease in production efficiency. Moreover, prefabrication buildings require long-term supervision in their life cycles. This requires better coordination and management among departments of the project [3].

### **3. PRINCIPLE AND CHARACTERISTICS OF BIM TECHNOLOGY**

BIM (Building Information Modeling) is a new application technology. This technology uses digital information to describe the real properties of a building. Geometric data such as dimension, position, or shape, as well as non-geometric data such as material, producer, or weight, are examples of real architectural properties that can be described. BIM also describes more than just the physical properties and functions of a facility. According to NBIMS (United States National Building Information Modeling Standard), BIM should also be a collaborative process that covers business drivers, automated processing capabilities, and open information standards. Moreover, it is a facility lifecycle management tool with easy-to-understand information exchange, workflow, and processes [4].

### **4. CURRENT STATUS OF BIM USE WORLDWIDE**

In the world, the use of BIM technology is very common in recent years. National Building Specification (NBS) surveyed the use of BIM technology to the professionals in a related field of architecture in England. According to the 10th Annual BIM Report of NBS, in 2011, only 13% of respondents were using BIM software, while 45% said they were unaware of the technology. In 2020, 73% of respondents said they were using BIM software and only 1% said they were unaware of the technology. This survey shows that BIM technology is developing rapidly in the UK, and most building and engineering professionals have recognized the advantages of BIM technology and put it into use. The biggest goal now is to popularize the technology in more fields so that it can reach more people [5].

However, the adoption of BIM technology in some other places has not been as smooth as in the UK. Le, Er, and Sankaran carried out case studies in Vietnam about The Implementation of Building Information Modelling (BIM) in Construction Industry. As a typical developing country, Vietnam's technological development level is lower than that of developed countries. This makes it more difficult to develop BIM technology in Vietnam, even though the Vietnamese government has a policy that all construction projects must use BIM. They believe that BIM is difficult to promote in Vietnam due to the following reasons: (1) established BIM teams cannot find their positioning and lack of cooperation from other teams; (2) BIM organizations prefer to find outsourcing or partners to share risks rather than develop complete BIM services themselves. (3) The use of pirated BIM software; (4) Companies in charge of large projects are unwilling to change the existing system to use BIM; (5) Low innovation motivation caused by corruption; (6) Contractors most suitable for guiding BIM use lack experience in software use; (7) Low professional knowledge level of construction personnel; (8) The interoperability between CAD and BIM is insufficient, resulting in cumbersome operation. Despite these obstacles, most Vietnamese construction practitioners have expressed their desire to continue to use BIM, but they are still waiting to see what the market needs and gradually adopt BIM [9].

### **5. ADVANTAGES OF BIM TECHNOLOGY IN THE CONSTRUCTION OF TEMPORARY MEDICAL FACILITIES**

Emergency construction projects refer to those projects that need to be constructed quickly in a short time to provide extra space or facilities for people in emergencies. Because of the high efficiency required, departments of different specialties often need to work simultaneously. It is necessary to reasonably allocate resources and coordinate the management of all construction teams to ensure that every link is carried out in an orderly manner. These requirements are exactly the advantages of BIM technology over traditional construction methods [3][4].

BIM technology has unique advantages for the construction of medical facilities. In 2008, Manning and Messner carried out two BIM Case Studies in BIM Implementation for Programming of Healthcare Facilities. The first case is an Expeditionary Hospital Facility and the other is a Medical Research Lab (MRL). Their research shows that BIM plays a significant role in the upstream design of medical facilities. These advantages are mainly reflected in (1) Rapid visualization, (2) improving the efficiency of information acquisition and facilitating upstream decision-making, (3) BIM can accurately show the changing information in concept development, (4) reduce the time needed for

spatial planning, (5) enhance the collaboration and communication between the different division of labor in the project, (6) reflect the integrity of the project development plan and increase the confidence of construction [8].

### 6. APPLICATION OF BIM TECHNOLOGY IN THE CONSTRUCTION OF HUOSHENSHAN AND LEISHENSHAN HOSPITAL

At the end of 2020, the coronavirus outbreak broke out in Wuhan, China. Due to the sudden onset and rapid spread of the epidemic, the large number of new patients

put enormous pressure on the existing medical system. Therefore, the Wuhan government decided to build two temporary hospitals named “Leishenshan” and “Huoshenshan” to treat a large number of patients. Referring to the form of other battlefield hospitals, the project adopts the design and construction of prefabricated container type movable board housing and combined with BIM technology for design, production, construction, and operation. Huoshenshan and Leishenshan hospitals took 9 and 12 days to be built respectively. The construction process was broadcast live on the Internet. In the following content, the application of BIM technology in the phase of designing, production, constructing, and operating of Huoshenshan hospital will be introduced [1].

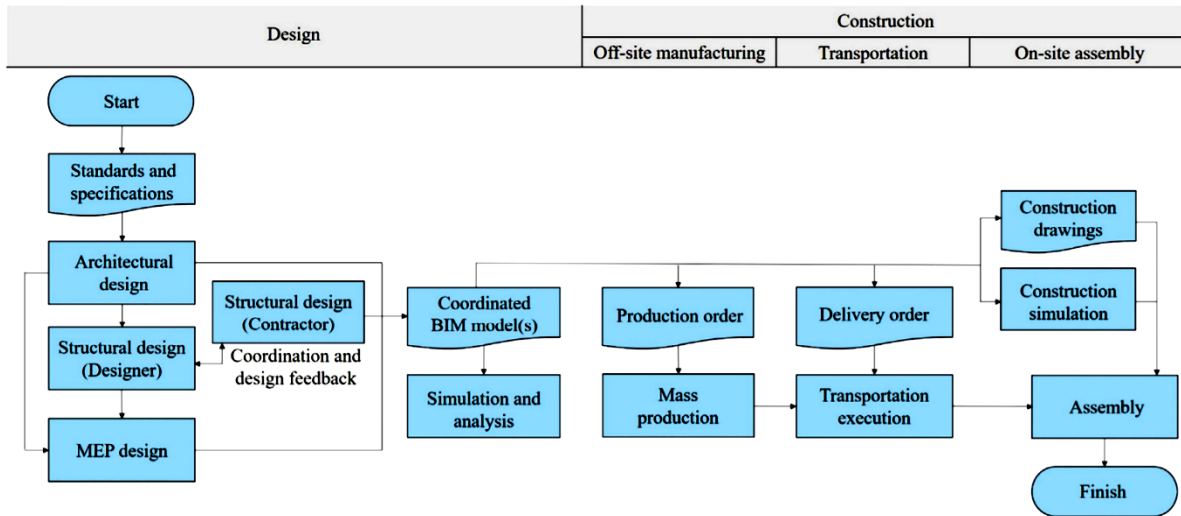


Figure 2. Procedures of Prefabricated Building

#### 6.1. Designing Phase

At the beginning of the design, the design unit first used Revit to design and model the types, dimensions, and materials of the building structure. Two-dimensional CAD drawings of different specialties are also transformed into the same 3D model by Revit, and the parameters are constantly modified and correlated. As the building is used as an infectious disease hospital, there are some additional different functional requirements,

such as ventilation issues. Engineers and other professionals use Naviswork to check and optimize drawings in real-time. In addition, the architects designed the assembled modules using the modular functions of YJK-AMCS. The use of this information software enhances the efficiency of communication between different professionals and unifies the construction drawings during the design phase. Moreover, the BIM software can simulate and test the situation of the building at the beginning of the design, reducing the possibility of building problems [4][7].

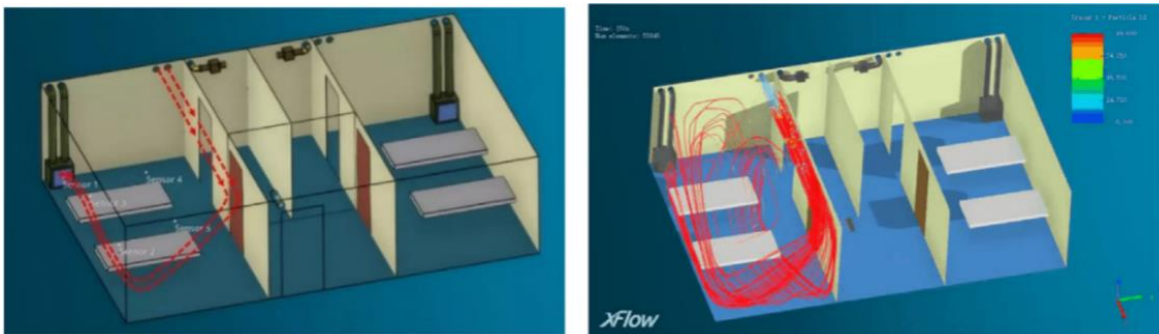


Figure 3. Use BIM software to simulate the ventilation of Leishenshan Hospital

## 6.2. Production Phase

Prefabricated buildings require building components to be prefabricated in a factory. Compared with the traditional method of production based on two-dimensional CAD, production based on the BIM model has more advantages. First of all, in terms of information acquisition efficiency, the 3D BIM model is more intuitive for production technicians, and the parameters of components are more complete. Second, it can be combined with the Internet of Things system to track the progress of production and transportation of components in real-time, so that construction units can better understand the progress and arrange work. Finally, in the construction stage, when the prefabricated components enter the site, the quality supervision department can scan the relevant information through RFID tags and add the information into the BIM model to realize the maintenance and management of the building components in the operation and maintenance stage [4].

## 6.3. Constructing Phase

In terms of information interaction, the design department uses THE 3D model of BIM to make technical disclosure to the construction personnel. The 3d model is presented to the construction personnel, and the dynamic simulation and collision inspection of the construction process is carried out. 3d rendering model is used to show some complex construction nodes which are difficult to be represented in 2D drawings. 3D printing technology is used to print 3D models into solid models for on-site workers to display. These enable the construction department personnel to better understand the construction objectives and construction steps, improve efficiency, reduce the possibility of error.

In terms of construction efficiency, the combination of prefabricated building and BIM technology can significantly improve efficiency. In the construction site, China Construction Third Engineering Bureau uses BIM technology to simulate lighting, ventilation, energy consumption, and other aspects in advance and adopts the optimal construction scheme. It improves the efficiency of construction and reduces the workload of site operation. Because of the combination of BIM technology and the Internet of Things, the construction department can master the transportation progress of components, to make a better transportation plan and speed up the construction progress. After the component arrives at the construction site, the construction personnel can match the component number with the 3D model one by one to quickly determine the location. Huoshenshan hospital also adopts the mode of combining external splicing and overall lifting, which can further speed up the construction process [4].

## 6.4. Operation and Maintenance Phase

The BIM model can record all the information from the beginning to the end of the building. The real-time status of components can be updated, monitored, and queried in real-time. It is convenient for the staff to find and report problems in time and prevent the occurrence of engineering accidents. In addition, through the three-dimensional model, we can better observe the division of spatial functions, optimize the path of staff, and improve the work efficiency of the hospital [4].

## 7. CONCLUSION

BIM technology can be well combined with the model of the assembly building, to promote the cooperation and communication of various departments, improve construction efficiency and real-time monitoring of building status. It is very effective in the construction of some short emergency projects. The rapid construction and smooth operation of Huoshenshan and Leishenshan hospitals prove the rationality and advance of the model. Such a model could serve as a reference for other countries and regions still affected by the pandemic. In the future, countries, and regions need to cultivate engineers who are skilled in using BIM technology. At the same time, the characteristic of BIM technology is that using a digital system to manage a complex and multivariate project can be an inspiration for projects in other disciplines more than civil engineering.

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