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# Building Information Modeling (BIM) Application in Construction Planning

Suzila Mohd
*Faculty of Technology Management and Business,*
*Universiti Tun Hussein Onn Malaysia (UTHM), Batu Pahat, Johor, Malaysia*
*suzilamohd@gmail.com*

Aryani Ahmad Latiffi
*Faculty of Technology Management and Business,*
*Universiti Tun Hussein Onn Malaysia (UTHM), Batu Pahat, Johor, Malaysia*
*aryani@uthm.edu.my*

## Abstract
Building information modeling (BIM) has been used in high-profile and complex projects in several countries such as America, United Kingdom (UK), China, Hong Kong, and Australia. Currently, BIM is also used by Architecture, Engineering and Construction (AEC) industry in Malaysia. It has been introduced to manage construction planning activities such as design, cost estimating and project scheduling. BIM utilization in construction planning can detect any clash analysis during design phase, improves project schedule, cost and quality of project as well as communication between construction players. This paper aims to explore BIM application in construction planning. A literature review explores previous BIM studies on definition of BIM, benefits, importance, barriers and BIM tools in construction planning. Furthermore, a semi-structured interview was made with client of the first Malaysian project using BIM. The interview reveals on necessities and benefits of implementing BIM in construction planning as well as challenges faced by the client in implementing BIM. BIM is necessary to construction planning because BIM can detect problems before and during construction phase. A critical analysis of the literature review and the interview results lead to a solid reason of showing the effectiveness of implementing BIM in construction planning. It also show that BIM in construction planning helps to reduce project delay, risk, cost overrun, clash analysis and disputes between construction players.

## Keywords
Application, Building Information Modeling (BIM), Construction planning, Construction projects

## 1. Introduction

Building Information Modeling (BIM) appears as a technology to improve performance and efficiency in managing construction projects (Azhar et al., 2012; Love et al., 2013). There is increasing implementation of BIM in construction planning in many countries including Malaysia. BIM in Malaysia was introduced by the Director of Public Work Department (PWD) in 2007, when Malaysian Government was aware of the ability of BIM in managing construction projects (Ahmad Latiffi et al., 2013; Jabatan Kerja Raya (JKR), 2013). BIM is an accurate virtual model used to manage construction projects in terms of design, cost estimating, project scheduling, construction and operation of facility (Azhar, 2011; Monteiro & Martins, 2013). BIM tools such as Revit, Bentley, Autodesk, Graphisoft and Exactal are used to assist construction players such as consultants and contractors in managing construction projects activities

(Eastman et al., 2011; Newman, 2013; Zhang et al., 2013). BIM detects design clashes and increase accuracy in cost estimating as well as project scheduling during pre-construction phase.

The first project in Malaysia that has successfully implemented BIM is the Multipurpose Hall of Universiti Tun Hussein Onn Malaysia (UTHM). The project was fully completed in 2012. Other projects involving BIM in Malaysia are the National Cancer Institute of Malaysia in Putrajaya, Ancasa Hotel in Pekan, Pahang and Educity Sport Complex in Nusajaya, Johor (Construction Research Institute of Malaysia (CREAM), 2012; Integrated Project Management Solution (IPMS), 2012; Ahmad Latiffi et al., 2013). BIM was utilized in those projects because the technology assisted in achieving better project planning.

Construction planning is important to avoid construction problems in construction projects. In construction planning, BIM has been implemented to detect potential problems that would lead to construction problems, such as design clashes, construction cost overrun, project delay and disputes among construction players (Furneaux & Kivvits, 2008; Cooke & Williams, 2009; Martins & Monteiro, 2012). As one of the activities in pre-construction phase, construction planning is an important activity to manage construction projects (Cooke & Williams, 2009; Azhar, 2011; Forbes & Ahmed, 2011). Azhar (2011) states that BIM implementation in construction projects is much better than conventional process because BIM application can detect potential problems as mentioned above, before construction phase.

There are five (5) types of BIM tools suggested by PWD in order to implement BIM in Malaysian construction projects as shown in Table 1.

**Table 1: BIM Tools Suggested by PWD (JKR, 2012; Ahmad Latiffi et al., 2013)**

| Construction Players | BIM Tools |
|---|---|
| Architect | Revit Architecture |
| Structural Engineer | Revit Structural |
| Mechanical, Electrical and Plumbing (MEP) Engineer | Revit MEP |
| Project Manager | Navisworks |
| Quantity Surveyor | Cost-X |

Table 1 shows five (5) types of BIM tools suggested by PWD namely Revit Architecture, Revit Structural, Revit MEP, Navisworks and Cost-X. The tools assist construction players such as architect, structural engineer, MEP engineer, project manager, and quantity surveyor to manage construction project activities. The tools are used to assist the construction players in producing better project documents (JKR, 2013; Ahmad Latiffi et al., 2013).

Although the implementation of BIM in construction projects has several benefits to construction projects, there are several barriers and challenges such as lack of BIM experts, contractual issue, and expensive cost for BIM tools adoption (Furneaux & Kivvits, 2008; Forbes & Ahmed, 2011; Eastman et al., 2011). Therefore, this paper discusses the first Malaysian project using BIM in construction planning.

## 2. Methodology

Literature review was conducted in order to gain information related to BIM such as on history, definitions, implementation in construction planning, tools, benefits, barriers, and challenges in implementing the technology in construction planning. Various sources were reviewed, such as books, journal articles, international conference papers and materials available on the Internet.

Moreover, a semi-structured interview was used as a method of data collection in order to identify BIM practices by respondent. The interview was conducted in face-to-face setting. The respondent was the client of Multipurpose Hall, UTHM project which was located in southern area of Malaysia. The client was the Deputy Director of Facilities Management and Property (FMP) in Property Management and Development Office, UTHM. The project was the client's first experience with BIM. The client was responsible to monitor the whole project development.

All data obtained from the interview was analyzed using content analysis. The content analysis viewed data representation through texts, images, and expressions (Krippendorff, 2004). Next section discusses the results and findings from the interview.

## 3. Results and Findings

### 3.1 Multipurpose Hall of UTHM

The construction of Multipurpose Hall of UTHM was fully completed in August, 2012. The hall is situated at UTHM, Batu Pahat, Johor, Malaysia. The purpose of constructing this hall is to replace the old UTHM hall (known as Tunku Ibrahim Ismail Hall) to support main events held in UTHM every year, such as convocation, Service Excellent Award, and PALAPES Royal Cadets commissioning ceremony. The Hall is also used as an examination hall to overcome lack of examination halls. This is because the existing examination halls are not enough to accommodate the increasing number of students in UTHM every year. The Multipurpose Hall of UTHM can accommodate at least 3000 people in an event. Brief project details are as follows:

- Project cost: RM 37,261,396.20 (MYR)
- Project schedule: 2 years
- Contract type: Fast track design and build
- Client: Universiti Tun Hussein Onn (UTHM) Malaysia.
- Main Contractor: Hamidah Fazila Sdn. Bhd., Skudai, Johor.
- BIM Consultant: Integrated Project Management Solution (IPMS) Sdn. Bhd., Johor Bahru, Johor.
- BIM Elements: Design coordination, clash analysis, and site coordination

(a) (b) (c)

Figure 1: Photo of Multipurpose Hall of UTHM

Photo (a) and (b) in Figure 1 show the outside views of the hall and photo (c) shows the inside view of the hall. At the beginning, the client planned to use conventional process without implementing BIM. However, the contractor offered the client to implement BIM in the project without additional cost. The contractor presented the 3-dimensional (3D) design model for the project and convinced the client to implement BIM. The client was satisfied and agreed to implement BIM without changing the contract

content. The collaboration between the contractor and client also improved the communication and trust between them.

In the project, BIM was used to design the whole building elements such as architectural, structural and MEP. Revit and Naviswork were chosen as BIM tools for the project and they were used for design process. According to the respondent, the critical design process in the project was to design roof and structure. Roof design of the hall is shown in photo (a) and (b) in Figure 1.

### 3.1.1 Roof Design and Structure

The Multipurpose Hall was designed according to the eagle bird concept. The roof has a unique design and needs a proper planning to avoid structure connection problem. The implementation of BIM in the project produced almost 100 % accuracy in detail drawings. The architect and structure engineer used Revit and Naviswork to design the roof, structure, detect all the design clashes in structure design and detect all the design clashes in MEP designs. Therefore, the entire roof structural connections were accurate and thus reduced the roof installation timeframe during construction phase. The tools also reduced redundant works during construction phase because BIM already produced accuracy in detail drawing during pre-construction phase.

According to the respondent, in the project, BIM also reduced Requests for Information (RFI) during construction phase. RFI is a process to gather information on confirmation of the interpretation of a detail and specification on the construction drawing during construction phase from the architect or client to get permission to continue work. The respondent also stated that BIM application in the project helped detect potential problems before construction phase.

## 3.2 Understanding on BIM

The respondent also stated that, BIM is a new technology to manage the whole process starting from pre-construction phase, construction phase, and post-construction phase. The respondent explained that with the 3D visualization, everyone can easily understand the percentage of work progress presented by project manager even though they did not have any technical background. The 3D visualization also helped the client to easily understand the weekly and monthly construction work progress. Moreover, client can also visualize the construction work progress on site using BIM without the need to visit the construction site. The respondent also argued that BIM reduced redundant work during construction phase because all the design clashes had been eliminated. The respondent also agreed that the detection of design clashes during pre-construction phase had avoided project delay and reduced construction cost.

## 3.3 Benefits of BIM Implementation in Construction Planning

According to the respondent, BIM implementation in the project had cut the time for roof installation because during pre-construction phase, all the clashes in structure design had been detected and adjusted. Construction works for the project only took eight (8) months to complete unlike similar hall developments in Malaysian construction industry that took longer duration. The time was shorter than planned because all design clashes has been eliminated during pre-construction phase.

The respondent also mentioned that BIM implementation in construction planning had reduced work redundancy such as MEP ductwork design adjustment during construction phase thus avoiding project delay. Moreover, the implementation of BIM in the project also increased the name and image of the main contractor and BIM consultant involved. Lack of BIM experts in the Malaysian construction industry provided the opportunities for them to increase their image as BIM experts.

### 3.4 Barriers and Challenges in Implementing BIM

BIM barriers and challenges can be divided into three (3) interrelated issues which are skill issue, contractual or legal issue and cost to adopt BIM tools (Furneaux & Kivvits, 2008; Forbes & Ahmed, 2011; Eastman et al., 2011). For skill issue and cost to adopt BIM tools, the company needs to incur double cost to send workers to attend BIM training and to buy the tools. The cost to adopt BIM tools such as Bentley system, Tekla, Cost-X and Navisworks is high and proper training is required to use them. The cost for BIM training itself is high, besides time constraints to attend such training. For contractual issue or legal issue, there is a question on will control the entry of data into project model and who will be responsible for any inaccuracies.

In Malaysia, the implementation of BIM in construction projects is still new. In the interview, the respondent explained that even though the project had been completed almost a year ago, BIM adoption in Malaysia is still much slower than anticipated because of those three (3) issues.

Moreover, the respondent was also aware that BIM implementation gives many benefits to construction projects. The respondent stated that barriers and challenges in implementing BIM can be avoided with encouragement from the Government. This effort can be done by reducing tax or by giving tax exemption for construction players adopting BIM tools to encourage construction companies, especially small and medium-sized companies, to implement BIM in construction projects.

## 4. Conclusion and Further Works

BIM is an emerging innovative technology to manage construction projects. The performance of construction projects will be greatly improved by adopting BIM in construction planning. BIM reduces cost overrun, produces better time management and accelerates as well as improves construction player's relationships.

The first Malaysian project that implemented BIM, the construction of Multipurpose Hall of UTHM showed that, the technology increased accuracy in roof structural connection, and reduced timeframe for roof installation and additional rework on detailed drawing. In addition to that, BIM also improved the communication and collaboration between client and contractor. The implementation of BIM in construction projects can be increased with the encouragement from the Government. BIM has to be put as one of the conditions in project tender documentation to encourage the construction players to implement BIM.

BIM implementation in the Malaysian construction industry can increase projects quality and improve the image of the industry. Therefore, more interviews with other construction players involved in BIM will be made to gain more information on how they have practiced BIM in their projects.

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