INTERNATIONAL JOURNAL OF ACADEMIC RESEARCH IN BUSINESS & SOCIAL SCIENCES

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ISSN: 2222-6990

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To Link this Article: http://dx.doi.org/10.6007/IJARBSS/v8-i1/4069 DOI: 10.6007/IJARBSS/v8-i1/4069

Received: *09 Dec 2017,* ***Revised:*** *19 Jan 2018,* ***Accepted:*** *23 Jan 2018*

Published Online: 29 Jan 2018

In-Text Citation: (Mohammad, Abdullah, & Ismail, 2018)

To Cite this Article: Mohammad, W. N. S. B. W., Abdullah, M. R. Bin, & Ismail, S. (2018). Understanding the Concept of Building Information Modeling: A Literature Review. *International Journal of Academic Research in Business and Social Sciences*, *8*(1), 957–963.

Vol. 8, No.1, January 2018, Pg. 957 - 963

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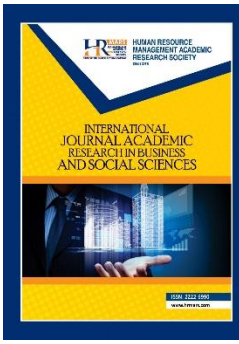
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Understanding the Concept of Building Information Modeling: A Literature Review

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Abstract

Building Information Modelling (BIM) has existed more than 20 years. BIM was introduced to enhance project delivery and as a productivity tool in the construction industry. However, there are various definitions of BIM, depending on the researcher's personal experience and understanding, which may vary from country to country. This paper intends to revisit the concept of BIM including the definition, history, maturity and capability models, uses, and advantages. A conceptual understanding has been proposed in this paper based on an extensive literature review. It is hoped that the concept highlighted in this paper will encourage positive debate on BIM and gain some attention from the practitioners and researchers at large.

Keywords: *Building Information Modelling, Concept, literature review*

Introduction

In many countries, construction industry is one of the most challenging industries. Issues such as low investment rate, raising cost, adding risk, and waste and labour productivity tremendously increase in this industry. This is supported by Haron (2013) where in AIA Guide (2007), many documents discussed on inefficiencies and wastes in the construction industry. McKinsey & Company (2015) reported that productivity issues in construction remain stagnant as compared to the manufacturing sector from year 1994 to 2012.

The introduction of Building Information Modelling (BIM) as an attractive solution to the problem occurred from traditional methods such as complexity, uncertainty, and ambiguity (Arayici et al., 2011); (Harris *et al.,* 2014) and (Hadzaman *et al.,* 2015). According to Ashcraft (2008), BIM is a platform of collaboration where the information is communicated and shared amongst project team members throughout the entire lifecycle. Furthermore, BIM also enables

designers to build the model in virtual world before the construction starts (Dan, 2015). Hence, the problems associated with error detection, construction sequencing, 4D scheduling, and cost estimation can be solved beforehand. Nevertheless, many stakeholders in construction industry do not know of the existence of BIM and thus refuse or are reluctant to use it. In other situations, some of them realize the existence of BIM, but due to lack of information and knowledge of BIM, they also refuse to use it. This paper revisits the fundamental of BIM including definition, history, maturity and capability models, uses, and advantages to encourage stakeholders and readers to understand BIM.

Literature Review

Definition of BIM

The existing definitions of BIM are available in various literatures. The definition depends on the understanding of a researcher. In general, BIM is not a software as many people in the construction industry think. The definition of BIM is in the form of using three-dimensional (3D) data in the process of producing and managing building data during its lifecycle, with appropriate building information software to improve productivity in building design and construction (Dan, 2015). BIM consists of various aspects such as building geometry, spatial relationships, geographic information, quantitates, and properties of building components are also produced from the process.

Apart from that, BIM also serves to share the knowledge through a digital presentation and forms a reliable basis for decision during the entire project life-cycle (BuildingSMART & National BIM Standard - United States, 2007). Succar (2009) also mentioned that BIM is a digital format to organize the appropriate building design and project data throughout the building's life-cycle. This definition is also concurred by (CIDB, 2014) where BIM encompasses of processes to produce, communicate, and analyse digital information models for an entire construction life-cycle in the form of modelling technology. From the definition given, it shows that BIM is a process to produce the digital information models (3D) with their relevant software in enhancing communication and interaction among the stakeholders.

BIM History

The history of BIM started with the application of computer-aided design or CAD in the 1950s and 1960s. In this era, Hanratty developed the first commercial computer-aided machining (CAM) in the year 1957. CAD software is then developed in 1963 by Ivan Sutherland by creating a graphical interface named Sketchpad. Sketchpad was a programme in which the user could graphically interact with the programme through a screen, a light pen used to draft, and a set of buttons that allowed the user to enter parameters and constraints (Eastman et al, 2011).

The transformation from two dimension (2D) to three dimension (3D) was during the 1970s by the French Aerospace Company who developed CATIA. CATIA is one of the famous software in aerospace, automotive and shipbuilding industries. In the 1980s, 3D as introduced by CATIA is already known and leading the industry.

Later, in the 1980s to 1990s, Autodesk become a popular developer and leading in the information technology (IT) industry with their product AutoCAD. However, at same time,

Bentley, as Autodesk's competitor, also introduced new products. Soon, the development of various competitors in IT development increased tremendously from time to time. The various software offers different function and tools, thus, the transition from 2D to nD also changed and they were able to solve various problems by using the respective software.

From 3D model, the 4D model was introduced to help stakeholders, especially in the AEC industry in managing schedules and resources with respect to time. Later, 5D was developed to relate to cost estimating. This 5D model is valuable to cost estimators or quantity surveyors in checking the estimated cost of projects. The development of 6D is related to sustainability and 7D more to facilities management. However, the development of nD is dependent on the functions. As mentioned by Beveridge (2012), 8D was identified as integrated project delivery and maintainability, 9D for acoustics, 10D for security, and 11D was for heat. This shows that the transition of BIM started in the 1950s and continues to the present day.

BIM Maturity and Capability Model

Two important models that need to be understood in the BIM field is BIM capability and BIM maturity model. According to Succar (2014), BIM Maturity Index encompasses several number maturity levels in accordance to improvement of processes, technologies, and policies within each BIM Stage. The maturity level is a basic process from immature to mature stages. The maturity model is developed as to dedicate this matter. In this maturity model, there are five levels as mentioned by Succar (2014) which is initial, defined, managed, integrated, and optimised.

On the other hand, the Capability Maturity Model (CMM) is developed in order to evaluate the ability of stakeholders in performing a software. This model scales from level 0 to level 3, depending on the individual or organisation in performing BIM. According to Haron *et al*., (2010), the BIM maturity and capability are not similar. BIM maturity is the degree of excellence of quality and degree of BIM services. Haron et al., (2010) added that BIM capability stages are the target levels that need to achieved by an organisation when delivering the task.

Figure 1: BIM Maturity stage (Succar, 2014)

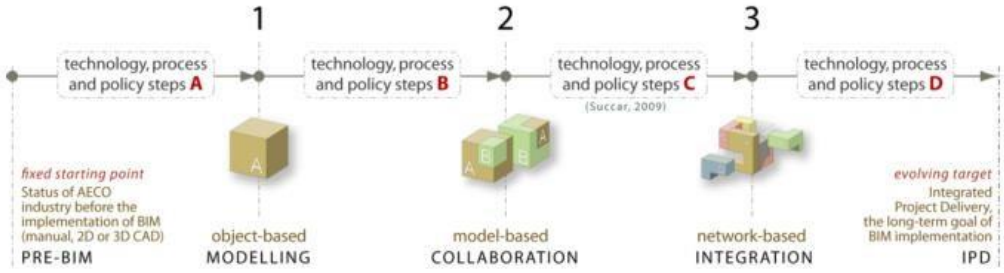

Figure 2: BIM Capability stage (Succar, 2014)

BIM Uses

BIM may be used in many fields throughout the construction life-cycle, starting from inception until the operation of the completed building. According to Kreider & Messner (2013), there are 25 uses of BIM from initial until handover of the project. The specific use is dependent on the objective of the projects due to certain reasons, for example cost, time, and manpower.

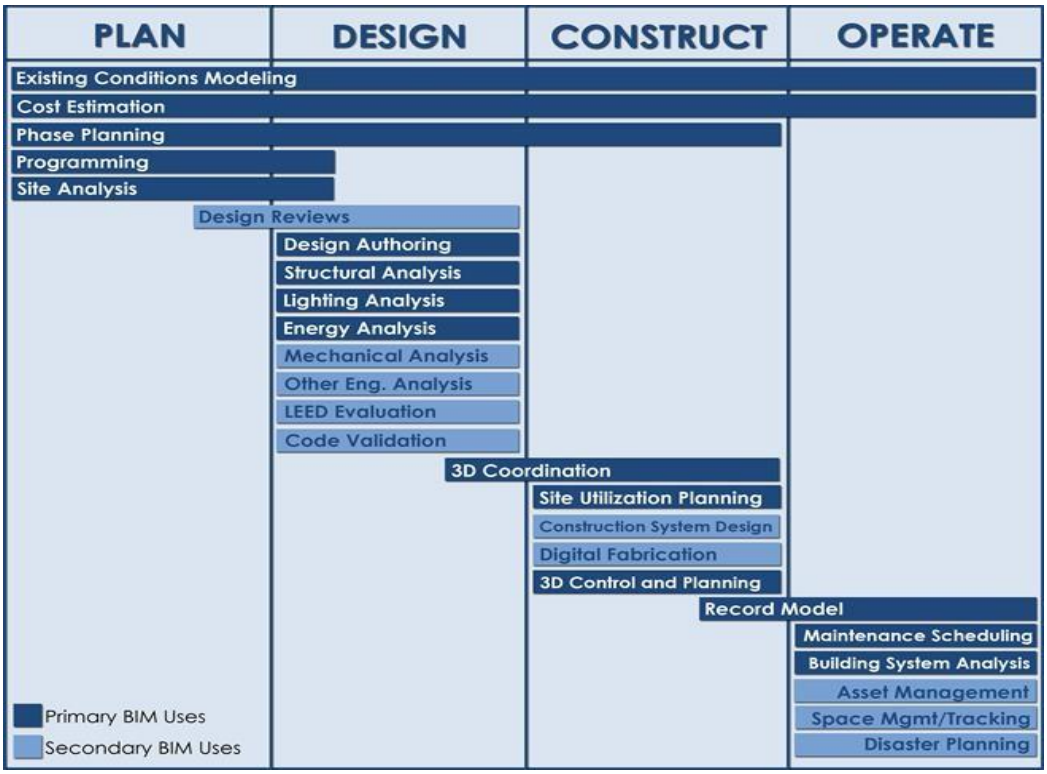

Figure 3: BIM Uses by (Kreider & Messner, 2013)

BIM Advantages

One of the ultimate benefits of BIM is the return on investment (ROI). According to McGraw Hill Construction (2012), the application of BIM gives positive values to many stakeholders in the AEC industry. On the other hand, ROI is one of the indicator of performance measurement of a certain organisation in the industry as it measures the reducing numbers of variation orders, clashes issues, design dispute, and conflicts.

Conclusion

In a nutshell, BIM provides a good platform for the AEC industry as it is able to improve the communication among the stakeholders, collaboration and avoid fragmentation. Hence, the understanding of the concept of BIM is necessary to help stakeholders in the AEC industry to adopt and implement BIM. In addition, the resistance to change from the stakeholders is also a vital element in achieving this mission.

Acknowledgement

The authors wish to address appreciation to the Centre of Postgraduate Studies, Universiti Teknologi MARA, Seri Iskandar Campus, Seri Iskandar for the encouragement and support in pursuing this study.

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