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# BIM Application in the Construction Industry

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**Abstract** - Building Information Modelling (BIM) is a relatively new 3-dimensional technology used in the construction industry. While many research has been done to harness its potential, most have been focused on the inter-operability. This paper serves to find ways to improve the Singapore BIM guidelines via evaluation and comparison with other nations' BIM guidelines. In particular, Hong Kong will be the first nation to be evaluated due to its similarity with Singapore. This paper will also look at a project to improve site productivity via an induction course for contractors. The results show some possible suggestions to improve the workflows and standards for both Singapore and Hong Kong. As for the induction course, more research was deemed necessary and administrative issues proved to be an obstacle. This research is neither definitive nor conclusive; it acts as a platform and will be used as background research for the longer-term investigation.

Keywords - Building information Modelling (BIM); guidelines; productivity

## 1 INTRODUCTION

### 1.1 BACKGROUND

Digital modelling has been developed over various industries, such as manufacturing and electronics. The construction industry soon recognized that 3 dimensional (3D) modelling is not a religious belief, but rather a practical business decision. It adopted this new technology, termed as Building Information Modelling (BIM).

BIM is a complex technology; powerful for structural analysis, design and specifications. It involves the creation and usage of a 3D model to inform and communicate project decisions. When completed, the model contains precise and accurate information necessary for the construction, fabrication, and procurement phase through which the building is realised.

### 1.2 LITERATURE REVIEW

As of today, BIM has reaped the benefits of great progress in engineering design quality, and improvement in labour productivity. Companies that have used BIM also reported benefits for estimation and risk analysis, scheduling, improved collaborative processes and better facility management. With the ability to absorb last minute changes and produce accurate drawings quickly with minimal rework, the

costs of rework due to error has also had been minimal. Furthermore there will be support for automation in production, and significant reduction in engineering lead time.

Yet, despite its benefits, there remains several obstacles to be overcome and more knowledge to be exploited.

Firstly, it has been noted that there is a lack of adequate inter-operability between BIM software tools. While some have not been integrated with the BIM tool, there are those which have been integrated but does not support local standard codes. Today, much research has been focused on providing 3D modeling software and achieving inter-operability between various applications.

Secondly, the costs of adopting BIM technology are relatively high. The small pool of talent skilled in both BIM and structural engineering means additional training cost. Moreover, much investment will go into the setup of templates and component libraries and for software purchase. In Singapore, the Building & Construction Authority (BCA) has been promoting BIM adoption. It is providing training services at its academy and setting up funds to help firms incorporate the new technology into their work processes to improve productivity.

Thirdly, new workflows and standards are needed to better exploit BIM tools. The paradigm shift from the 2D computer aided drafting (CAD) to the 3D BIM requires vast changes in terms of human resources, work practices, and skills. This has to be integrated with leadership as well as careful planning. Strategies for the adoption phase will be crucial, requiring constant inspections to enable benchmarking process. For a start, basic modelling skills should be honed before attempting to use BIM for enhancing productivity. Structural analysis can be ventured in the later stages of its adoption.

### 1.3 OBJECTIVES

Research about BIM technology and its application covers a large scope and depth. Many of the previous and current researches are concerned with the inter-operability between various applications, as well as cost cutting measures to encourage BIM adoption. On the contrary, lesser research have assessed the types of workflows and standards in the adoption and application of BIM technology.

The primary focus of this research paper will be on the BIM guidelines that have been adopted by other countries. An analysis is made to evaluate and compare the workflows and standards of the Singapore BIM guidelines with the Hong Kong BIM guidelines. By understanding how the new technology is integrated into the construction industry, this paper aims to provide suggestions to improve the Singapore BIM guidelines.

In addition, this paper aims to investigate ways to improve site productivity. More specifically, it will look at the design of a course and facilities to link the main contractors, MEP sub-contractors and fabricators, with the skill of taking BIM from design to fabrication and installation in order to improve productivity.

## 2 METHODOLOGY

### 2.1 BIM GUIDELINES COMPARISON

3D modelling is a relatively new technology in the construction industry. The United Kingdom, the United States of America, China and Hong Kong are amongst a few that stand out as the leading nations in its adoption. While the technology adopted is similar across the nations, it is their workflows and standards that make them stand out. As we seek to improve our workflows and standards for BIM, we intend to benchmark with these leading nations and learn from their greater wealth of knowledge and experience.

The closest leading nation geographically to Singapore is Hong Kong. Not only is Hong Kong similar to Singapore in terms of its limited land space; the use of high rise buildings for public housing is also a common identity between the two nations. This is due to both nations having high population density. In fact, many of Singapore's systems, such as the mass rapid transport and public housing, are similar to that of Hong Kong. Thus, Hong Kong's BIM guidelines were selected to be the first nation BIM guidelines to be evaluated and compared to the Singapore BIM guidelines.

Based on the resources available, the workflows and standards were evaluated and compared using the categories as follow:

- Project Start-up
- Templates
- Project Folder Structure
- Design Coordination
- Inter-operability

### 2.2 INDUCTION COURSE TO IMPROVE SITE PRODUCTIVITY

Nanyang Technological University (NTU) has partnered Building and Construction Authority (BCA), with the assistance of BIM Solution Center (BIMSC) in

the NTU - Center of Excellence (CoE) MEP Project. The project aims to bring the design model through fabrication and finally to installation in order to improve the site productivity.

- Set up a training course on BIM based modelling, coordination, shop drawing production, pre-fabrication and installation using laser layout method
- Set up of a training facility to support computer based and hands-on fabrication and installation training
- Teaching course on the various MEP trades (HVAC, Plumbing and Fire Protection Systems)
- Conduct a live pilot project with MEP contractor and sub-contractors
- Training for members

Laser scanning technology is used to scan the completed installations, and verify with the design model for accuracy of design intend, testing the effectiveness of using BIM for productivity enhancement.

The following are the recommended Key Performance Index (KPI):

- Time reduction for shop drawing production and approval process
- Time reduction from Design to Production to Installation
- Reduction of wastage due to BIM based coordination and shop drawing production

## 3 RESULTS AND DISCUSSION

### 3.1 BIM GUIDELINES COMPARISON

The BIM guidelines of Singapore and Hong Kong were evaluated as shown in table 1.

Table 1 BIM guidelines comparison between Singapore and Hong Kong

	Singapore	Hong Kong
1. Project Start-up		
a. Architectural model as a Base model	Yes	Yes
b. Setup of a project team & assigning responsibilities	Yes	Yes
c. Deliverables	Conceptual, Preliminary, and Detailed Design	Level of details for models
d. Timeline	Stage by stage allocation	Not mentioned in details
2. Template		
a. Dimension & Leader Styles	Yes	Yes

b. Standard drawing paper size & layout	Yes	Yes
c. Schedules	Yes	Not mentioned in details
3. Project Folder Structure		
a. Central Server - connects multiple local server	Yes	Yes
b. Local Server - silently request updated info from central server	Yes	No
c. Saving of data	Only save in local server	Save to central server, which has backup and disaster recovery facilities
4. Design Coordination		
a. Use common platform (tools and version) and ensure fit for coordination of data	Yes	Yes
b. Project reference (site and model)	Use Project Review Tool to ensure common location and orientation	Use Project North (coordinates & elevation)
c. Colour code for each trade	Yes	Yes
d. File naming conventions	Yes	Yes
e. Individual disciplines create own model and copy to shared folder	Yes	Yes
f. Coordination check & clash detection	Plan and have sharing between project members, and coordination to resolve conflict upfront	BIM coordinator generates the clash report, and notifies project team
5. Inter-operability		
a. Transfer CAD to Revit	Create site model and implement modelling plan	Not mentioned in details
b. Transfer Revit to CAD	Part models as individual files (zones, levels, discipline)	Views (2D/3D) or sheets, with range and layer selection
c. Import - Can explode to elements - No auto update of changes to cross reference file	Yes	Yes
d. Link - Cannot explode to elements - Auto update of changes to cross reference file	Yes	Yes

From the above tables, it can be noted that Singapore and Hong Kong do indeed have many similarities in the BIM guidelines.

Some notable ways which can improve the Singapore BIM guidelines include:

- At the early stage of the project, consider the level of details necessary for model design
- As the project progresses, save the project to the Central Server to avoid loss of data
- At the ending stage, consider the prospect of a BIM Coordinator

As for the Hong Kong BIM guidelines, the following can be noted for improvement:

- Provide sample timeline for the various phases from design stage up to tender
- Automatic update of information from Central server to Local server to improve productivity
- Begin coordination check within the project team from the beginning, to resolve conflicts upfront

Although the full details in which how each country's industry obliged by the guidelines are not scrutinized, this comparison serves as a base for future study.

### 3.2 INDUCTION COURSE TO IMPROVE SITE PRODUCTIVITY

The project outcomes are listed as follow:

- Course outline and sample materials developed
- Training facility designed & sites identified for training facility setup
- Sponsors, consultants and potential trainees identified

The live project with the MEP contractor and sub-contractors and practical training were, however, uneventful. More research was necessary and administrative issues proved to be an obstacle. This project has since been put on hold as a project for the not too distant future.

## 4 CONCLUSION

The objective of this paper is to benchmark with the leading nations in BIM adoption, thereby improving the Singapore BIM guidelines, as well as to develop a course to improve site productivity.

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On the other hand, there was no practical result, in terms of the KPI, from the induction course to improve site productivity.

This research is neither definitive nor conclusive; it acts as a platform and will be used as background research for the longer-term investigation. This paper has considered only one other nation (Hong Kong) to evaluate and compare with reference to the Singapore BIM guidelines. Other countries, such as The United Kingdom, the United States of America, and China, can and should be further studied upon. Furthermore, other pointers such as details in design stage for the various disciplines can be researched.

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