International Journal of Construction Engineering and Management 2013, 2(4A): 1-6
DOI: 10.5923/s.ijcem.201309.01

# Building Information Modeling (BIM) Application in Malaysian Construction Industry

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**Abstract** Building Information Modeling (BIM) is a set of digital tools that can manage construction projects effectiveness. BIM has been used by the Architecture, Engineering and Construction (AEC) industries in Malaysia. The idea to implement BIM in Malaysia was introduced by the Director of Public Works Department (PWD) in 2007. The aim of this paper is to explore BIM implementation in Malaysian construction industry. A literature review was done to explore previous BIM studies on definitions and history of BIM, construction issues, application of BIM and BIM tools in construction projects as well as benefits of BIM. Malaysian government encourages construction players to apply BIM to construction projects because it can overcome construction project problems such as delay, clash of design by different professionals and construction cost overrun. Autodesk tools have been suggested by the government as a BIM tool platform. Other tools include Revit Architecture, Revit Structural, Revit MEP, Navisworks and Cost-X. It is crucial for construction players to be aware of the importance of BIM application in construction projects. This is because BIM can be one of the conditions required of a company to qualify for government and private projects, similar to what is practiced in some other countries. Moreover, BIM helps to increase construction project efficiency and effectiveness. It can also be implemented to improve communication and collaboration between construction players. The implementation of BIM technology is expected to become more widespread in Malaysian construction industry because of the government's efforts in promoting BIM.

**Keywords** Building Information Modeling (BIM), Application, Construction Project, Effectiveness, Malaysia

## 1. Introduction

Building Information Modeling (BIM) is a collaborative tool used by architectural, engineering and construction (AEC) industries based on a number of software solutions[1]. It is a technology and a process to manage construction projects[2]. BIM is a set of technology developments and processes that has transformed the way infrastructure is designed, analyzed, constructed and managed[3]. BIM can enhance and improve planning process, design and construction of projects. BIM concept has been introduced since 1970 by Professor Charles M. Eastman[4][5]. In mid-year of 2000, AEC industries have started to implement BIM in construction projects[2]. The United States of America (USA) is the first country to implement BIM[6].

Nowadays, BIM has been implemented in many countries such as the United Kingdom (UK), Australia, Hong Kong, Denmark, Norway, Finland and Singapore[6][7]. In Malaysia, the idea to implement BIM was introduced by the Director of Public Works Department (PWD) in 2007[8]. This step was a result of the government's awareness of the potential of BIM to reduce construction cost and avoid design problems in planning phase. Moreover, BIM also has been seen as a concerted action to ensure collaboration between construction players such as architects, engineers, project managers and contractors[7][8].

On 27 August 2007, PWD committee was established by the government to choose the right BIM platform to ensure interoperability[8]. The purpose of establishing the committee was to identify construction project processes that involved BIM implementation. Moreover, the committee also prepared a BIM standard manual documentation for PWD as a guideline for construction players' reference. The committee also provides BIM training and advisory assistance to project teams in using BIM tools[8].

The first project in Malaysia that involved the implementation of BIM is Multipurpose Hall of Universiti Tun Hussein Onn Malaysia (UTHM) in the Southern region of Malaysia[9]. Other BIM projects in Malaysia are National Cancer Institute of Malaysia, which is expected to be completed on 31 August 2013, Educity Sports Complex in Nusajaya, Johor and Ancasa Hotel in Pekan, Pahang[9][10][11].

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Published online at http://journal.sapub.org/ijcem

BIM will be implemented in the following future projects in Malaysia:[8][12].

i. Healthcare Center Type 5 at Sri Jaya Maran, Pahang.

ii. Administration Complex Project of Suruhanjaya Pencegah Rasuah Malaysia (SPRM) at Shah Alam, Selangor.

iii. Primary School of Meru Raya Ipoh, Perak.

iv. Primary School of Tanjung Minyak 2, Melaka Tengah, Melaka.

These projects are known as pilot projects. Pilot projects are part of Malaysian government's initiative in exposing government officers to BIM[8]. To date, there are twelve (12) projects using BIM in Malaysia[8][9][10].

The government encourages construction players to apply BIM to projects because BIM has a huge potential to facilitate solving problems of construction projects. For instance, BIM can prevent disputes between construction players, manage the right quantity for each structure, decrease construction cost and avoid project delay[8][13].

Nowadays, BIM implementation in Malaysia is seen more suitable for complex projects and high risk projects[13]. The setback for BIM implementation in construction projects is that local contractors from Grade 1 (G1) to Grade 6 (G6) are not ready to apply BIM. This is because the above-mentioned groups of contractors hardly use information technology (IT), and they need substantial amount of money to purchase BIM tools such as Revit Architectural, Revit Structural and Navisworks as well as to attend BIM-related training[13]. To overcome these issues, Malaysian government has allocated a grant to undergraduate students and any organizations or individuals to receive training on BIM provided by Multimedia Super Corridor (MSC) Malaysia[11]. MSC Malaysia is a Malaysia National Information and Communications Technology (ICT) initiative, designed to attract world class technology companies while grooming the local ICT industry[11]. MSC Malaysia gives explanation about BIM guidelines and provides training in using BIM tools. It also awards BIM professional certificates to all participants[11].

The Malaysian government's effort in introducing BIM in the AEC industries offers beneficial opportunities to small construction companies, as they will be able to explore and apply BIM to projects[12]. With BIM applications, small construction companies can increase staff efficiency, productivity and job satisfaction, which will lead to reduction in operating cost[12]. These advantages give companies opportunities to be involved in large construction projects[12]. Therefore, this paper discusses how BIM can benefit Malaysian construction industry.

## 2. BIM and the Construction Industry Issues

The construction industry is one of the major industries that contributes to Malaysian economy. The industry continues to support social development through provision of basicinfrastructure[14]. In 2005, the demand for construction projects came from government and private construction sectors to fulfill the economic needs of infrastructures and commercial buildings[14].

Several problems occurred in construction projects. The problems include delay, dirty construction sites, difficult and dangerous site conditions, poor quality of work and occurrences of accidents on construction sites such as the collapse of Jaya Supermarket in Petaling Jaya, Selangor[14] [15]. These problems had caused negative impact to the industry. They are signs of weaknesses of Malaysian construction industry.

However, these problems can be solved with ICTsolutions. The use of ICT in construction projects helps to manage projects in productive and effective ways[16]. ICT has introduced BIM as a tool to manage construction projects effectively[14]. Effective construction planning can prevent potential problems from occurring during pre-construction phase, construction phase and post-construction phase[17]. BIM has emerged as an innovative way to manage construction project planning[18].

Even though implementing BIM can overcome problems in construction projects, its application remains in its infancy[8]. Construction players need to be aware of the benefits of BIM in helping them to improve implementation of construction processes. It is noted that BIM is still new in Malaysian construction industry. BIM is seen as an expensive technology to be adopted, but it has been proven to provide solutions to the above-mentioned construction problems. The next section of this paper will discuss BIM application in different phases of construction projects. They are pre-construction phase, construction phase and post-construction phase.

## 3. BIM Application in Construction

BIM applications in construction projects bring many benefits to construction players such as improving communication between construction players and facilitating faster design decision[3]. Moreover, one of the BIM features is ease of use related to its tools; hence, the use of BIM can reduce time spent in design as well as decrease cost and duration of construction[8].

BIM can be applied to all construction project phases, which are pre-construction phase, construction phase and post-construction phase[7][13][9].

Table 1 shows BIM application in a construction project for every phase, consisting of pre-construction phase, construction phase and post-construction phase. It can be seen that BIM application in a construction project helps in managing the project more effectively. The ability of BIM to foster collaboration between construction players facilitates the design process decision[2]. Moreover, detection of clash and clash analysis during the design stage can reduce time and construction cost. BIM also ensures completion of a quality construction project because it assists in organizing

activities and phasing during planning stage of a project[2].

**Table 1.** BIM applications in a construction project[7][13][9]

| Phase | Stage | Uses of BIM |
|---|---|---|
| Pre-construction | Existing conditions modeling | →Enhances accuracy of existing conditions documentation. |
| | Planning | →Identifies schedule sequencing or phasing issues. |
| | Design | →Facilitates better communication and faster design decision.<br>→Perform clash detection and clash analysis.<br>→Increases design effectiveness. |
| | Scheduling | →Enables project manager and contractor to see construction work sequence, equipment, materials and track progress against logistics and timelines established. |
| | Estimate | →Enables generation of takeoffs, counts and measurements directly from a 3-Dimensional (3D) project model. |
| | Site analysis | →Decreases costs of utility demand and demolition. |
| Construction | Construction | →Enables demonstration of construction process, including access and exit roads, traffic flows, site materials and machineries.<br>→Provides better tracking of cost control and cash flow.<br>→Enables tracking of work in real time, faster flow of resources and better site management. |
| Post-construction | Operation / Facilities management | →Keeps track of built asset.<br>→Manages facilities proactively.<br>→Enables scheduled maintenance and provides review of maintenance history. |

The application of BIM in pre-construction phase is more evident than during the construction and post-construction phases. This is because there are many activities done in this phase such as design, scheduling and estimating; these activities generally involve the use of BIM technology. BIM tools such as Revit Architectural, Revit Structure, Revit MEP, Navisworks and Cost-X aredeveloped to assist construction players in all phases in construction process. Discussion on BIM tools applicable to the industry is discussed in the next section of this paper.

# 4. BIM Tools

BIM tools have been introduced in many types and functions. Among the tools are Revit, Tekla, Bentley, Autodesk, Vico and Cost X. Each tool has its own functions, and they are each used to manage different activities in construction projects[8][19]. The selection of BIM tools is based on four (4) features, which are communication reliability, accuracy, usability and reliability of data exchange[8].

Communication reliability can be seen through BIM process in defining a project team, identifying the key processes and dependencies throughout a project, assigning roles and assigning responsibilities to each project team[12]. The application of BIM in estimating process shows the accuracy of BIM during the taking-off process. BIM can reduce the number of errors related to measurement estimates during the estimating process[20].

In terms of usability, BIM tools such as RevitArchitectural and Revit Structural are able to illustrate construction processes through 4-Dimensional (4D) simulation and clash detection[21]. Furthermore, BIM has proven itself through successful projects that have been managed in other countries such as the USA, the UK, Hong Kong and Australia[7]. Examples of the successful projects are One Island East in Hong Kong, Hilton Aquarium Atlanta, Georgia, The Freedom Tower, New York and The Sydney Opera House, Australia[7][22]. Additionally, the reliability of data exchange between architects and structural engineers must be verified before proceeding to develop a model that can facilitate other processes such as mechanical andelectrical design, estimates and construction phase process[23].

Based on the above-mentioned features, the PWD acknowledged that BIM tools from Autodesk and Exactal Cost-X were applicable to the industry. The tools serve as an application platform for Malaysian government. This has been officially declared by the PWD on 25 February 2010[8]. As mentioned earlier, Autodesk has all four (4) features of BIM selection. Autodesk is an American multinational software corporation. It focuses on 3D design software for AEC industries[24]. Autodesk has produced many tools such as Revit Architectural, Revit Structural, and Revit MEP for construction players.

Exactel was established in October 2003 to develop an estimating tool for the construction industry, known as Cost-X. It focuses on estimating process and morespecifica lly, it is used to integrate the estimating process with CAD drawing files[25].

Figure 1 shows five (5) types of BIM tools recommended by the government to be applied toconstruction projects. They are Revit architecture, Revit structural, Revit MEP, Navisworks and Cost-X[8].

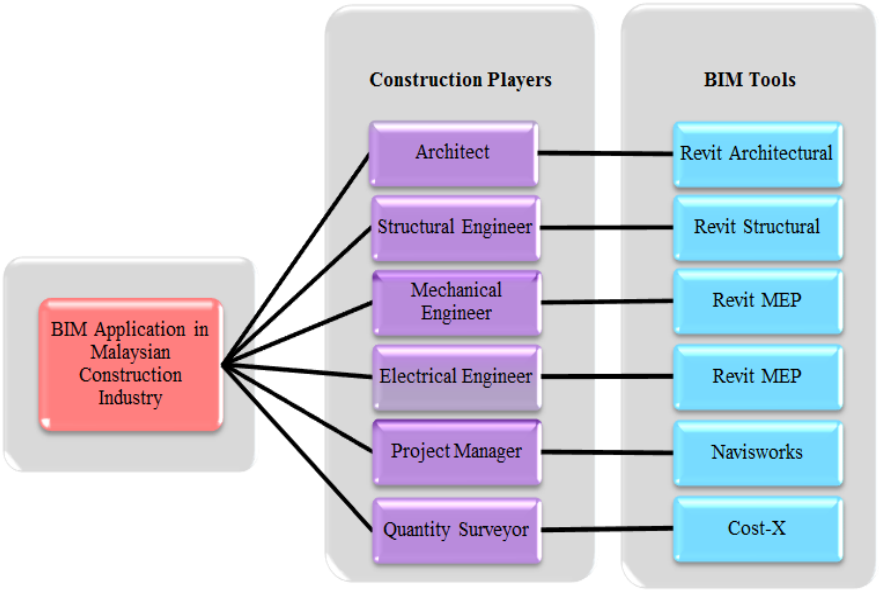


**Figure 1.** BIM tools suggested by PWD[8]

An architect uses Revit Architecture to design plans of every aspect of a building including walls, staircases, doors and roof[25]. Revit Structural allows structural engineers to perform structural design and analysis by modeling building using the basic components of walls and a foundation[26]. Meanwhile, Revit MEP can be used by mechanical engineers to develop a model of ducts, piping and to gain a betterunderstanding of HVAC zones[26]. On top of that, Revit MEP allows electrical engineers to model placement of light fixtures as well as to create circuits and wiring. All of these tools can be used to create drawings in 2 Dimension (2D) and 3D[26]. Moreover, project managers can use Autodesk Navisworks to create a multidiscipline model to simulate and optimize scheduling, identify and coordinate clashes as well as establish collaboration between contractors and design team, which consists of architects, structural engineers as well as mechanical, electrical and plumbing (MEP) engineers; this collaboration enables the team to gain insight into potential problems[26]. Furthermore, Cost-X tool can be used in construction cost estimating. It contains numerous additional features such as advanced viewing tool and unique revision tool to increase the speed of take-off process[25]. Advanced viewing tools use the transparent and filter mode to make model navigation quick and easy to review. Meanwhile, unique revision tool can identify changes in design and automatically update the quantities[25].

There are several companies in Malaysia that are associated with BIM by providing consultancy services, training, and also BIM tools to support BIM implementation in the construction industry[10][27][28]. The companies are Integrated Project Management Solution Sdn. Bhd. (IPMS) at Johor Bahru, Johor[10], Precision Design Solution Sdn. Bhd. (PDSSB), Petaling Jaya, Selangor[27] and Sunway Berhad, Petaling Jaya, Selangor[28].

## 5. Benefits of BIM

Implementing BIM in construction projects can overcome construction problems such as delay, clash of design and disputes between construction players.

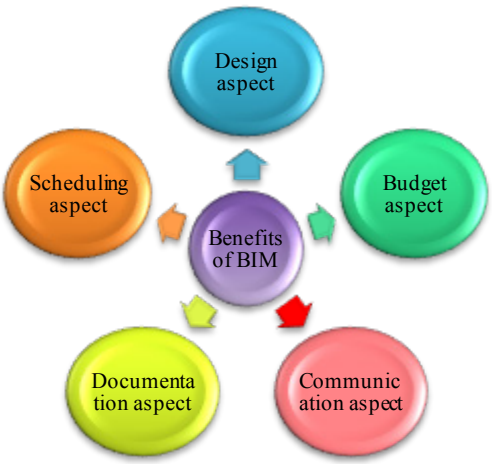


**Figure 2.** Benefits of BIM implementation[3][7][8]

Figure 2 shows five (5) main benefits of implementing BIM in construction projects. The benefits of implementing BIM in construction projects can be seen in each construction phase. The explanations of the benefits are as follows[3][7][8]:

i. BIM gives support to design, scheduling, and budgeting of built assets.

ii. BIM provides a platform to help architects initiate the process of evolutionary design.

iii. The speed of design can be increased when using the database provided by BIM tools as less communication with engineers is required.

iv. A visualization of the construction process through a

4D model greatly enhancesunderstanding of processes and helps to identify construction issues as well as possible problems in the building assets process.

v. The 4D BIM models allow demonstration of how a construction project would affect traffic flows, access and exit roads, public transport and storage of materials on site as well as, scheduling of machineries and personnel.

vi. BIM provides an effective way to improve design and documentation quality significantly.

vii. BIM saves 10% of contract value through clash detection.

viii. BIM helps to achieve 3% of cost estimationaccuracy.

ix. BIM reduces drawing coordination issues and conflict errors.

x. BIM reduces design conflict issues by integrating all key systems into the model.

xi. Design BIM systems can detect internal conflicts; model viewing systems can detect and highlight conflicts between models and other information imported into the viewer.

BIM in construction projects gives many benefits, and its implementation can increase the quality of projects[7]. Based on the benefits discussed, it is clear that BIM is useful in assisting construction players to construct small or high-risk projects successfully[7]. Moreover, through BIM, problems such as delay, increase in construction cost, accidents on construction sites and disputes between construction players can be reduced[2].

## 6. Conclusions

Implementing BIM in construction projects can lead to successful construction of projects. BIM does have a significant value to Malaysian government[8]. As a major client, the government needs to be an early adopter of BIM technology[19].

BIM application in construction projects can reduce waste and safety problems in construction, leading to completion of quality projects. Several BIM tools have been used in Malaysian construction industry for improving construction processes. BIM benefits construction projects by improving project schedule, detecting any clash during the design stage, decreasing construction cost and improving communication between construction players.

Implementing BIM in the construction industry can increase the overall quality of projects and improve image of the industry. Moreover, with the government's efforts, it is expected that BIM technology will be used more widely in construction projects in Malaysia.

## ACKNOWLEDGEMENTS

The authors would like to thank **Ministry of Education of Malaysia (MOE), office of Research, Innovation, Commercialization and Consultancy (ORICC), UTHM,** for supporting this research under the Exploratory Research Grant Scheme (Vote No. E029).

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