

## PROJECT MANAGEMENT INNOVATION BASED ON BUILDING INFORMATION MODELING

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### ABSTRACT

Application and development of Building Information Modeling (BIM) brings benefits for the construction industry. However, some problems such as lack of good collaboration, lack of skilled BIM manpower are serious. Project Management Innovation relative research questions include how to overcome the barriers in BIM implementation and how to improve the environment of using BIM technology are addressed.

**Key words:** Building Information Modeling; construction industry; project management innovation; benefits and barriers

### INTRODUCTION AND RESEARCH METHOD

The greatest challenge in the China construction industry is the increased construction cost and the slim profit margin associated with the old or traditional methods of design and construction (Chinese Electronic Information Industry Development Research Institute, 2013). The implementation which promotes the in-depth fusion of information and industrialization strategy is a breakthrough in the transformation and upgrading of the construction industry. Building Information Modeling can eliminate or reduce design and construction waste (The Ministry of housing and Urban Construction Information Center, 2014). It has become the most embraced technology for both design and construction activities, especially at present as China is promoting the construction industrialization. So using BIM technology is representing the general trend.

In 2014 July, Ministry of Housing and Urban-Rural Development of the People's Republic of China issued a number of opinions on promoting the development and reform of the construction industry (<http://www.mohurd.gov.cn/>). It pointed out to promote the engineering project management mode innovation, positively and pragmatically promote the construction industrialization and modernization. Many local governments are actively promoting this and some enterprises are actively participating.

However, the BIM technology needs to match the organizational processes and management systems. Some research problems in the field of BIM such as lack of good collaboration, lack of skilled BIM manpower are serious. Some of the ensuing research questions are addressed in this paper.

The research method used in this paper is exploratory and focuses mainly on some literature to address some of the problems associated with the implementation of BIM technology in the construction industry. This exploratory research method is useful in the early phases of research such as the area that this paper addresses. Some of the research questions addressed in the paper focus on identifying typical characteristics of BIM technology, applications of BIM and barriers to implementation of BIM technology.

### **CONNOTATION OF BUILDING INFORMATION MODELING**

There are three basic characteristics of BIM technology, namely the three-dimensional graphical, object-oriented components and information parameterization. From the connotation of BIM, it is a three-dimensional digital technology, integrating a variety of engineering construction projects related to the underlying data model of information; it covers not only the three-dimensional geometry information, but also contains a wealth of information of non-geometric shapes such as material, weight, price, and the progress of projects of building elements.

BIM is a digital expression of project facilities and entities with functional properties. It is the project deliverables and construction process information, which can be connected to the data, processes and resources for engineering objects in different phases of the engineering project life cycle. It's a complete statement of multiple parties and a number of professional, integrated modeling software generated models and process management. It ensures real-time application uniqueness and improves the project manager on project information management (Underwood. J. & Isikdaq, U., 2009).

The parties involved in project management are numerous. The investment cycle of an engineering project is usually long. The uncertainty and risk degree are generally high. The participants' information islands need to be broken to achieve the information integration management through the whole project lifecycle. For all parties involved, project management is a line that runs through the whole process of the project, while BIM technology is an important point on this line to shorten the project cycle, ensure project quality, and reduce project costs. It plays an important role to improve the work efficiency.

### **CURRENT APPLICATION OF BUILDING INFORMATION MODELING**

BIM technology is one of the most important technical means to realize full information access in the construction industry. In the construction industry in China, many design and construction companies have begun to use BIM technology as a management tool (Ma Zhiliang, 2013). It provides a very good management collaboration platform for investment decisions, design, tendering and bidding, construction, completion and acceptance. It makes project management more effective (Autodesk, 2011).

Internationally, many countries have entered into a period of rapid advance of BIM applications in the integrated support of government and industry, while in China BIM technology is still in its infancy stage of promotion, mainly applied in the following aspects:

### **Uses in decision-making stage**

In the decision-making stage, BIM technology is used in virtual reality or three-dimensional animation multimedia visual and intuitive way to express the intent of the program, and provide qualitative and quantitative analysis of the data. It adds to analysis merit of the scheme and facilitates well-reasoned decisions. So that the basis for non-professional personnel to participate in decision-making is provided and communication time is reduced.

### **Uses in design stage**

In the design stage, BIM technology is applied to achieve accurate expression of the complex shape of a building, to avoid unclear understanding deviation arising. The special structure design description, such as steel structure and curtain wall design are typically realized. It not only improved the quality of the design results, but also reduced risks caused by design errors, extension of time and increasing cost

In the construction design stage, application of BIM technology is used to produce the floor, elevation, and section plans through three-dimensional model. Inconsistent problems brought by the design change are typically avoided. Shortened construction design time is realized. The complicated and simple works are figured out and undertaken by different staff with different skills, and design cost is saved.

Through the application of BIM technology, structure design optimization can be performed to meet for example the seismic resistance constraint conditions, reduce the steel consumption, save cost of the materials. Pipeline installation layout optimization, reducing pipeline crossing and bending in a given space constraints, determining the reasonable layout, looking for the best construction methods, and saving the construction cost are also some foci of BIM technology applications in this optimization effort.

### **Building performance analysis**

In building performance analysis, BIM technology software is used for example to carry out structural mechanics analysis, energy saving analysis, and green building qualitative and quantitative analysis etc. The security and comfort of the building, quality of construction are improved. The cost of building energy consumption is reduced.

### **Collision detection technology**

By collision detection technology, structure elevation and location conflict error can be found more effectively. The structure and equipment pipeline collision conflict problems can be found. The quality of design results can be improved.

### **For calculating material**

In application of BIM technology for project cost control, quantities and costs can be calculated quickly and accurately to control price for tenders. It is convenient for completing the measurement-based progress payment by quickly and accurately calculating quantity and cost. It easy to implement change cost impact analysis by quickly and accurately calculating the change of

quantities. The quality of the results of the cost calculation is improved and risk of cost control is reduced (Qin LI, 2014).

#### **For schedule control**

BIM technology also assists in making intuitive 4D reasonable schedules by application, to facilitate and analyze the progress schedule control deviation through comparing the actual and planned progress. This may improve the quality of schedule control and reduce the risk of schedule control (Hergunsel, 2011).

#### **For technical clarification**

Technical clarification using BIM technology assists construction workers to fully understand the discussion program so that the construction is consistent with the results of the design goals. The construction key points and difficulties of nodes can be analyzed to reduce the construction technology risk, reduce the communication time in the process of construction, reduce construction work stoppage or enforced idleness or rework, saving construction time and improve construction safety.

#### **For asset management**

Application of BIM technology to carry out asset management, directly reflects the equipment and facilities in the building to facilitate the management of the asset location movement records, and easy to maintain equipment and facilities assets. This ultimately improves asset management quality and reduces the risk of asset loss.

#### **For project maintenance management**

With the help of BIM technology project maintenance management can be achieved; this is convenient to query design data and building component damage relevant information, such as equipment and materials suppliers and the origin, quality, brand etc. This then leads to relatively easy determination of the repair scheme to avoid risks of damaging the normal building components caused by maintenance turnovers.

#### **For security and counter-terrorism**

In security and counter-terrorism, building location information can be fully controlled by using BIM models and the monitoring facilities. BIM models can be used to analyze and form the best evacuation plans. It can also be used to determine the positions of terror officers, hostage, and sniper. It can also facilitate the identification of the best rescue program and improve the safety of the building used for counterterrorism, and make the anti-terrorism decisions efficiently.

#### **For teaching building knowledge**

Teaching and studying by using BIM technology can enable the students' understanding the relationship between building components. The combination of architectural theory and engineering practice can be achieved. It is easy to understand the whole process of engineering project management for the students and to improve the student's practice ability.

## **THE ENVIRONMENT OF USING BUILDING INFORMATION MODELING TECHNOLOGY**

BIM technology may be used directly or indirectly. It is typically used directly in the design, consulting, construction, calculation of quantities and other construction management work. In another cases, the professional engineers may use more traditional methods and software to do design, measurement of quantities, construction and management. BIM technology may then be used by professional BIM service engineers to complete the design, measurement of quantities, construction simulation modeling.

In the case of using full BIM software, the ideal situation is that the various parties use BIM software's compatible interoperability. This is the future direction of BIM technology development. In case of mixed use of BIM and non BIM software, it is subjected to various constraints due to the fact that BIM software is used only in part of the work leading to possible communication problems.

BIM services may be provided by a professional company which is commissioned by the owners and is independent of the designer, construction cost consultant and contractor. The professional company provides special services to the owner to evaluate the quality of project participant's work. Types of BIM professional companies at present are mainly service teams from design institutes, software companies or cost consulting companies (Cheng Jianhua, Wang Hui, 2012).

## **BARRIERS OF BUILDING INFORMATION MODELING APPLICATION**

The BIM technology needs to match the organizational processes and management system. However, some problems such as collaboration environments and information management in BIM application are serious (Han, Y., & Damian, P, 2008) (El Dado, F., 2011).

There are some obstacles in China to promote the BIM technology application. This has been researched to some extent albeit it an exploratory manner in an action research context by the authors more knowledgeable of the Chinese context.

First of all, from an overall point of view for the Chinese construction industry the understanding of the BIM technology is not deep enough. It is believed that BIM application is mainly in the design phase. It is considered to be used typically in modeling, rendering and collision detection.

Secondly, BIM technology is not considered as mature and not yet fully with aligned with international standards. Supporting software related to BIM technology is not mature yet. The compatibility is poor and development cost is high. At present, widely used in China is foreign software company launched BIM design software, which does not always match the current national standards of China. This software from another country can typically only be used in the establishment and maintenance of BIM models. While the BIM model is transferred from design phase to construction phase, due to the different of software operating system platform and poor compatibility, repeated modeling may be needed. This causes an additional workload and data without reusability.

Again, the construction enterprises often encounter some difficulties in BIM technology promotion, especially due to lack of experience. BIM application just stays on the show level in many construction companies and does not really filter through to real practical application level.

Finally for the Chinese context currently the BIM technology related personnel gap is sizeable. BIM practitioners should not only master the tools and concepts, but must also have the appropriate

engineering practical background. Users not only need to master one or two BIM software, more importantly, they should be able to combine the actual demand of enterprises to develop the BIM application plan and scheme. BIM talents in Chinese construction enterprise are quite poor. The current popularity is smaller in BIM education field. There are few open BIM related courses in colleges and universities, very few teachers truly mastering the BIM technology.

## **PROJECT MANAGEMENT INNOVATION**

The emergence of any new technology will bring different degrees of change. The application and development of BIM brings benefits for the industry. It also brings organizational innovation for the enterprises. The enterprise management mode is changing in the face of BIM. It is also changing the mindset of the people. BIM will bring the multi dimensional change in project management in China as observed also during limited initial action research by authors knowledgeable in the Chinese context:

### **Professional Building Information Modeling talent appears**

In fact, both for the Chinese enterprise or industry, the emergence of BIM leads to a new type of work skill required. Practitioners will increase rapidly in the future. Professional BIM personnel in the construction industry will produce great value for all parties involved in the construction industry.

### **Professional service companies appear**

The present situation in China is that some designer, contractor and relevant government agencies can not master BIM technology in a certain period. BIM consulting companies which provide professional services should appear. These companies will guide the BIM technology implementation and promote the development BIM application for China's construction industry.

### **Promoting Building Information Modeling technology**

Development of BIM technology in China needs to be supported from both the government and the construction industry to promote it. Application of BIM technology may require government intervention to promote it vigorously; otherwise the majority of companies do not want to break the current operating modes. So to integrate BIM technology smoothly into the construction industry and provide technical support for the entire process of project management, it needs the owners, government, design institutes and contractors all actively cooperating and working together.

Government and relevant departments should accelerate the development of domestic standards and formulation about the application of BIM to increase the knowledge of BIM, so that more practitioners have in-depth understanding of BIM.

The construction industry should respond to the government's call to promote BIM technology. The project parties involved should use BIM technology in various stages of construction, rather than just in the design phase, especially to strengthen the use of BIM technology as a productivity tool in construction stage. Construction enterprises should truly enhance the corporation and project management level in order to increase revenue, reduce costs, and enhance the core competitiveness of enterprises.

Leaders of enterprises should pay more attention to BIM; otherwise BIM implementation may be difficult to carry out. BIM technology should be positioned as corporate strategy and get all members of the company to reach a common understanding, in order to truly implement it. So firstly there is a need to change business leader's consciousness of BIM. Leadership should take the lead in learning BIM and encourage the staff to do it for comprehensive promotion. Secondly, a BIM team can be set up within the enterprise as a sample, and gradually spread to all members. Enterprises can also be organized to carry out occupation BIM grades that reach certain levels. Each staff may be required reach a certain BIM operating level to undertake a management position.

### **Improve compatibility of Building Information Modeling**

The problems that exist at present include the relevant BIM supporting software not being mature yet; poor compatibility and high development costs in BIM application also need to be solved. The major domestic software companies need to work closely with BIM application-related standards which domestic government and relevant departments issued. High professional BIM software in accordance with national conditions that can be used on different operating platforms need to be developed.

### **Cultivation of Building Information Modeling talents**

The construction industry and the education circle should work together to cultivate talent in BIM related fields for the shortage of qualified personnel. Construction industry and education circle may work together to conduct a nationwide BIM skill contest and related level exam or for example organize a contest for social workers and university students to promote BIM technology.

### **SUMMARY AND CONCLUSION**

The application status and general trend of BIM technology in China have been stated and discussed in this paper. The barriers in BIM technology implementation especially in a Chinese environment such as lack of skilled BIM manpower, lack of high level expertise with BIM, lack of good cooperation have been identified also using a literature review approach to the research. How the software and the professionals must work together and how the project team are to cooperate well using modern and scientific management methods, and how to overcome the barriers in BIM implementation have been discussed and analyzed.

Future research may include some practical application case studies of BIM technology in for example the Chinese context and for example comparing them to case studies in the South African context. A survey on some construction industry professionals on the barriers to implementation of BIM technology may also be beneficial.

### **ACKNOWLEDGEMENTS**

The author would like to thank and acknowledge Research Center for International Association for Management of Technology for generous and expert support to this study.

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