

A Propose Study of Developing Building Information Modelling (BIM) Framework in the Malaysian Construction Industry

Yaakob, M., Nawi, M. N. M., Ibrahim, A., and Hanafi, M. H.

Universiti Utara Malaysia (UUM), Malaysia, {mazri, amlus}@uum.edu.my, {nasrun, hanizun}@gmail.com

ABSTRACT

Currently, construction industry becomes more innovative, competitive and complex, more participants are involved in projects and thus, more integrated collaboration is needed especially during the design phase of the construction life cycle process. Accordingly, the construction industry especially the developing country including Malaysia has been urged to use innovative construction techniques, and to shift from the traditional practice of project delivery to an integrated practice. Unfortunately, most of the current construction project developments especially in Malaysia are still based on the traditional construction process approach; fragmented and separation of the design and construction phase. This fragmented practice has been widely criticised due to the related problems such as reworks, time delay, rising costs, lack of communication and coordination, and wastages. This paper aims to highlight this fragmentation issue and discuss the definition, concept and potential of Building Information Modeling (BIM) as an integrated tool that can minimise the issue. Further, the discussion of research process on how to develop a framework of BIM implementation in Malaysian will be concluded.

Keywords: Building Information Modelling (BIM), framework, construction industry.

I INTRODUCTION

Nowadays, the reinvention of matters and processes on a daily basis has been decreased due to the lack of knowledge sharing, which was inhibited by the clashes of traditional methodologies (e.g. business models, processes, legal and compensation schemes, etc.) and multi-disciplinary team in organisations. Furthermore, the fragmentation and calcified processes inhibit widespread change in the building industry, which is also traditionally disconnected from life cycle evolution methods. Hence, the pressure to provide value for money and sustainable infrastructure etc. in building industry atmosphere generate the adaptation of Building Information Modelling (BIM) technology. BIM is a lifecycle

evaluation concept seeks to integrate processes throughout the entire life cycle of a construction project. BIM incorporate a methodology based around the notion of collaboration between stakeholders using Information Communication Technology (ICT) to exchange valuable information throughout the lifecycle. To date, there are many projects that have utilized BIM systems; such projects have recommended BIM systems as a remedy to address low productivity issues. In some states such as Finland, Denmark, Norway and USA, the use of BIM has been endorsed, while some other states have progressed toward it. The realization of the benefits of BIM is contingent upon a proper implementation of BIM at an organisational level and its integration at the industry level. Therefore, the main objective of this research is to develop the framework or roadmap for implementation of BIM in the Malaysia learned from the UK construction industry. In order to achieve these objectives, a research methodology employing qualitative and quantitative techniques (mix method). It is hoped that the research finding will be able to pave a solid foundation for organisations to make informed decisions in BIM adaptation within the overall organisation structure. Later, the construction can be demonstrated for more sustainable products, compared with non-BIM usage.

II PROBLEM STATEMENT

This research is inspired with two issues:
1) Streamline adaptation the benefit of BIM technology
2) Current state of BIM realization and the readiness

The building industry is under pressure to provide value for money, sustainable design and construction, etc. and this has propelled the adoption of Building Information Modeling (BIM) technology, which transforms the paradigm of the construction industry from 2D based drawing information systems to 3D object based information systems (Mihindu and Arayici, 2008). It changes the base documentation used in building design and construction to a new representation that are machine readable for automation as opposed to human readable for manual conducts (Smith and

Tardif, 2009). Therefore, BIM adoption is becoming an increasingly important matter for the construction industry that has been facing barriers and challenges to increase productivity, efficiency and quality to create sustainable development.

On the other hand, there are challenges in implementing BIM such as (Eastman et al., 2008; Arayici et al., 2009a; Arayici et al., 2009b):

- a. Overcoming the resistance to change, and getting people to understand the potential and the value of BIM over 2D drafting;
- b. Adapting existing workflows to lean oriented processes;
- c. Training people in BIM, or finding employees who understand BIM;
- d. The understanding of the required high-end hardware resources and networking facilities to run BIM applications and tools efficiently;
- e. The required collaboration, integration and interoperability between the structural and the MEP designers/engineers;
- f. Clear understanding of the responsibilities of different stakeholders in the new process by construction lawyers and insurers.

Hence, implementing BIM effectively requires significant changes in the way construction business work at almost every level within a building process. BIM technology implementation not only requires learning new software applications, but also requires the knowledge of how to reinvent the workflow, how to train staff and assign responsibilities, and the way of modelling the construction (Bernstein and Pittman, 2004; Eastman et al., 2008). Thus, it appears that the Malaysian construction industry could benefit from a development of roadmap for implementation of BIM learned from the UK strategy. The roadmap has been formulated by the UK construction industry originally learned from the Finland in order to establish the best practice maturity model. This idea was referring to Finland as the world leader in BIM implementation which has 108 projects (TEKES, 2008). Apparently, they have a clear vision of BIM implementation at operational levels.

III LITERATURE REVIEW

Starting a couple of decades ago and still ongoing, much research been conducted all over the world to facilitate or even to solve the problems of fragmentation in construction (Nawi et al., 2014). As highlighted earlier, many researchers and construction industry practitioners dealing with fragmentation of construction would agree that integrated practice could solve many problems within construction and much effort has been

applied to explore in depth on how it could really be applied and other potential benefits that it could bring to the industry (Nawi et al., 2012). Therefore, many approaches and concepts have been introduced to support integrated practice in construction like as concurrent engineering (Anumba et al, 1998; Love and Gunasekaran,1997), web based project management (Anumba et al, 2008; Alshawi and Ingirige, 2003), partnering (Bresnen and Marshall, 2000; Barlow et. al, (1997), Building Information Modelling (Nursal al., 2014; Eastman et al., 2008; Sacks et. al., 2005; Howard and Bjork, 2007), 4D modelling (Fischer, 2001; Heesom and Mahdjoubi, 2004), nD modelling (Aouad et al., 2007; Lee, 2002) and Integrated Project Delivery (AIA, 2007). This paper however will discuss on the development of BIM as part of the efforts for overcoming the issue of fragmentation in the construction industry.

BIM is defined as a multi-dimensional tool. It involves managing of data by generating a visual model of the building at the early stage of project (i.e. design stage), throughout the construction phase and during its working life. The concept of BIM has existed since the 1970s (Eastman et al., 1974; Eastman et al., 2011). The term Building Information Model first appeared in a 1992 paper by G.A. van Nederveen and F. P. Tolman (Van Nederveen and Tolman, 1992).

In the traditional building design process, industry norm practice was largely reliant upon two-dimensional drawings (plans, elevations, sections, etc.). However, BIM covers more than just geometry of product or process by extending this beyond 3D, augmenting the three primary spatial dimensions (width, height and depth) with time as the fourth dimension (4D) and cost as the fifth (5D), etc. (Wikipedia, 2014). It also covers spatial relationships, light analysis, geographic information, and quantities and properties of building components (for example, manufacturers' details). In addition, BIM is a new tool and platform for project stakeholders seem to be able design and construct almost anything they can visualize, and the data they use enables these buildings to be well managed by their owners (Nawi et al., 2013). Architect, engineer, contractor, developer, client and manufacturer are also working together more closely than ever towards fully integrated team.

In the white paper by Autodesk the implementation of BIM could potentially reduce the construction cost. Manning and Messner (2008) identified that sections, perspectives, plan views and quantity take offs could quickly (in many cases automatically) be

updated to effectively ascertain potential costs. Another way BIM could reduce construction cost is by having minimum change order during project execution. As highlighted by Khanzode et al., (2008), there are zero change orders related to field conflicts on the case study project.

IV METHODOLOGY

This paper is part of an on-going research on the fragmentation issue that affect to the implementation of the construction industry in Malaysia. The information presented in it is primarily based on the review of available relevant literature materials on the system. A literature review, considered by many as part of research methodology, is essential in organizing theoretical framework, developing a pertinent problem statement and research questions, and forming conjectures before formulating hypotheses to be tested. In this regard, Wisconsin (2008) has aptly opined that a thorough literature review is a “critical analysis of a segment of a published body of knowledge through summary, classification, and comparison of prior research studies, reviews of literature, and theoretical articles.” This is precisely what this paper intends to present.

Through the literature review, the definition, concept, application, and related issues of fragmentation and Building Information Modelling (BIM) in the construction industry is examined and highlighted. All the data and information gathered directly from libraries, books, articles and other printed materials searched in the international and national journals, proceeding and bulletin.

As has been mentioned in the previous section, in order to capture the roadmap which has been formulated by the UK construction industry, extensive literature review and interviews with the developers will be conducted to obtain the in-depth understanding about the BIM roadmap for solutions against a lot of challenges, barriers and strategies. The interviews will be carried out in an unstructured manner via Skype platform, as each company and institution had a unique experience of BIM and various viewpoints on their activities. The unstructured approach to the interviews will be adopted in order to capture their uniqueness as well as commonalities in their BIM matters. However, all the interviews had the same aim and goal, which are to understand their view and strategies for BIM use and implementation in practice (Khosrowshahi and Arayici, 2012). Then, the quantitative method of data gathering and analysis of Malaysian’s status will be conducted towards proposing the BIM implementation strategies that are believed will

enhance the BIM adoption and implementation efficiently. Hence, series of interviews will be held among the focus group who involved in construction. The information of the focus group is retrieved from Construction Industry Development Board (CIDB) Malaysia. However, the major problem among this focus group is to find perfect date to gather everyone, thus the implementation should be narrowed into several series.

Accordingly, the research methodology will be divided into 4 stages:

A. Preliminary Study and Literature Review

The first stage involves the gathering of related literature from existing publication: books, journals, theses, reports and the internet; upon which to establish contextual setting for a systematic approach towards developing an effective BIM roadmap as well as providing an overview of the research questions, issues and problems. The literature review involves understanding of the comprehensive and existing models roadmap which has been developed to respond the particular circumstances.

B. Pilot Study and Case Studies

This stage include the gathering of primary and secondary data. The methods of gathering data is through observation, interviews and distributing questionnaires. The pilot study will identify specific issues and problems faced during the process and will be the basis for review, checklist and fine tuning for the study. Both approaches namely qualitative and quantitative are vital towards developing BIM maturity framework, concept map, validating a proposed BIM roadmap.

C. Data analysis

The data will be analysed by using descriptive analysis based on the observation, qualitative and quantitative methodology approach. An effective roadmap for implementation of BIM will be produced to respond the current environment in the Malaysian construction industry.

D. Implementation

The effective BIM roadmap will be aired and identifying the current state of organisation readiness in the Malaysian construction industry. Then, the data will be analysed by using descriptive analysis based on the quantitative methodology approach.

V RESEARCH PLAN

In order to capture the roadmap which has been formulated by the UK construction industry, extensive literature review and interviews with the developers will be conducted to obtain the in-depth understanding about the BIM roadmap for solutions against a lot of challenges, barriers and strategies. The interviews will be carried out in an unstructured manner via Skype platform, as each company and institution had a unique experience of BIM and various viewpoints on their activities. The unstructured approach to the interviews will be adopted in order to capture their uniqueness as well as commonalities in their BIM matters. However, all the interviews had the same aim and goal, which are to understand their view and strategies for BIM use and implementation in practice (Khosrowshahi and Arayici, 2012). Then, the quantitative method of data gathering and analysis of Malaysian's status will be conducted towards proposing the BIM implementation strategies that are believed will enhance the BIM adoption and implementation efficiently. In order to guide this research to achieve its intended objectives, the following research questions have been formulated:

- What is the current state of BIM realisation and readiness of Malaysian construction organisations in implementing BIM?
- What are the main factors that will influence Malaysian construction organisations to adapt and change towards BIM implementation?
- Where could a developed and validated business model strategy for the Malaysian construction industry be adopted and streamlined into the overall BIM roadmap?

As shown in Figure 1, the research consists of a number of stages. Initially, literature review will establish the contextual setting by identifying the drivers and barriers of BIM implementation. A series of interviews will be conducted of the case in UK via Skype Platform with the developers in UK. Then, the questions will be designed to elicit the opinion of experts about the industry and not just their own organization. The product of this exercise will be a concept map that reflects the case in Malaysia. Finally, the qualitative approach will be conducted in order to validate the roadmap which has been developed before.

Figure 1: Research plan

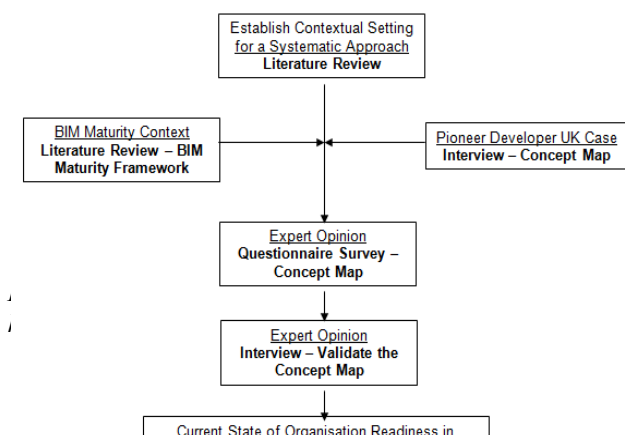
The research output is in a form of a strategies and guidelines for the effectively implement of BIM in the Malaysian construction industry. The roadmap formulated by the UK construction industry based on the experience gained by the stakeholders in Finland will be referred.

VI CONCLUSION

As a conclusion, it could be summarized that there is an urgent need for a paradigm shift within the current design construction practice especially in the Malaysian construction industry. As has been discussed earlier, majority of the construction project are still practicing the traditional construction project delivery practice in which generated many problems associated with fragmentation, such as; isolation of professionals, lack of co-ordination between design and construction, and as it is carried out in a sequential manner. It is recommended that construction lifecycle process should involve the adoption of new business strategies, with the aims of integrating the functional disciplines at the early stages of project. This paper also discussed and suggested that by implementing an integrated approach in design and construction, the fragmentation gaps could be minimised as well. Therefore, it shows that Building Information Modeling (BIM) is a highly effective to brings together various skills and knowledge, and removes the traditional barriers towards an effective and efficiency delivery of the project. These strategies indirectly hinder the result in scheduling problems, delays and disputes during the construction process, and, hence, harm the overall project performance.

REFERENCES

- AIA California Council (2007) Integrated Project Delivery: A Working Definition. Available at: <http://www.ipd-ca.net/images/Integrated%20Project%20Delivery%20Definition.pdf> [Accessed: 3February 2011].
- Alshawi, M. and Ingirige, B. (2003). Web-enabled project management: an emerging paradigm in construction. *Automation in Construction*, Vol.12, pp 349-64
- Anumba, C.J., Cutting-Decelle A.F., Baldwin A.N., Dufan J., Mommesin M., and Bouchlaghem D. (1998). Intergration of Product and Process Models as a keystone of Concurrent



- Engineering: the ProMICE project. *Proceeding of ECPPM 98: Product and Process Modelling in the Building Industry* pp9-19
- Anumba, C.J., Cutting-Decelle A.F., Baldwin A.N., Dufan J., Mommessin M., and Bouchlaghem D. (1998). Intergration of Product and Process Models as a keystone of Concurrent Engineering: the ProMICE project. *Proceeding of ECPPM 98: Product and Process Modelling in the Building Industry* pp9-19
- Anumba, C.J., Pan, J., Issa, R.R.A., and Mutis, I.(2008). Collaborative project Information Management in a Semantic Web Environment. Vol 15 Issue 1 pg. 78-94
- Aouad, G. , Lee, A., and Wu, S. (2007). *Constructing the future : nD modelling*. Taylor and Francis, London and New York (2007)
- Arayici, Y., Coates, P. Koskela, L., Kagioglou, M., Usher, C. & O'Reilly, K. (2009b). BIM Implementation for An Architectural Practice. Managing Construction for Tomorrow International Conference. October 2009. Istanbul. Turkey.
- Arayici, Y., Khosrowshahi, Y., Ponting, A.M., Mihindu, S. (2009a). Towards Implementation of Building Information Modeling in the Construction Industry. 5th International Conference on Construction in the 21st Century (CITC-V). Collaboration and Integration in Engineering, Management and Technology. May 20-22, 2009. Istanbul. Turkey
- Barlow, J., Cohen, M., Jashapara, A., and Simpson, Y. (1997). Towards Positive Partnering. *The Policy Press*, Bristol.
- Bernstein, P.G. and Pittman, J.H. (2004). Barriers to the Adoption of Building Information Modeling in the Building Industry. Autodesk Building Solution. White Paper.
- Bresnen, M., and Marshall, N. (2000). Partnering in construction: a critical review of issues, problems and dilemmas. *Construction Management and Economics*, Vol. 18 No.2, pp.229-3
- Eastman, Charles; Fisher, David; Lafue, Gilles; Lividini, Joseph; Stoker, Douglas; Yessios, Christos (September 1974). *An Outline of the Building Description System*. Institute of Physical Planning, Carnegie-Mellon University.
- Eastman, C., P. Teicholz, et al. (2011). *BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers and Contractors*. Hoboken, New Jersey, Wiley.
- Eastman, C., Teicholz, P., Sacks, R., and Liston, K.,(2008). *BIM Handbook : A Guide to Building Information Modelling for Owner, Managers, Designers, Engineers, and Contractors*. John Wiley and Sons, Inc. New Jersey
- Eastman, C., Teicholz, P., Sacks,R. & Liston, K. (2008). BIM Handbook: A Guide to Building Information Modeling. Canada: John Wiley & Sons
- Fischer, M., (2001). 4D modeling: building better by building virtually first. available at: ww10.ececafe.com/(accessed 25 Jun 2009).
- Heesom, D., and Mahdjoubi, L., (2004). Trends of 4D CAD applications for construction planning. *Construction Management and Economics* 22 (Feb 2004) 171-182
- Howard, R., and Bjork, B.C., (2008). Building Information Modelling: Experts' Views on Standardisation and Industry Deployment. *Advanced Engineering Informatics* 22, 271-280
- Jordani, D. (2008). BIM: A Healthy Disruption to a Fragmented and Broken Process. *Journal of Building Information Modeling*. Spring 2008. Matrix Group Publishing, Houston
- Khanzode et al (2008) Benefits and Lesson Learned of Implementing Virtual of design and construction technologies for coordination of mechanical, electrical and plumbing system on a large healthcare project, *ITcon*, 13, 325.
- Khosrowshahi, F and Arayici, Y. (2012). Roadmap for Implementation of BIM in the UK Construction Industry. *Journal of Engineering, Construction and Architectural Management*. Vol. 19(6). pp. 610-635
- Koo, B., and Fischer, M., (2000). Feasibility study of 4D in commercial construction. *Journal of Construction Engineering and Management* pg. 251- 260 (July-August)
- Kymmel, W. (2008). *Building Information Modeling: Planning and Managing Construction Projects with 4D CAD and Simulations*. The Mc-Graw Hill Companies
- Lee, A. (2002) *The Development of a Project Process Evaluation (PPE) Framework that Aims to Measure the Effectiveness of Implementing a New Design and Construction Project Process*, PhD Thesis, University of Salford, UK.
- Love, P. E. D., and Gunasekaran, A., (1997). Concurrent Engineering in the Construction Industry. *Concurrent Engineering*, Vol. 5, No. 2, 155-162 (1997)
- Manning, R., and Messner., J.I., (2008). Case Studies in BIM Implementation for Programming of Healthcare Facilities. *ITcon* Vol. 13 pg. 446
- Marshall-Ponting, A.J., and Aouad, G., (2005). An nD Modelling Approach to Improve Communication Processes for Construction. *Automation in Construction* 14, 311-321
- McKinney, K., and Fischer, M. (1998). Generating, Evaluating and visualization Construction Schedules with CAD tools. *Automation in Construction* 443-447
- Mihindu, S. and Arayici, Y. (2008). Digital Construction through BIM Systems Will Drive the Re-Engineering of Construction Business Practices. 2008 International Conference Visualisation, IEEE Computer Society, CA, ISBN 978-0-7695-3271-4,P29-34
- Nawi, M. N. M., Lee, A., Azman, M.N.A., and Kamar, K.A.M., (2014) Fragmentation Issue in Malaysian Industrialised Building System (IBS) Projects. *Journal of Engineering Science & Technology (JESTEC)*, Vol. 9(1), 97-106.
- Nawi, M. N. M., Haron, A.T., Omar, M.F., and Ibrahim, S.H., (2013). Building Information Modelling (BIM): An integrated Practice in Malaysian Industrialised Building System (IBS) Perspective, The 3rd International Building Control Conference (IBCC 2013), November 21st, 2013. K. Lumpur, Malaysia, ISBN 9789675878909, P230-238.
- Nawi, M.N.M., Lee, A., Kamar, K.A.M. and Hamid, Z.A., (2012). Critical Success Factors for Improving Team Integration in IBS Construction Projects: The Malaysian Case. *Malaysia Construction Research Journal (MCRJ)*, 10(1), 44-62.
- Nursal, A.T, Omar, M.F., Nawi, M.N.M. (2014). Case Study Methodology of DSS Development for BIM Software Selection in Construction Industry. *American-Eurasian Journal of Sustainable Agriculture (AEJSA)*, 8(3), 81-85.
- Smith, D.K. and Tardif, M. (2009). *Building Information Modeling: A Strategic Implementation Guide for Architects, Engineers, Constructors and Real Estate Asset Managers*. New Jersey: John Wiley and Sons
- TEKES, (2008). Sara-Value Networks in Construction 2003-2007. Technology Programme Report 2/2008. Helsinki. ISBN 978-952-457-392-4
- Ting, H. A., Kong, C. W., Guo H.L, Baldwin, A., and Li, H. (2007). A virtual prototyping system for simulating construction processes. *Automation in Construction* 16 pg. 576-585
- .Van Nederveen, G. A, and Tolman, F. P. (1992). "Modelling multiple views on buildings". *Automation in Construction*. Vol. 1(3), 215-224