DOI:10.16670/j.cnki.cn11-5823/tu.2010.03.021

第2卷 第3期
2010年9月

土木建筑工程信息技术
Journal of Information Technology in Civil Engineering and Architecture

Vol.2 No.3
Sep.2010

Opportunities and Challenges of BIM Implementation: Current Practice in Hong Kong

Fan Hongqin, Guo Hongling, Jin Zhigang, Li Heng

(Department of Building and Real Estate, The Hong Kong Polytechnic University)

Abstract

Building Information Modeling (BIM) has gained rapid acceptance in the building industry in recent years in Hong Kong, both the government and the industry practitioners realize this irreversible trend of changing gradually from traditional 2D representation of building product and fragmented contributions from the stakeholders to 3D product model and streamlined lifecycle management in the near future. This research presents an overview on the implementation of BIM, its current state of practice in Hong Kong. While the primary intention is to introduce the BIM-related works and preliminary benefits, the authors also intend to identify the obstacles and challenges faced by industry practitioners of such implementation in Hong Kong from social and technological contexts. A case study is used to illustrate the benefits of BIM implementation by a large contractor, as well as the technical limitations and difficulties steering toward the "ideal scenario" envisaged by using BIM technologies.

Key Words

BIM; BIM Implementation; Technical Limitation; Hong Kong Practice

[Chinese Library Classfication] TU201.4 [Document Code] A [Article ID] 1674—7461(2010)03—0058—07

Introduction

Building Information Modeling (BIM) is the process of generating and managing a building information model through the use of three-dimensional, intelligent design information (AGC America, 2010). Implementation of BIM among building industry practitioners will undoubtedly help to improve communication and collaboration during the different stages of the building lifecycle, from planning, design, construction, to the operations and maintenance. In an ideal scenario, a project can be started and completed with all the information added to its Building Information Model without producing any printed 2D drawings: start with a 3D model of the building, all the information at later stages such as design changes, construction records, commissioning, operations history, can all be added to the same model to have an integrated single version of truth on the project.

Although the participants in the building industry of Hong Kong realize the potential benefits to be brought by the application of BIM, the overall level of implementation is relatively low. Architects are early adopters of BIM as they see the obvious advantages of visualized 3D design and easier communication of their design with clients. BIM

【作者简介】 樊宏钦，男，博士，助理教授。主要研究方向：BIM技术以及数据挖掘技术在建筑工程领域中的应用。
E-mail: bshfan@polyu.edu.hk

is now very popular among large architecture firms. Consultants specializing in BIM services are also a popular business in the local market. Other than the architects and BIM consultants, preliminary and some limited implementations of BIM have been observed in government organizations (e.g. Hong Kong Housing Authority and Housing Department), structural engineer consultants and contractors. Overall both the government and industry practitioners are feeling the pressure brought by the evolving BIM technology; it is believed that earlier adopters will gain competitive edge in the market.

The Hong Kong Institute of Architects (HKIA) has been promoting the use of BIM among its members in Hong Kong. In earlier 2009, Hong Kong Institute of Building Information Modeling (HKIBIM) was formally established to promote the adoption of BIM in Hong Kong. HKIBIM brings together all BIM-related parties for concerted efforts in BIM research, training, promotion and regulation. As a recognized leading provider of BIM tools and solutions, Autodesk has been organizing the annual BIM conference since 2005. Autodesk also established "The Autodesk Hong Kong BIM Awards", a yearly event since 2007 to celebrate building industry professionals and educators in Hong Kong who are helping to drive the transformation of the building and construction industry through innovation with BIM technology (Autodesk 2010). BIM courses have been offered at the major universities for degree and non-degree programs.

In contrast to the popularity of BIM in architecture services, limited applications have been reported in structural designers and contractors, the main players in design and construction stages. According to our interviews with local structural engineers and building contractors, the most appealing feature of BIM is still visualization. Structural Engineers find that BIM is effective in visualizing MEP works and identifying conflicts in their physical locations and sizes, however traditional 2D drawings are still being used as their output to their clients based on legal requirements and practical needs. BIM has been implemented on a few projects fully or partially in parallel with 2D drafting. For the contractors, the primary driver for BIM implementation is to showcase their construction technologies for bidding or optimizing their sequence and work methods in complex structures; from the owners' side, either the government or private business, showcasing their yet-to-built projects and communicating with potential stakeholders is one of the most desired features of BIM. As for the property managers, no BIM implementation has been reported so far in Hong Kong.

Although the industry practitioners have reaped benefits from BIM implementation, to various degrees, the gap between the envisaged implementation of BIM and the reality in project life cycle is still huge. The authors identify some issues which make hinders the rigorous implementation of BIM in Hong Kong as the following.

From social perspective, BIM represents a fundamental change to project design, construction and maintenance process; a revamp in the current practice means significant changes in contract clauses, communications, skill sets of participants, even the legal requirements in building codes and regulations. It should be recognized that BIM is not mandatory in the foreseeable future due to various obstacles and limitations. Implementation of BIM should be considered as a long term strategy initiated and led by the government and industrial leaders. BIM implementation will be more efficient with better acceptance if the industry practitioners receive better education and training in terms of technology and best practice in their practicing area. Pilot projects especially in public works should serve as the models of examples for other to follow suit.

From technological perspective, BIM tools are still under development; tools from different vendors have different design in BIM data structure; data exchange may cause loss in information (Tse et al. 2005); programmability of these BIM tools are generally poor; APIs are vendor-specific and their capabilities in exchanging information between BIM and other applications are limited. No commercial packages are available in the market taking care of the specific needs of a construction project in its life cycle. BIM standards and guidelines are still insufficient in addressing construction needs of building projects.

With the aim of introducing the opportunities and identifying future challenges to wider BIM acceptance, this research introduces the current BIM practice in Hong Kong from various stakeholders of building projects, with a fo-

cus on the BIM implementation in the design and construction stages of building projects. A real life case is also presented to demonstrate the benefits of BIM and some problems identified in this case are discussed.

BIM implementations in Hong Kong

The emergence of BIM is catalyzing a revolution to the building industry of Hong Kong, in which all stakeholders in the industry are involved. Their conventional operation styles are needed to be converted to keep pace with the development of BIM. This is opportunities as well as challenges for BIM implementation. This section discusses BIM implementation in Hong Kong for different perspective practices.

Promotion from the Government

Considering the sound promising of BIM technology to the development of the building industry, the Hong Kong Housing Authority (HA) has been proactive in applying BIM technology in the design, sustainability studies and construction coordination of public housing projects. To further promote the application of BIM technology and leverage the competitiveness of industry, a BIM Centre is set up at the headquarters of the HA, under the Development and Construction Division (DCD) of the Housing Department. The Centre aims to serve as the basis for BIM development, facilitating BIM project teams in reality execution, exchange experience in application, as well as carry out research and training.

Involvement of Institutes and Societies

Apart from attention given by the government, there is great enthusiasm for BIM research and application from many institutes and societies in Hong Kong. The Hong Kong Institute of Building Information Modelling (coined HKIBIM) is one of these institutes. Its aims are to promote the application of BIM technology, to facilitate knowledge sharing within the industry, and to uphold and advance the standard of competence for the profession. The involvement of institutes and societies like HKIBIM will play an active role in promoting the application of BIM technology in Hong Kong.

Commitment of the Industry

BIM for the perspective of consultants

Some consultants especially like architecture firms (e.g. ARUP, SOM) in Hong Kong have been applying BIM technology in their projects for many years to capture more international market share. They have taken BIM as their competition advantages. BIM improves the work efficiency of designers, as well as increases clients' satisfaction. Comparing with conventional methods, BIM assists designers in representing their ideas vividly and therefore communicating with clients directly and efficiently. On the other hand, BIM makes some buildings with unmistakable and innovational overall appearance come true. Consultants in Hong Kong have employed BIM technology to successfully complete some complex building projects within time and budget and in a sustainable way, such as One Island East office building, Hong Kong Tseung Kwan O (TKO) Sports Ground. BIM provide a useful tool for designers to turn the dream buildings in their mind to reality human legends. Therefore, BIM will bring a promising and foreseeable future for the building consultants industry of Hong Kong.

BIM for the perspective of contractors

Comparing with consultants, contractors in Hong Kong seldom use BIM technology. In recent years, some general contractors in Hong Kong begin to adopt BIM so as to improve their competitiveness in the keen competitive market. For example, Gammon Construction Ltd. and China State Construction have applied BIM technology in

some of their projects and gained rich experience in the application of BIM technology. The former has set up a BIM research team, while the later has planned to adopt BIM in the majority of their projects. Moreover, both of them have conducted the close cooperation with universities and research institutes, for example CVP laboratory in The Hong Kong Polytechnic University, so as to strengthen the application of BIM. Through their pilot projects of using BIM, many contractors in Hong Kong are recognizing the benefits of BIM technology.

BIM for the perspective of owners

Some owners in Hong Kong, for example The Swire Group and Hong Kong Housing Authority (HA), have been being aware of the importance of BIM and begin to apply BIM technology in lots of their projects. The benefits provided by BIM include aiding in design assessment, reducing time to market, improving sustainability, aiding in cost control, and aiding in facility management. Owners can streamline the delivery process of high quality buildings by using BIM technology since BIM is a powerful tool to being able to integrate information in the design, construction, operation, and facilitate management stages. They are becoming the main driver for promoting the application of BIM. For some projects, these owners require designers and contractors to use BIM.

BIM for the perspective of educators

Although Hong Kong government and building industry aggressively impel the use of BIM, many think BIM is only about the design of buildings and do not understand BIM as a lifecycle methodology for buildings. Hence, it is very necessary to create new courses that provide the know-how about BIM and let students understand how to utilize BIM during the lifecycle of building projects. Additionally, it is also very urgent to provide some BIM training tailored for practitioners. In order to fulfill these requirements from the industry, the tertiary education and research institutions in Hong Kong, such as The Hong Kong Polytechnic University, have made lots of useful research and trials in BIM application.

Difficulties and Challenges in BIM implementation

Although BIM provides the aforementioned benefits and opportunities, during the implementation of BIM in Hong Kong, many difficulties and challenges are confronted and need to be conquered. The main challenges in implementing BIM in the construction practice include: overcoming the resistance to change (from 2D to 3D) and getting people to understand the potential and value of BIM over 2D drafting; solving the compatible problems of different BIM software and other functional software (e.g. environmental analysis software) and resolving data exchange problems of BIM software; and training people in BIM or finding employees who understand BIM (Sasmikhindu and Yusuf Arayici, 2008).

The compatibility and data exchange problem of software is the biggest challenge in all of these challenges. It is the main barrier for the BIM adoption in Hong Kong building industry. At present, there are a myriad of software packages that address one or various necessities for a contractor. The most popular BIM software in Hong Kong includes Autodesk Revit, Autodesk Architecture Desktop, Bentley Architecture/TriForma, Gehry Technologies' Digital Project, Graphisoft ArchiCAD, and so on. Also some functional software related to BIM is used, for example Autodesk Ecotect Anays is. Since each software package has its own proprietary data standard, the compatibility and data exchange are vital for enabling the interoperability between software applications. Although IFC (Industry Foundation Classes) released by the International Alliance for Interoperability (IAI) provides a solution for data exchange for different BIM software, the compatibility and data exchange problem between BIM software and related functional software remains.

Case study

Hong Kong Tseung Kwan O (TKO) Sports Ground is a design and build (D-B) project for the 5th East Asian

Games held in Hong Kong in 2009. BIM and simulation technologies were employed in this project as a pilot project. As the general contractor, China Overseas Holdings Limited (COHL) hoped to use BIM technology to reduce design problems, evaluate design performance, make the communication among stakeholders more efficient in the detail design stage, and further based upon the BIM model(s), to adopt simulation technology to simulate and optimize construction sequences before real construction commences. Note that BIM technology provides the 3D model(s) for the simulation of construction sequences.

BIM implementation

The BIM model of this Sports Ground (see Figure 1) was firstly built through transferring 2D drawings to 3D models so as to conduct design analysis and construction simulation. This model consists of architectural, structural and building services models. For example, Figure 2 shows the roof truss models.

Based on above the BIM model, design problems were easily identified, more than 50 design errors, including collisions (e.g. Figure 3), dimensional discrepancy, wrong spatial location, lack of some detail information, etc. These design problems were solved before real construction commenced and therefore the constructability of design was improved. Also design performance was evaluated using the BIM model, for example the spectator stand was tested (see Figure 4) so that spectators on the stand can watch the whole soccer ground. Moreover, the BIM model provided an efficient communication platform for designers (e.g. P&T Architects & Engineers Ltd.), the contractor (COHL), and the owner (Architecture Services Department).

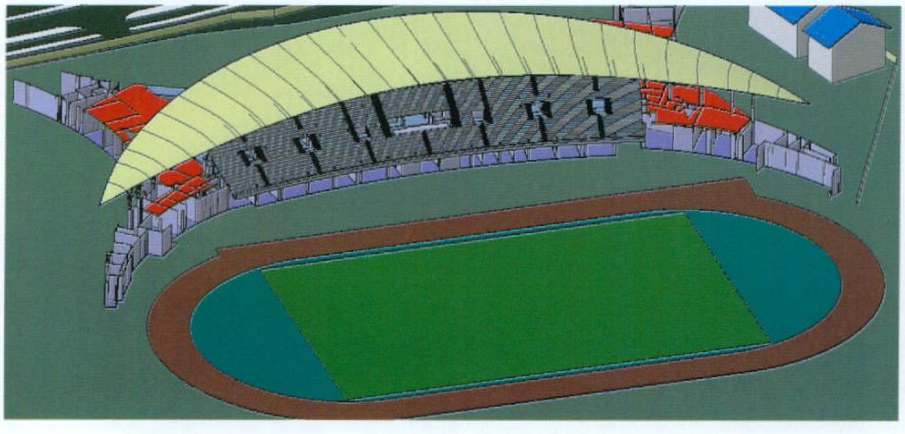

Fig. 1 The BIM model of TKO Sports Ground

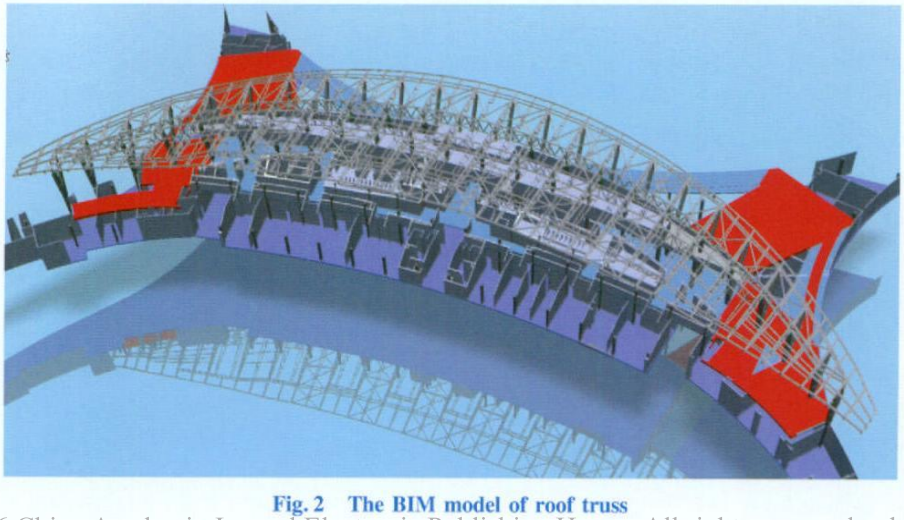

Fig. 2 The BIM model of roof truss

Fig. 3 A collision instance between pipe and roof structural component

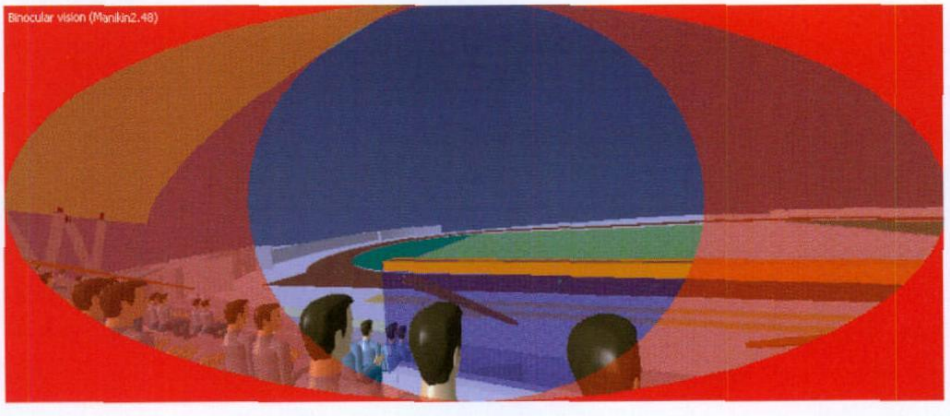

Fig. 4 The design performance evaluation of the spectator stand

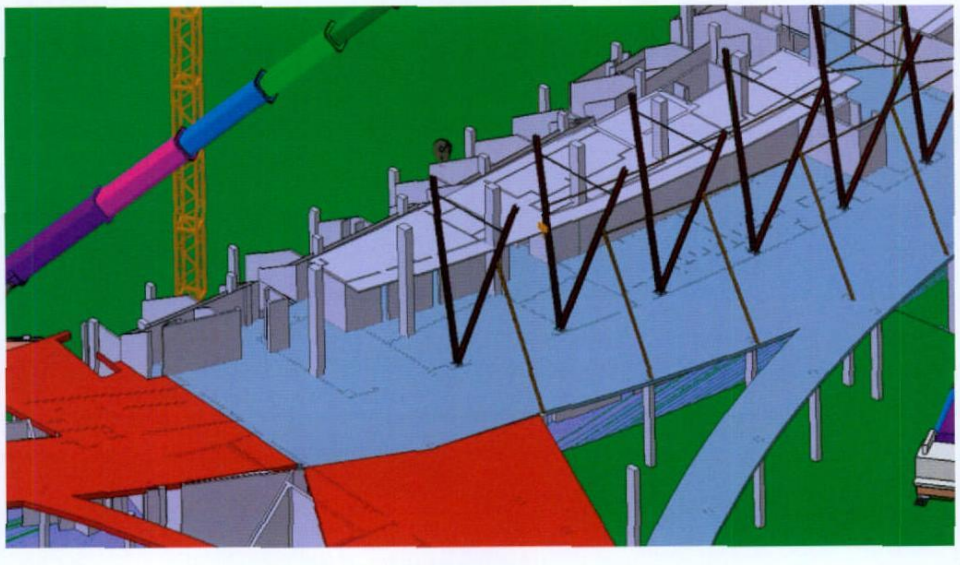

Fig. 5 Simulation of installing V-columns

BIM integrating with simulation technology on the other hand was used to simulate and optimize construction sequences. For example the installation of V-columns was simulated for many times until an appropriate sequence was found (see Figure 5). Through simulation the construction time and cost of this project was reduced to a great extent.

Discussion

Similar to the application of BIM in TKO Sports Ground BIM has also been employed in other building projects in Hong Kong for example Tuen Mun Police Quarter One Island East and iSQUARE Shopping Mall. Through the application of BIM to some extent the design and construction are optimized and an efficient communication platform also provided. Nevertheless some problems are also found during these applications.

1) BIM does not all function in current projects although in theory it can be used in the life cycle of building projects. The application of BIM just focuses on the geometries related with design and construction some other information e.g. material price contractors manufacturers etc. is not integrated into BIM model. As a result BIM is almost not used in the tendering and maintenance stages and even in the design and construction stages BIM-based environmental or structural analysis is seldom conducted. Moreover the BIM model has to been built through transferring from 2D drawings and therefore additional works have to be done. This limits the successful implementation of BIM.

2) Lack of interoperability between BIM software and other functional software (e.g. environmental analysis software) limits the application of BIM. When a BIM model is built it should be able to be used to do some functional analyses for example environmental analysis structural analysis etc. However it is normally difficult to carry out the analysis of this kind due to the lack of interoperability which makes the BIM model partly or not be loaded/reused by the software concerned with functional analyses.

3) Practitioners in the building industry do not know well BIM technology. Although BIM has been developped and promoted for many years practitioners in these cases did seldom or not know what BIM is. This makes it difficult to extensively implement BIM in Hong Kong. Furthermore some practitioners just think of BIM model(s) as 3D model(s) which are just used to represent the design of a building project. This is a reason why BIM model is often used to detect design errors and construction problems seldom adopted to conduct functional analyses.

Conclusions

Through the overview of BIM implementation in Hong Kong building industry the perspective practices of different stakeholders in the industry are analyzed and the challenges in BIM implantation are identified. BIM technology has the potential to assist in the design tendering construction and maintenance of building projects. This has attracted researchers' and practitioners' attention in recent years. However BIM is neither so far extensively applied in Hong Kong nor used completely in the life cycle of building projects. The main challenges identified for this are the lack of BIM awareness for practitioners and the lack of interoperability between BIM software and other functional software. This is also verified by the case study through which the benefits of BIM in the design and construction stages are shown and moreover some problems are also found.

In order to achieve the successful and extensive application of BIM in the building industry it is suggested that the promotion of BIM should be strengthened by the governments owners/developers should play a leading role in the application of BIM and the interoperability between software related to BIM should be improved. Also the standards and guidelines on BIM implementation in the local industry should be set up early.

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BIM技术应用的机遇与挑战:香港建筑业实践情况

樊宏钦　郭红领　金志刚　李　恒

(香港理工大学建筑与房地产学系，香港)

【摘　要】近年来,建筑信息建模(BIM)在香港的建筑行业中获得了广泛的认同,无论是政府还是业内人士都意识到这将是一个不可逆转的趋势。BIM正逐步改变传统的以2D图表达建筑产品及其将各建筑阶段分散的设计模式,在不久的将来,BIM将可以为建筑业的相关各方提供一个可用于全生命周期管理的三维产品模型。本研究首先对BIM技术在香港目前的运用状况做了一个概述,然后主要介绍了BIM技术应用中相关各方的主要工作及其在应用的成效。其次,介绍香港建筑行业中各个相关方在现有的社会和技术环境下运用BIM技术中将面对的障碍和挑战。最后,文章通过一个案例来说明的BIM在实际运用中的好处,同时阐述了在实现"理想的状况"使用的BIM技术将面临的技术上的局限性和困难。

【关键词】BIM;　BIM技术的应用;技术局限性;香港实践