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Studying the Obstacles to Implementing BIM in Educational System and Making Some Recommendations

Ali Hedayati[a*], Saeed Reza Mohandes[a], Christopher Preece[b]

[a]Master of Construction Management, Department of Structures and Materials, Faculty of Civil Engineering, Universiti Teknologi Malaysia, 81310, Johor Bahru, Malaysia
[b]Professor of International Construction Business at Razak School of Engineering and Advanced Technology, Malaysia, kuala Lumpur

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ABSTRACT

Despite the fact that innumerable advantageous involved in exploiting BIM, there are some barriers to implement it properly. These barriers have been proved as impediments for academicians and members of construction team project to take the maximum advantage of its utilization. Although some research has been conducted to identify these barriers regarding BIM implementation in construction industry, more research is needed to be carried out among academicians to identify these barriers in institutions, and most importantly, to make suggestions for eliminating these obstacles. In light of this, this paper is aimed to determine these barriers with regard to a survey conducted at one of the universities in Malaysia based on the students' responses studied in civil engineering and built-environment faculty, and to get feedbacks from lecturers' taught in the mentioned faculties to make suggestions to overcome these impediments.The results indicated that, although, majority of students were aware of advantages involved in implementing BIM technology at construction stages, they are not capable of usingcorrespondent software. Additionally, some barriers were identified and recommendations made based on the lecturers and students responses with the aim of enhancing the utilization of BIM in institutions.

KEYWORD: Building Information Modeling, barriers of BIM adoption, institutions and recommendations

1.0 INTRODUCTION

Controlling and monitoring construction projects have been complicated [1-3]. Mutual interdependencies among various stakeholders like authorities, financing bodies, architects, contractors, lawyers, engineers, suppliers, and trades is regarded as one of the factors leading to this complexity [4]. As such, the information and communication technology [ICT] has been developed very fast due to this increased complexity and errors that may occur during projects [5]. The proliferation of Building Information Modeling [BIM] occurred during the 1990sin industrial and academic contexts as a new Computer Aided Design (CAD) paradigm was contemplated as an enormous stride in shifting ICT toward its evolved future. [6]. Currently, 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." [6]. Also, BIM is referred to as "shared digital representation of physical and functional characteristics of any built object which forms a reliable basis for decisions" according to the international standards [7]. When construction projects are modeled with the usage of BIM software, there is a chance for all groups of construction team involved in a project to collaborate effectively throughout the whole process of construction project leading to minimize further expenses resulted from poor efficiency [8]. On top of all the aforementioned benefits of using BIM, the uilization of BIM would bear much fruits at the postcontruction stage including maintenance and asset management of the buildings [9].

Despite the fact that innumerable advantageous involved in exploiting BIM, there are some barriers to implement it properly. These barriers have been proved as impediment for academicians and members of construction team project to take the maximum advantage of its utilization. Although some research has been conducted to identify these barriers regarding BIM implementation, more research is needed to be carried out among academicians to identify these barriers in institutions, and most importantly, to make suggestions for eliminating these obstacles. In light of this, this paper is aimed to determine these barriers with regard to a survey conducted in one of the universities in Malaysia, and to get feedbacks from lecturers to make suggestions to overcome these impediments. Section 2 of this paper has elucidated the past studies conducted pertinent to the identification of barriers and the utilization of BIM in educational system. Research methodology used for this paper has been expounded in section 3. Section 4 presents the results and findings based on the survey conducted, followed by conclusion of the current paper explained in section 5.

[*]**Corresponding Author**: Ali Hedayati, Master of Construction Management, Department of Structures and Materials, Faculty of Civil Engineering, Universiti Teknologi Malaysia, 81310, Johor Bahru, Malaysia.
Email Address:ali_hedayati81@yahoo.com

2.0 LITERATURE REVIEW

2.1 Definition of BIM

Building Information Modeling (BIM) is defined as a process of generating an intelligent virtual model integrating the project data from design to construction and operation, which results infacilitating the project documentation, project quantification and estimation. Furthermore, the process of communicating the progress of construction to stakeholders; facilitating the integrated project delivery, coordination, and clash detection by visualizing the different phases of project development would be considerably enhanced through BIM models [10].

2.2 Barriers of BIMImplementation

In a research conducted by Yan et al. [11] to determine professional opinions about BIM and whether companies adopt BIM tools or plan to adopt this technology. It was observed that BIM utilization was much higher in the US in comparison with rest of the world. Many companies were neither currently using BIM technology, nor did they have any plans to exploit BIM. Theyconcluded that improvements were still needed in theevolution of BIM technology. However, the results of questionnaire proved that there were some obstacles regarding BIM implementation. For instance, few people had requisite knowledge pertinent to its operation, or current design technology was considered enough for them to design the projects.

As mentioned in a BIM seminar for Malaysian construction industry, cost, IT components, time and readiness were ranked as the highest four barriers of BIM adoption with 26.2%, 23%, 16.4% and 14.8% respectively.On the other hand, knowledge (8.2%), technology (8.2%) and information (3.3%) were amongst the lowest barriers recorded [12].

2.3The extension of BIM adoption at institutions

BIM-integrated curriculums for students of construction engineering and management (CEM) have recently been developed at several universities; however, quite a small minority of the large numbers of such programs that are available worldwide have been represented [13 and 14], and in addition, there is significant diversity in their content. In order to establish coherent and comprehensive curricula, both within existing courses and through introducing new courses by educators, a BIM education framework for CEM programs is strongly needed.

Sobongi and Farid administered a survey to determine the extent to which BIM was integrated in American universities' undergraduate construction management programs.The major goal of their research was to describe the status of BIM in the curricula of undergraduate programs in construction management. All members of the Associated Schools of Construction which offer four-year undergraduate programs were the respondents of the survey conducted via mail. The survey was concerned mainly about whether AutoCAD and BIM were offered as stand-alone courses or as part of other courses; which particular aspects of BIM were offered; and what were the obstacles for offering BIM in the curriculum. Less than 1% of the respondents stated that BIM was taught as a stand-alone course, while 9% claimed that BIM is emphasized as part of existing courses. The already-existing requirements for graduation, the absence of room in the curriculum for additional elective courses and the lack of reference materials and established curricula were observed as the most significant obstacles to adopt BIM at the undergraduate level [15].

In order to observe the dynamics between college building information modeling (BIM) education and student career development, a survey was conducted [16]. It was found that both communities gained substantial benefits resulted from BIM adoption. Moreover, it was observed that there was a gap existed between the incentives in place to encourage students to commit to a BIM-oriented career pathand the rapid growth of the BIM-related job market. Also, the effectiveness of BIM education in colleges and industry recruiting practices in BIM staffing was evaluated. The findings indicated thatthe proliferation of BIM education and BIM talent acquisition in the architecture, engineering, and construction (AEC) industry may come to fruition if an enhanced and more proactive partnership is put in place.

3.0 METHODOLOGY

The methodology employed for this paper includes reading numerous articles, papers and books as regards the barriers of BIM adoption. In the next step, a survey comprising 3 different types of questions based on the aims of this research were prepared and sent to the students and lecturers. The first questionnaire was sent to the master and phd students of UTM (Universiti Teknologi Malaysia) with the aim of observing their level of understanding regarding BIM software. Afterwards, another type of questionnaire was sent to the students to determine their knowledge pertinent to the advantageous of utilizing BIM in 3 different construction phases named preconstruction, construction and post-construction. It is noteworthy that all the results obtained from the respondent's answers were calculated based on average index (percentage) method in which ai and xi identify index or a class and frequency of a response respectively as below [17]:

Average Index (percentage)=$\frac{\sum a_i x_i}{\sum x_i} \times 100$

If the average index calculated is identified by I, then an appropriate classification of a rating group would be as bellows:

Extremely effective:	$87.5 \leq I \leq 100$
Very effective:	$62.5 \leq I \leq 87.5$
Moderately effective:	$37.5 \leq I \leq 62.5$
Ineffective:	$12.5 \leq I \leq 37.5$
Extremely ineffective:	$0.00 \leq I \leq 12.5$

Finally, some suggestions were made by the lecturers to diminish the repercussions of the barriers on BIM implementation in educational system.

4.0 RESULTS& DISCUSSION

In this section, the results obtained from the questionnaires responded by students and lecturers based on the aforementioned goals of this research were expounded.The questionnaire was sent in paper/electronic form toapproximately 200 AEC academics (150 students and 50 lecturers). Thosewere randomly chosen from personal contacts. The responserate was about 71% of students and 66% of lecturers. Several responses containedinvalid answers or not familiar with this technology and were therefore disregarded. Thus, 139 valid responses were gathered; 106 from the students, 33 from the lecturers.

4.1 Identifying the awareness of students as regards the BIM software and its advantageous

In the first step, it was indispensable to identify the perception level of students pertinent to the BIM software mentioned in the questionnaire prior to go further for determining barriers of implementing BIM. Results were indicative of students' unfamiliarity with BIM software. The overwhelming majority of them; around 89.6%, stated that they were not capable of working with any of those BIM software mentioned in the questionnaire (see Table 1).

BIM Software	Frequency	Percent
Revit (Arch, struct, MEP)	11	10.37
Bentley (Arch, struct, Mech, Elect)	0	0
AutodskNaviswork	3	2.83
VICO	0	0
GraphisoftArchicad	2	1.88
Bentley Generative Components	0	0
NemetschekVectorworks	0	0
GehryTechnolgies Digital Projet	0	0
TEKLA	1	0.94
Beck TehnologyDprofiler	0	0
Innovaya	0	0
Dassault Systems CATIA	0	0
Solibri Model Checker	0	0
Synchro Project Constructor	0	0
None	95	89.64

Table 1: identifying the perception level of students pertinent to the BIM software

In this step, it was aimed to determine the extent to which the students are aware of the benefits in utilizing BIM, as the mentioned awareness may not be similar to their level of perceptions pertaining to the BIM software. By doing so, 3 different types of questions were asked concerning different stages of construction namely pre-construction, construction and post-construction as follows:

No	BIM Technology at Pre-construction Stage	1	2	3	4	5	Average Index(P)	Index classification
1	Improved cost estimating at Pre-construction stage	0	5	16	52	33	89.6	Extremely aware
2	Improved productivity of estimator in quantity take-off	0	6	21	42	37	90	Extremely aware
3	Easier quantity take-off	0	3	9	68	26	88.2	Extremely aware
4	Reduced cost from health and safety issues	2	0	7	63	34	90.5	Extremely aware
5	Reduced overall project cost	0	0	12	29	65	96.6	Extremely aware
6	Increased speed of delivering projects	0	0	28	54	24	86.5	Very aware
7	Reduced overall project duration	0	0	16	51	39	91.4	Extremely Unaware
8	The use of 4D BIM (integrating schedule dimension)	0	9	13	64	20	85.7	Very aware
9	Improved management of projects schedule milestones	0	7	23	37	39	90.2	Extremely aware
10	Improved design quality	0	6	19	41	40	90.9	Extremely aware
11	Efficiencies from reuse of data (enter once use many)	0	13	17	39	37	89.5	Extremely aware
12	Reduced redesign issues	2	5	16	45	38	90.6	Extremely aware
13	Earlier and more accurate design visualization	0	0	13	46	47	93.4	Extremely aware
14	Generation of accurate and consistent 2D drawings at any stage	0	6	52	19	29	83.3	Very aware
15	Improved site analysis	2	0	52	41	11	78.6	Very aware
16	Allows accurate site logistics plans	0	16	38	47	5	76.1	Very aware
17	Greater predictability of project time and cost	0	4	16	41	45	92.5	Extremely aware
18	Greater productivity due to easy retrieval of information	0	4	28	42	32	88.3	Extremely aware
19	Improved conflicts detection	0	16	25	38	27	85	Very aware
20	Improved human resources management	0	13	17	39	37	89.5	Extremely aware

Table 2: Students' awareness regarding the advantageous of BIM adoption at preconstruction stage

No	BIM Technology at construction Stage	1	2	3	4	5	Average Index(P)	Index classification
1	Improved cost estimating at construction stage	0	5	17	52	32	89.2	Extremely aware
2	Reduced waste	1	0	14	28	63	96.2	Extremely aware
3	Fewer change orders at the construction stage	0	3	9	48	46	93.2	Extremely aware
4	Improved communication between project parties	0	4	21	54	27	87.6	Extremely aware
5	Improved communication among various divisions of the same company	0	9	20	46	31	88.2	Extremely aware
6	Improved documents management	0	0	10	64	32	90	Extremely Unaware
7	Enhanced management of security and safety information	0	3	21	49	33	89.3	Extremely aware
8	Enhanced team collaboration	0	4	15	51	36	90.5	Extremely aware
9	Enhanced work coordination with subcontractors / supply chain	1	3	23	54	25	88.9	Extremely aware
10	Improved coordination in the construction phase	0	0	16	54	36	90.7	Extremely aware
11	Reduced safety risks	0	0	13	36	57	95.3	Extremely aware

Table 3:Students' awareness regarding the advantageous of BIM adoption at construction stage

	BIM Technology at Post-construction Stage	1	2	3	4	5	Average Index(P)	Index classification
1	Improved cost estimating at Post-construction stage	0	3	7	52	44	92.8	Extremely aware
2	Potentially Improved maintenance scheduling	0	12	21	38	35	88.7	Extremely aware
3	Enhanced energy efficiency and sustainability of the building	0	11	16	28	51	93	Extremely aware
4	Allows increased energy analysis of the building	2	16	19	27	42	89.5	Extremely aware
5	Potentially Improved whole life asset management	0	11	19	41	35	89.1	Extremely aware
6	Improved maintenance due to Building Automation System	0	12	25	49	20	84	Very aware
7	Potentially Improved maintenance of the facility due to the as-built model	0	12	20	38	36	89	Extremely aware

Table 4:Students' awareness regarding the advantageous of BIM adoption at postconstruction stage

As can be seen from tables 2, 3 and 4, majority of students were aware of advantageous involved in implementing BIM by being extremely aware and very aware, since they were informed through reading articles, journals and books in which the advantageous of adopting BIM are discussed in a great detail. Also, some of them claimed that they acquired knowledge and/or information based on what they heard from their friends. More importantly, some of their lecturers often stated the innumerable advantageous of employing BIM throughout the whole lifecycle of construction projects by showing quite a relatively high amount of power point's slides. It is notable that the mentioned awareness was the most extreme in reduced overall project cost, reduced waste and reduced safety risks. By contrast, respondents were less aware of benefits in the adoption of BIM in two categories compared to others named allows accurate site logistics plans and improved site analysis.

4.2 Identifying the barriers of BIM implementation

This question is now arisen what are the causes of students' reluctance to assimilate knowledge and information concerning BIM technology and/or software inspite of their good level of perceptions regarding the upsides of BIM adoption. Both lecturers and students were asked to rank the barriers of BIM implementation identified in the institutions based on the past studies undertaken. First type of questionnaire was sent to the students and second one was sent to the lecturers.

No	STATEMENT ABOUT BARRIERS	1	2	3	4	5	Average Index(P)	Index classification
1	Lecturers' unwillingness to change traditional working practices	0	23	48	20	15	75.2	Agree
2	High cost& training of software	0	4	21	48	33	89.2	Strongly Agree
3	The age factor - mature lecturers uncomfortable with new	0	10	32	43	21	83.7	Agree
4	Lack of expertise among the lecturers	0	14	31	44	17	81.8	Agree
5	Poor level of understanding regarding the BIM implementation among the students	0	26	49	23	8	71.6	Agree
6	Current technology is enough	3	17	45	26	15	76.9	Agree
7	Too much time is needed for learning BIM software	3	5	12	53	33	89.5	Strongly Agree
8	The unsuitability of some projects to the adoption of BIM	1	2	56	39	8	76.6	Agree
9	Difficult to ensure data integrity	1	5	67	32	1	70.7	Agree
10	Uncertainty about the outcome	1	5	64	35	1	71.5	Agree

Table 5:Ranking the barriers of BIM implementation based on the students' responses

No	STATEMENT ABOUT BARRIERS	1	2	3	4	5	Average Index(P)	Index classification
1	The unsuitability of some university projects to the adoption of BIM	2	5	10	14	2	75.7	Agree
2	Institute not want to invest for new syllabus	1	6	13	11	2	73.7	Agree
3	Having legal barriers for starting new course for BIM	3	15	12	2	1	58.2	Moderate
4	Not have trained staff for teaching for BIM	4	15	8	3	3	62.8	Agree
5	No room for new courses in existing curriculum	4	14	12	1	2	59.2	Moderate
6	Not considered important	3	7	17	6		64.3	Agree
7	Insufficient student demand		4	18	8	3	74	Agree
8	limited number of courses students can take and still graduate in three semesters	1	5	10	15	2	76.6	Agree
9	Lack of BIM textbooks and other educational resources	2	4	9	15	3	78.2	Agree
10	Software related issues	1	6	3	16	7	84.4	Agree

Table 6:Ranking the barriers of BIM implementation based on the lecturers' responses

The findings of the study based on the average index indicated clearly that three major barriers in terms of students' viewpoint were; 1) Too much time is needed for learning BIM software 2) High cost& training of software 3) The age factor - mature lecturers uncomfortable with new technologies. When it comes to lecturers' opinions, these barriers were as; 1) Software related issues 2) Lack of BIM textbooks and other educational resources 3) Limited number of courses students can take and still graduate in three semesters. By contrast, the three less important items were chosen from students' perspective were as; 1) Difficult to ensure data integrity 2) Uncertainty about the outcome 3) Poor level of understanding regarding the BIM implementation among the students. Also, lecturers identified three barriers which have the least impact onBIM adoption as; 1) Having legal barriers for starting new course for BIM 2) No room for new courses in existing curriculum 3) Not have trained staff for teaching for BIM (see Tables 5 and 6).

4.3Making some suggestions to overcome the barriers of BIM implementation

In this step of this research, the proliferation of the utilization of BIM technology in educational system was taken into account in accordance with the lecturers'' response. It was attempted to get participants' opinions and perceptions to rank recommendations made in previous studies for overcoming the current impediments of BIM adoption. It was found that all of the respondents believed that mentioned factors had significant effects on the BIM implementationin educational systems. Table 7 presents these recommendations and the average index pertinent to each of them. Required training for the lecturers and know how to transfer to their students and realizing the value from facilitating the construction process by students were regarded as the two most crucial recommendations ranked by the lecturers. By using such factors, the usage of software will be accelerated.

No	STATEMENT ABOUT SUGGESTIONS	1	2	3	4	5	Average Index(P)	Index classification
1	Training lecturers on new software and technology	0	2	3	15	13	91.8	Strongly Agree
2	Realizing the value from facilitating the construction process	0	0	4	15	14	92.8	Strongly Agree
3	Purchasing software and technology	0	0	3	19	11	90.7	Strongly Agree
4	Clear understanding of benefits that outweigh the cost and other factors	0	1	3	18	11	90.5	Strongly Agree
5	Required training and know-how transfer to their students	0	0	3	15	15	93.6	Strongly Agree
6	Attending workshops to discuss BIM uptake and further information	0	0	4	19	10	89.8	Strongly Agree
7	Recommendation of a way forward with regards to software and hardware	0	0	6	20	7	86.7	Agree
8	Overcoming the resistance to change, and getting people to understand the potential and the value of BIM over 2D drafting	0	2	5	20	6	85.4	Agree
9	In-house training sessions	0	2	5	17	9	88.1	Strongly Agree
10	Given bonus to students for BIM implementation on their university projects	0	3	8	13	9	86.7	Agree

Table 7:Ranking the mentioned recommendations with regard to lecturers' responses

5.0 Conclusion:

The information and communication technology [ICT] has recently evolved due to the complexity of construction projects' processes. Meanwhile, Building Information Modeling (BIM) has gained many researchers', engineers' and contractors' attentions as a useful tool to facilitate the process of construction throughout the whole lifecycle leading to minimizing errors, reworks and expanses and improving work efficiency and coordination among all members of a construction team. On a downside, there are some barriers which have hindered the implementation of BIM effectively. Although many practitioners are aware of benefits of BIM utilization in construction industry due to a relatively large amount of research carried out, this emerging technology has not been widely taken into consideration in institutions in where many engineers could be given proper knowledge regarding the BIM adoption prior to work on a real project. Thus, the authors of this paper attempted to observe the implementation of BIM in an institution located in Malaysia. The main goals of this paper were; firstly, to identify perceptions of students pertinent to the BIM operation, secondly, to discover barriers existed in the chosen institution based on the students' and lecturers' responses. Then, some recommendations were made by the lecturers to minimize the current barriers for operating BIM. The methodology used for this paper included gathering a large amount of information and data from the past studies undertaken and preparing different types of questionnaires to ne responded. It was observed that the students' perception regarding the BIM software was poor; however, they were aware of its advantageous during the 3 different stages of construction.

When it came to rank the barriers identified in the questionnaire, too much time is needed for learning BIM software, high cost& training of software andthe age of lecturers were regarded as the three major obstacles by the students, while the lecturers contemplated software related issues, lack of BIM textbooks and other educational resources and limited number of courses students can take as the main barriers. On the other hand, most lecturers were of the opinion that required training for the lecturers and know how to transfer to their students and realizing the value from facilitating the construction process by the students would be the most beneficial recommendations in order to diminish the negative impacts of obstacles mentioned in the questionnaires that may have on utilizing BIM properly in educational system.

6.0 REFERENCES

[1] Alshawi, B., and Ingirige, B, 2003. Web-enabled project management an emerging paradigm in construction.

Automation in Construction 12 (4): 349–364.

[2] Williams, T, 2002. Modeling Complex Projects. Wiley, London, UK.

[3] Chan, A.P.C., Scott, D., and Chan, A.P.L, 2004. Factors affecting the success of a construction project. Journal of Construction Engineering and Management 130 (1): 153–155.

[4] Clough, R.H., Sears, G.A., and Sears, S.K, 2008. Construction Project Management: A Practical Guide to Field Construction Management. Wiley, New Jersey.

[5] Taxén, L., and Lilliesköld, J, 2008. Images as action instruments in complex projects. International Journal of Project Management 26 (5): 527–536.

[6]Succar, B, 2009. Building information modelling framework: a research and delivery foundation for industry stakeholders. Automation in Construction 18 (3): 357–375.

[7] ISO Standard, ISO 29481-1:2010(E), 2010. Building Information Modeling — Information Delivery Manual — Part 1: Methodology and Format.

[8] Mohandes, S, R., Abdul Hamid, A, R., andSadeghi, H, 2014.Exploiting Building Information Modeling Throughout the Whole Lifecycle of Construction Projects. Journal of Basic and Applied Scientific Research.,4(9): 16-27.

[9] Mohandes, S, R., Preece, C.,andHedayati, A, 2014. Exploiting the effectiveness of Building Information Modeling during the Stage of Post Construction. Journal of Basic and Applied Scientific Research. 4(10): 5-16.

[10] Nejat, A., Darwish, M. M., &Ghebrab, T. 2012. AC 2012-5582: BIM TEACHING STRATEGY FOR CONSTRUCTION EN-GINEERING STUDENTS.

[11] Yan Han, Peter and Damian, 2008.Benefits and barriers of building information modelling. 12th International Conference on Computing in Civil and Building Engineering

[12] Construction Research Institute of Malaysia (CREAM), 2014. Retrieved From: https://www.cidb.gov.my/cidbv3/images/pdf/announcement/BIM/bim%20seminar%20%20workshop%20for%20malaysia%20construction%20industry.pdf

[13] Barison, M. B., and Santos, E. T., 2010. BIM teaching strategies: An overview of the current approaches. International Conference of Computingin Civil and Building Engineering, W. Tizani, ed., Nottingham UniversityPress, Nottingham, UK: 577–584.

[14] Becerik-Gerber, A. M. A. B., Ku, K., and Jazizadeh, F., 2012. BIMenabledvirtual and collaborative construction engineering and management."Journal of Professional Issues in Engineering Education and Practice. 138(3): 234–245.

[15] Sabongi and Farid J, 2009. The Integration of BIM in the Undergraduate Curriculum: an analysis of undergraduate courses.45th Annual Conference of ASC.

[16] Wu, Wei, and Raja RA Issa., 2013. BIM Education and Recruiting: Survey-Based Comparative Analysis of Issues, Perceptions, and Collaboration Opportunities. Journal of Professional Issues in Engineering Education & Practice 140(2).

[17] Al-Hammad, Abdul-mohsen, and SadiAssaf., 1996. Assessment of work performance of maintenance contractors in Saudi Arabia. Journal of Management in Engineering 12(2): 44-49