Incorporation of Building Information Modelling (BIM) in Malaysian Higher Education Institutions: A Review

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ABSTRACT

Building Information Modelling (BIM) is initiated for the sake of managing construction projects effectively and efficiently. However, the adoption of BIM in Malaysian construction industry is still low because of lack of awareness among professionals and Architecture, Engineering, and Construction (AEC) undergraduates. This paper aims to evaluate the current adoption of BIM in syllabus among higher education institutions (HEIs). The methodology of this paper is based on literature review regarding BIM syllabus adopted in HEIs. The findings reveal that BIM in Malaysia is still lagging in practice and literature taught for academic aspects respectively compared to other developed countries such as United Kingdom and Lithuania. From the current adoption of BIM in Malaysian HEIs syllabus, it can be concluded that fully stand-alone BIM module in Malaysian HEIs is crucial which consequently hampering the production of high-quality BIM expertise that master in methodology and 3D modelling skills.

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INTRODUCTION

Building Information Modelling (BIM) has gained vast interest from the worldwide Architecture, Engineering and Construction (AEC) industries. The AEC industry has practically started using BIM in construction projects since the mid-2000s (Latiffi, Brahim, & Fathi, 2014). In the opinion of Hedayati, Mohandes, & Preece (2015), BIM is characterized as a process of generating a smart virtual model that integrates project data from design to construction and operation, thus facilitating project documentation, project quantification and estimation. According to Kivits & Furneaux (2013), BIM has the potential for sustainability to be applied in the building life cycle from the planning and design process to the construction phase and subsequently the building management phase. Namlı, Işıkdağ, & Kocakaya (2019) agreed that BIM is a useful tool that could further add value on the architectural design proposal by enabling a building to be modelled and simulated in order to achieve optimum energy and cost effectiveness. Hedayati, Mohandes, & Preece (2015) further added that the utilization of BIM would pan out at the post-construction stage including maintenance and asset management of the buildings.

LITERATURE REVIEW ON BIM FOR HIGHER EDUCATION INSTITUTIONS (HEIS) IN MALAYSIA

This section presents the BIM definitions and illustrates the BIM implementation in both Malaysian and international HEIs context. Challenges and strategy of BIM adoption in HEIs will be elaborated.

Overview of Building Information Modelling (BIM) Definitions

According to Yusuf, Embi, & Ali (2017), Building Information Modelling (BIM) is a digital technological-change that assist the transformation of construction industry delivery processes from its conventional methods into a full information of digitalised model. Added to that, Hedayati, Mohandes, & Preece (2015) mentioned that BIM is expounded as "a set of integrated policies, processes and technologies to create a new method to manage and control the requisite design and construction of the buildings based on data in digital format throughout the whole lifecycle of construction projects".

Yusuf et al., (2017) described BIM as a new delivery technology that revolutionizing the global activity of the construction industry, capable of reducing inefficiencies, improving efficiency and increasing profitability through improved coordination and connectivity among project teams during the life cycle of the project. Yusuf et al. (2017) also added that even though BIM is beneficial, its acceptance has remained insignificant due to the extent to which lack of knowledge and skills required for the adoption and lack of competent BIM graduates faced by the industry. On the other hand, Mcgough, Ahmed, & Austin (2013) stated that it is therefore important that the principle of BIM being integrated into the training of future construction professionals. The statement is agreed by Namlı, Işıkdağ, & Kocakaya (2019) where in today's construction industry, the BIM concept has become a necessity in terms of providing integration among project stakeholders which providing the possibility to process and store the project data in one place.

From the definitions above, it can be summarized that BIM is a digital technology that capable to assist construction industry in maximising the efficiency and profitability throughout the project lifecycle via coordination and communication among project teams. Therefore, it is crucial and important to introduce and implement BIM in both academics and industry accordingly.

Current Incorporation of BIM at Higher Education Institutions (HEIs)

Education institutions are the producers and central of information to produce graduates for expertise. From the interview conducted by (Yusuf et al., 2017), many of the respondents from industrial experts believed that HEIs played a significant role in BIM education development in the construction industry. This part presents the current BIM education in Malaysia and other countries.

BIM Education in Malaysia

In 2007, the Director of Public Works Department (PWD) had introduced the use of BIM in PWD projects with the objective to reduce construction costs and avoid design problems (Latiffi, Mohd, & Brahim, 2015). The first Government project implemented by PWD using BIM is the National Cancer Institute (NCI) which took place in 2010 (Latiffi, Brahim, & Fathi, 2016). Subsequently, the Malaysia's first International BIM Day was held in Putra World Trade Centre (PWTC) Kuala Lumpur in 2015, marking the largest awareness event to highlight the national BIM adoption and implementation campaign on this emerging technology. (Rosli, Razak, & Amer Younus, 2016)

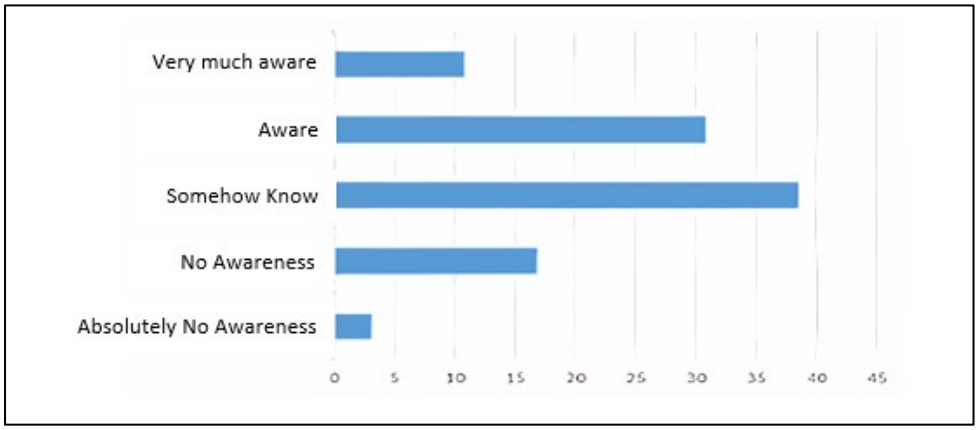
Since 2013, Construction Industry Development Board (CIDB), the body responsible for the activities in construction industry in Malaysia had been actively organizing various workshops, seminars and conferences with the government's objective to promote BIM usage to the AEC. (Rosli et al., 2016). According to Brahim (2018), there are five (5) government-related bodies mandated in

promoting the use of BIM among professionals: The Public Works Department (PWD), PR1MA Corporation Malaysia (PR1MA), the Construction Industry Development Board (CIDB) of Malaysia, Multimedia Super Corridor (MSC) and the Construction Research Institute of Malaysia (CREAM).

PWD had come to realize that the importance of engagement with HEIs in promoting BIM in education and academics for undergraduates. A collaboration between PWD and Universiti Malaysia Pahang (UMP) as the first university to foster the understanding and effectiveness of BIM in the Construction Industry in the form of Memorandum of Understanding (MoU) was signed in 2018. Brahim (2018) added that the MoU is aimed to formalise a strategic formation of BIM implementation in three (3) ways i.e. academic, research and negotiation.

In 2018, PWD and Universiti Teknologi Malaysia (UTM) had made another collaboration by jointly conducting a Five (5) Months BIM Training Programme which attended by ten (10) lecturers from different selected community colleges and polytechnics focusing on the skills to develop and manage digital building in 3Dimensional (3D) way. The participants were finally awarded Professional Certificate by the organizers after completing the training (UTM, 2018). According to PWD (2019), there are currently seven (7) public universities which have signed MoU and collaborated with PWD in promoting BIM, namely Universiti Malaysia Pahang (UMP), Universiti Sains Malaysia (USM), Universiti Malaya (UM), Universiti Putra Malaysia (UPM), Universiti Malaysia Perlis (UniMAP), Universiti Teknologi MARA (UiTM), Universiti Tun Hussen Onn (UTHM), and Universiti Kebangsaan Malaysia (UKM). These collaborations are expected to help PWD's initiative in pushing BIM forward as one of the government's strategies to boost the productivity of Malaysian construction sector (Sinoh, Ibrahim, Othman, & Muhammad, 2020)

Despite of the initiatives taken by the government and industry players, Malaysian construction industry is still facing the lack of competent and reliable BIM modellers among AEC professional with the technical know-how of BIM software (CREAM, 2014) as cited by Rosli et al. (2016). Therefore, it is absolutely necessary for future generations of AEC graduates to acquire the knowledge of this technology during their early years of education. A survey conducted by Yusuf et al., (2017) had identified the level of BIM knowledge among academicians in HEIs as shown in Figure 1 below. From the results of the survey, it implies that majority of academicians are lack of BIM awareness and do not have any competency through BIM trainings. As the results, they are not able to utterly teach the students and produce BIM knowledgeable graduates at the end of their studies.



Source: (Yusuf et al., 2017)

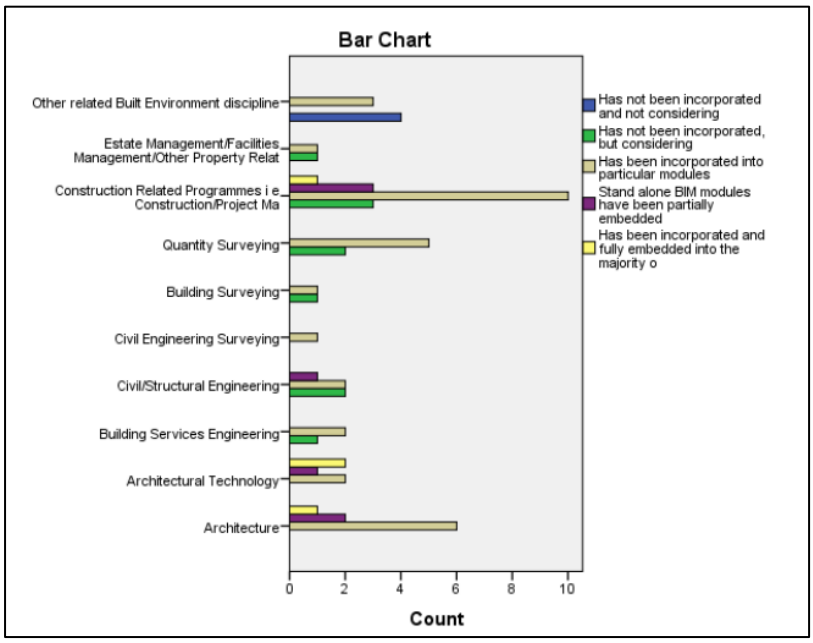
Figure 1: Level of BIM Awareness among Educators

Therefore, it is agreed by Ali et.al (2018) that the level of implementation of BIM in Malaysian construction industry is fairly low and limited. This shortcoming is barely due to the shortage of skilled personnel who well versed with 3D modelling, understanding of the methodology and coordination among AEC and other industry players.

BIM Education in Other Developed Countries

Internationally, adoption of BIM in some developed and developing countries has reached high level of implementation (Othman *et.al*, 2020). Macdonald (2012) further stated that the use of BIM in construction industry has now been made compulsory by several national governments, such as the United States, Singapore, the United Kingdom (UK), Norway, Denmark, Finland, Hong Kong, South Korea, and Netherlands. In the UK, in order to keep the pace with recent BIM development in industry, HEIs are normally facing with the options of either adapting their existing syllabus towards an integrated approach or as a separate standalone arrangement (Underwood & Ayoade, 2015). On this issue, Wong & Fan (2013) emphasized that the integrated approach is the best way to in line with industry requirements.

Likewise, a survey was conducted by Underwood & Ayoade (2015) to identify incorporation of BIM syllabus among AEC programme in several HEIs in the UK. From the results, BIM has been incorporated and embedded in few AEC-related programmes in the UK universities via stand-alone BIM modules either partially or fully. The results are as shown in Figure 2 below:



Source: (Underwood & Ayoade, 2015)

Figure 2: BIM Curriculum Incorporation in United Kingdom

Meanwhile, in The Republic of Lithuania the introduction of BIM into the country is considered late compared with other countries (Jolanta & Pupeikis, 2018). In 2015, The Republic of Lithuania government initially decided on the plan to digitalize the Lithuanian AEC sector including BIM education. Jolanta & Pupeikis, (2018) further emphasized that the initiators of BIM promotion understand that a key success factor which is young graduates and professionals with adequate BIM knowledge is missing from the plan. Jolanta & Pupeikis, (2018) also added in consideration of there is a lack of skilled workers and engineers in the country, the government had taken initiative to sign an agreement with universities to provide more education courses on digital construction in order to resolve the issues.

Challenges of Adopting BIM into HEIs

According to Hietanen, J. and R. Drogemuller (2008) as cited by Yusuf, Embi, & Ali (2017), BIM is a new technology area that currently presents some challenges that hindering academicians in terms of their preparation, due to the limited resources required for information, expertise, cost and time and coupled with influences on project delivery processes. Hietanen, J. and R. Drogemuller (2008) also added that these challenges created academic gap where HEIs and academicians had moved their subject from teaching how to use software to the practical usage of resources for present and future generations.

Universities that offer BIM related courses have always been responsible to provide teaching and training to professionals in the construction industry. However, the universities has scarcely adopted tertiary BIM knowledge into their training due to limitation of resources, awareness and even BIM knowledge among their academicians (Macdonald, 2012). According to Hon et al. (2016), in order for lecturers to adopt BIM into their syllabus, the lecturers themselves must have awareness, knowledge and training skills to teach BIM related subjects.

A survey was conducted by Hedayati et al. (2015) at a university in Malaysia where students and lecturers had become two (2) perspectives of the main concern. From the survey, it was proven that there were three (3) major challenges in incorporating BIM to HEIs from students' perspective: a) takes time to learn BIM software, b) high cost of training and software, and c) the age factor where senior lecturers could not adapt with new technologies. Meanwhile from lecturers' perspective: a) non-user-friendly software, b) lack of BIM textbooks and educational resources, and c) lack of competent staff in teaching BIM. Table 1 below shows the summarize of survey conducted by Hedayati et al. (2015)

Table 1: Challenges of Adopting BIM in Malaysian HEIs summary

Concerns	Challenges
Students	• Takes time to learn BIM software
	• Expensive training and software
	• Senior lecturer not adapted with new technology
Lecturers	• Non-user-friendly software
	• Lack of BIM textbook and educational resources
	• Lack of competent BIM staff

Source: (Hedayati et al., 2015)

Hietanen, J. and R. Drogemuller (2008) as cited by Yusuf (2018) added that the challenges of adopting BIM have created a niche on the university education, where the focus of the HEIs and academicians has convey from teaching on how to use tools, to actual using of the tools for both the current and future generations. In addition, it is challenging for the current BIM system to adapt its method of teaching and approach as the system is still evolving rapidly, making it a challenge for academicians to keep up dated (Macdonald, 2012). The shortage of BIM expertise is the upmost concern in every country including Malaysia. From the survey conducted by Hedayati et al. (2015) regarding not having trained staff, it is agreed by Macdonald (2012) where the current shortage of building design professionals trained in BIM remains a barrier to universal adoption of collaborative working practices in the industry.

BIM Adoption Strategy

In an effort to keep up and aligned with the industry developments, Underwood & Ayoade (2015) advocate that the integrated approach must be in congruence with industry requirements so that the process is suitable to stay abreast with recent developments. However, it will require inculcating avenues that cater to new developments in technology or new methods of project delivery to their students. Besides, Forsythe et al (2013), indicated that an active and regular collaborative design

charrette with industry, staff and students is a useful tool towards encourage an up to the minute involvement of construction industry.

As claimed by Macdonald (2012), collaborative working style using BIM requires not only the learning of new technologies and software, but also the learning of a new working norm. This indicates the transition from litigation and fragmentation culture to an integrated information sharing, collaboration, and integrated project delivery. Current building design in academic practices rarely involves collaboration where students can participate training in the Architecture, Engineering and Construction (AEC) professional companies. Macdonald (2012) further added that AEC students tend to be trained in different departments at most universities in the USA, Europe and Australia with little to non-integration to collaboration between the disciplines.

According to Riel (2000) as cited by Yusuf *et al*. (2017) efforts should be made not to reduce BIM education in an uncoordinated operation that lacks of standardized project execution procedures due to the absence of awareness and skills required for the projects to be delivered diligently. Yusuf et al., (2017) emphasized that education remains the structured and coordinated body which incorporates learning into wider intellectual structures. It also provides learners or students with intellectual skills in an immediate and multiplicative context. Hence, a mechanism of collaboration, interactions and cooperation between industry experts and academicians for the provision of integrated expertise and skilled workers should be established in order to fulfil construction industry needs which will eventually contribute to a higher standard of learnings in HEIs and impact of economics growth. (Riel, 2000; Shahela, Norazlin, & Mohd, 2014; Yusuf et al., 2017).

METHODOLOGY

A review was conducted on the past literature towards obtain information related to BIM such as definitions, current adoptions, strategies, and challenges of BIM incorporation in HEIs. Various sources were reviewed, such as books, journal articles, international conference papers and materials available on the internet.

DISCUSSIONS

From the literature review, it is proven that every country is actively foster awareness among construction players and higher institutions. This can be seen that every government for each country has its own approach and strategies to foster and promote BIM among industry players and HEIs as shown in Table 2.

Table 2: Government's BIM adoption in HEIs initiative for each country

Countries	**Malaysia**	**United Kingdom**	**Lithuania**
Initiatives	Memorandum of Understanding (MoU) with universities 5 months BIM Training Programme for lecturers	Partially/fully stand-alone BIM module in AEC related programme	Digitalize AEC sector including HEIs

Table 2 above shows three (3) countries' initiatives on how to incorporate BIM into HEIs. Malaysian's Government has put more initiatives to complement BIM in HEIs by having MoUs with universities and 5-month BIM Training programme for lecturers where the participants are awarded with Professional Certificate. In the United Kingdom, a stand-alone BIM subject is applied into the AEC programme. Meanwhile in Lithuania, practicing digitalized method in AEC sector and HEIs is introduced.

In Malaysia in particular, the MoUs signed between government departments and universities have paved the way to develop partially stand-alone BIM module incorporated into the HEIs' syllabus.

However, since it is time consuming for learning BIM software, partially module is not suitable for students to master the software since it leads to production of relatively a small number of 3D modellers and slow progress in development of BIM practice in Malaysian construction industry. Therefore, the need of a fully stand-alone BIM module as implemented in Australia such as Diploma or Bachelor in BIM is very crucial. In fact, young and fresh undergraduates are very easy and keen to adapt with new technology. Therefore, it is ideal for students to learn and practice BIM through fully adopted module in HEIs.

CONCLUSIONS

This paper has discussed the current adoption of BIM in HEIs for both local and international from various sources of past literature. Based on the literature review, it can be concluded that Malaysia is still behind in terms of BIM awareness and usage for both in industry and academics sectors as compared to other country such as UK and Lithuania. In addition, only a fair number of high learning institutions in Malaysia have departments and faculties linked to the construction industry and responsible for production of BIM related graduates for the industry. Therefore, in order for the government to educate industry players and to promote BIM in construction industry, awareness should be introduced by adopting fully stand-alone BIM module in academic institutions in Malaysia. This step will subsequently produce high quality of BIM graduates whom will become expertise in practicing and implementation of BIM in construction industry.

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REFERENCES

Ali, M., Ismail, K. M., Hashim, K. S. H. Y., Suhaimi, S., & Mustafa, M. H. (2018). Historic building information modelling (HBIM) for Malaysian construction industry. *Planning Malaysia*, *16*(3), 332–343.

Hedayati, A., Mohandes, S. R., & Preece, C. (2015). Studying the Obstacles to Implementing BIM in Educational System and Making Some Recommendations. *J. Basic. Appl. Sci. Res*, *5*(3), 29–35.

Hon, C. K. H., Drogemuller, R., Owen, R. B., Beazley, S., Gray, J., Utiome, E., … Coffey, V. (2016). An Evaluation of Learning and Teaching Initiatives for BIM Education at Queensland University of Technology (QUT). *CIB W78 Conference, 31 October - 2 November 2016*, (November).

Jolanta, Š., & Pupeikis, D. (2018). Review of BIM implementation in Higher Education. *Journal of Sustainable Architecture and Civil Engineering*, *22*(1). https://doi.org/10.5755/j01.sace.22.1.21116

Kivits, R. A., & Furneaux, C. (2013). BIM: Enabling sustainability and asset management through knowledge management. *The Scientific World Journal*, *2013*(August 2014). https://doi.org/10.1155/2013/983721

Latiffi, A. A., Brahim, J., & Fathi, M. S. (2014). The development of building information modeling (BIM) definition. *Applied Mechanics and Materials*, *567*(August), 625–630. https://doi.org/10.4028/www.scientific.net/AMM.567.625

Latiffi, A. A., Brahim, J., & Fathi, M. S. (2016). Transformation of Malaysian Construction Industry with Building Information Modelling (BIM). *MATEC Web of Conferences*, *66*, 00022. https://doi.org/10.1051/matecconf/20166600022

Latiffi, A. A., Mohd, S., & Brahim, J. (2015). Application of Building Information Modeling (BIM) in the Malaysian Construction Industry: A Story of the First Government Project. *Applied Mechanics and Materials*, *773–774*(May 2012), 996–1001. https://doi.org/10.4028/www.scientific.net/amm.773-774.996

Macdonald, J. a. (2012). A Framework for Collaborative BIM Education Across the Aec Disciplines. *37th Annual Conference of the Australasian Universities Building Educators Association (AUBEA)*, 223–230.

Mcgough, D., Ahmed, A. (Coventry U., & Austin, S. (2013). Integration of Bim in Higher Education : Case Study of the Adoption of Bim Into Coventry University ' S Department of Civil Engineering , Architecture and Building. *Sustainable Building and Construction Conference (SB13)*, 394–403.

Namlı, E., Işıkdağ, Ü., & Kocakaya, M. N. (2019). Building Information Management (BIM), A New Approach to Project Management. *Journal of Sustainable Construction Materials and Technologies*, *4*(1), 323–332. https://doi.org/10.29187/jscmt.2019.36

Othman, I., Al-Ashmori, Y. Y., Rahmawati, Y., Mugahed Amran, Y. H., & Al-Bared, M. A. M. (2020). The level of Building Information Modelling (BIM) Implementation in Malaysia. *Ain Shams Engineering Journal*, (xxxx). https://doi.org/10.1016/j.asej.2020.04.007

Riel, M. M. (2000). *Education in the 21st Century : Just-in-Time Learning or Learning Communities Education in the 21 st Century : Just-in-Time Learning or Learning Communities Margaret Riel Center for Collaborative Research in Education*. (March).

Rosli, M. F., Razak, A. S., & Amer Younus, M. (2016). To BIM or not to BIM: A pilot study on University of Malaya's architectural students' software preference. *Journal of Design and Built Environment*, *16*(1), 13–26. https://doi.org/10.22452/jdbe.vol16no1.2

Shahela, M., Norazlin, M. S., & Mohd, E. M. (2014). Building Information Modeling (BIM) awareness among higher education Institution students. *Proceedings of the 2nd International Conference on Green Technology & Ecosystem for Global Sustainable Development*, (November), 1–6.

Sinoh, S. S., Ibrahim, Z., Othman, F., & Muhammad, N. L. N. (2020). Review of BIM literature and government initiatives to promote BIM in Malaysia. *IOP Conference Series: Materials Science and Engineering*, *943*(1). https://doi.org/10.1088/1757-899X/943/1/012057

Underwood, J., & Ayoade, O. (2015). Current Position and Associated Challenges of BIM Education in UK Higher Education. *BIM-Education*, (March), 47.

Wong, K. din, & Fan, Q. (2013). Building information modelling (BIM) for sustainable building design. *Facilities*, *31*(3), 138–157. https://doi.org/10.1108/02632771311299412

Yusuf, B. Y. (2018). *Development of the Framework for the Integration of Building Information Modeling To Higher Education in Malaysia Badiru Yunusa Yusuf Universiti Teknologi Malaysia*.

Yusuf, B. Y., Embi, M. R., & Ali, K. N. (2017). Academic readiness for building information modelling (BIM) integration to Higher Education Institutions (HEIs) in Malaysia. *International Conference on Research and Innovation in Information Systems, ICRIIS*, 0–5. https://doi.org/10.1109/ICRIIS.2017.8002491