International Journal of Innovation, Creativity and Change. www.ijicc.net
Volume 9, Issue 7, 2019

Assessing BIM Education Level in Quantity Surveying Programme: A Survey in Malaysian Higher Institution

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Building Information Modelling (BIM) is regard as the highly utilized technology in the construction industry. This new paradigm shifts have contributed to an increase in demand for Quantity Surveyors that have BIM skills and knowledge. It meets with the current demand; higher education institution has obligation to improve their current curriculum to embed in the BIM education. This paper highlights on the current BIM Education level of the quantity surveying degree programme in Malaysian Higher Institution. A quantitative study was conducted which involved 17 higher education institutions that offer degree programme in Quantity Surveying. Using the BIM education Framework for Quantity Surveying Students, their current BIM education level was identified. Findings reveal that the current BIM Education level in quantity surveying courses fall under infused level categories of visualisation, quantification, planning, scheduling and management. The implication of the findings implies that higher education institutions should be aware of the needs as well as necessity to embed BIM into the curriculum in the near future.

Key words: *Building Information Modelling (BIM) Education, Quantity Surveying, Malaysian Higher Education System, Building Information Modelling (BIM).*

Introduction

The evolution of drafting in the construction industry started with the pencil drawing which lasted for thousands of years. The process was then evolved from to 2D and 3D AutoCAD and now emerges to the implementation Building Information Modelling (BIM). BIM is defined as a process that involves generating and operating the construction project such as building and infrastructure digitally. BIM shared the information and data among professionals involved in a project and eased the decision making throughout the construction life cycle (National Institute of Building Sciences, 2007). The implementation of BIM has been proven to enhance the productivity and efficiency throughout the construction process in other countries such as United Kingdom, United States, Singapore, Hong Kong (Building Research Levy, 2016). Thus, Malaysian government has highly encouraged the application of BIM to transform Malaysian construction industry to a higher level. In reaching these objectives, several initiatives such as the Construction Industry Transformation Program (CITP) 2016-2020 and the BIM Roadmap (2014-2020) were introduced (Construction Industry Development Board (CIDB) Malaysia, 2015). Based on the BIM Roadmap (2014-2020), 300 to 600 graduates who were well equipped with BIM skills from Engineering and Built Environment courses need to be produced to meet the industry demand (Construction Industry Development Board (CIDB) Malaysia, 2017).

The 2018 NATSPEC report has shown that several countries such as Australia, Canada, China, Finland, Hong Kong, Netherland, New Zealand, Singapore, UK and US has conducted studies to identify the current level of BIM education. These countries have put in many efforts to impose BIM in their education system to increase the BIM awareness and train their graduates to be well adequate with BIM skills (Ali, 2013; Kevin, 2018). The United Kingdom on the other hand, have started to investigate the BIM education requirements in order to achieve Level 2 and Level 3 BIM.

The BIM education is not only about the skills to operate the BIM tools but also involve the collaboration of multidisciplinary in a project which include the engineer, architecture, quantity surveyor and parties that take part in it (Zhao, McCoy, Bulbul, Fiori, & Nikkhoo, 2015). In order to achieve the targeted BIM Roadmap (2014-2020), the Royal Institution of Surveyors Malaysia (RISM) has established an education framework in BIM implementation for the QS graduates in 2016. This framework can be used as a guideline to prepare and equip the students with BIM skills in project delivery in construction industry (Ali et al., 2015).

QS BIM Education Framework RISM

A BIM education framework for quantity surveying students have been proposed by Ali et al.(2016) to facilitate the BIM education for the Diploma and Degree programs in quantity surveying in Malaysia. Table 1.1 below shows the framework known as QS BIM. This

education Framework was accepted by the QS Accreditation Council (QSAC) and the Board of Quantity Surveying Malaysia (BQSM) and the members from both private and public Higher Education Institutes. There are four main focuses in this framework; visualization; quantification; planning and scheduling and management, as described in Table 1.1 below:

Table 1.1: QS BIM education Framework

	Diploma	**Degree**
MEDIUM	**OUTCOME**	**OUTCOME**
Visualisation		
Draughtsmanship	To be able to appreciate 2D design and basic 3D models	To be able to appreciate 2D design and basic 3D models
Construction Technology		
Construction Services		
Quantification		
Measurement	To be able to apply the quantity take-off software and spreadsheets software	To be able to apply the quantity take-off software and spreadsheets software
Cost Estimating		
Planning & Scheduling		
Cost Planning & Scheduling	To be able to appreciate the fundamental principle of cost planning and cost analysis through the application of appropriate software	To be able to understand the fundamental principle of cost planning, scheduling and cost analysis through the application of appropriate software
Cost Analysis	To be able to appreciate the economics of construction project using digital data through the application of appropriate software	To be able to evaluate the economics of construction project using digital data through the application of appropriate software. To be able to integrate 4D (scheduling) and 5D (QS BIM) into their tasks
Management		
Contract	To be able to appreciate the legal implications of the integrated project delivery system	To be able to assess the legal implications of the integrated project delivery system
Professional Practice	To be able to appreciate the procedural aspects of the integrated project delivery	To be able to assess the procedural aspects of the integrated project delivery system

	system	
Project Management	To be able to appreciate the complexity of working in interdisciplinary teams and managing collaborative design and production To be able to a construction through visualization of construction process	To be able to assess the complexity of working in interdisciplinary teams and managing collaborative design and production To be able to manage a construction project through visualisation of construction process

Source: Ali et al. (2016)

Visualization: referring to the courses that fall under visualization include the Draughtsmanship where the introduction of the BIM software as a tool for design; Construction Technology in improving students' knowledge and skills on the construction documents, construction safety, mechanical system, the construction building codes and the construction services using BIM.

Quantification: referring to the courses that fall under quantification which include measurement and cost estimating. The students are required to take-off using the BIM software to perform an effective measurement to meet the current industry demand.

Planning and Scheduling: referring to the courses which involve Cost Planning & Scheduling and Cost Analysis (4D & 5D BIM) where the students are required to perform the cost planning and analysis using the BIM software and evaluate the project status accordingly.

Management: referring to the courses involve include the Contract courses, Professional Practice and Project Management where students will expose to the legal dimension when implementing BIM, the collaboration among different disciplines, the changes in adopting BIM throughout the entire construction life cycle.

To produce graduates equipped with BIM skills and knowledge, it is important for the higher education institutions to know and understand their current level as it will help to move forward in the right direction. To date, information on the current BIM Education level in QS programme in Malaysian Higher Education System is still minimal. Therefore, this research was undertaken to extend knowledge in assessing the current BIM Education level of QS degree programme in Malaysia.

Research Methodology

Data Collection

This research began with comprehensive literature reviews which focus on BIM education via reviewing relevant journals, articles, books, reports, conference proceedings and thesis. The process of evaluating and interpreting all the available resources relevant to this study will be carried out. Quantitative research approach was then used in identifying the level of BIM implementation in Quantity Surveying programme in Malaysia. For this, a questionnaire was designed based on the QS BIM education Framework. The questionnaire was divided into 2 sections; general information and current BIM education level. Referring to the BIM Education outcome, respondents need determine their BIM education level using the BIM teaching impact matrix as tabulated in Table 2 below:

Table 2: BIM Teaching Impact Matrix

BIM Level	Description
Absent	Not embedded
Aware	Key modules are identified, and BIM knowledge incorporated
Infused	Target modules identified for a BIM review. BIM impact identified in all areas of the curriculum, but BIM use restricted to a few.
Embedded	Full curriculum review to allow every module to identify changes required for delivery through a BIM model.

Source: HEA (2013)

The respondents for this questionnaire were Malaysian Higher Education Institute that offers degree in Quantity Surveying and accredited by the Board of Quantity Surveyors Malaysia (BQSM). A total 17 universities had been identified; 5 public universities and 12 private universities. The questionnaire was sent to the targeted respondents that shall include the Head of Programme, Module Leader, BIM lecturer and tutor that involve in planning the BIM Education in the program. The targeted respondents were contacted via email with attached URL link to the questionnaire.

Response

A phone call or a reminder letter or emails were sent out to respondents who did not reply to the questionnaires after reaching the deadline given. After two weeks of not receiving any reply, the statistic tests were then performed as the response rate is 47%, which meet the minimum response rate of 30% as stated by Sugiyono (2008) for the quantitative research in education sector.

Findings and Discussion

General Respondents Demographic

From the 47% response received, 38% of them were senior lecturers. This is followed by 25% of Module leader and BIM tutor and 12% of the respondents were the Head of Department, as shown in Figure 1. Figure 2 illustrates the experience of the respondents, where majority of them (50%) have experience of more than 10 years in education, 37.5% have 5 to 10 years' experience and 12.5% have less than 5 years' experience.

Figure 1. Respondents Position

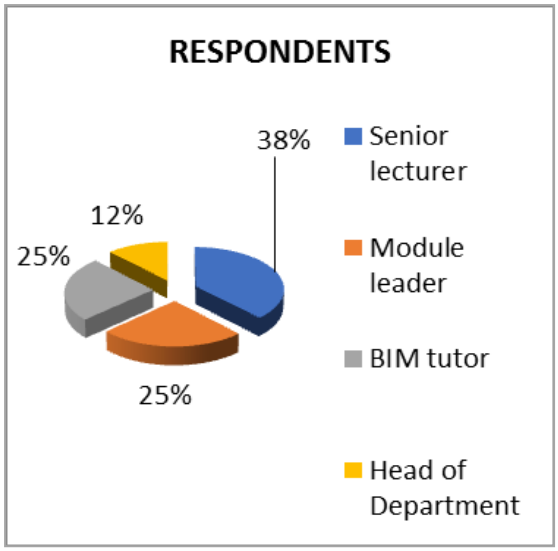
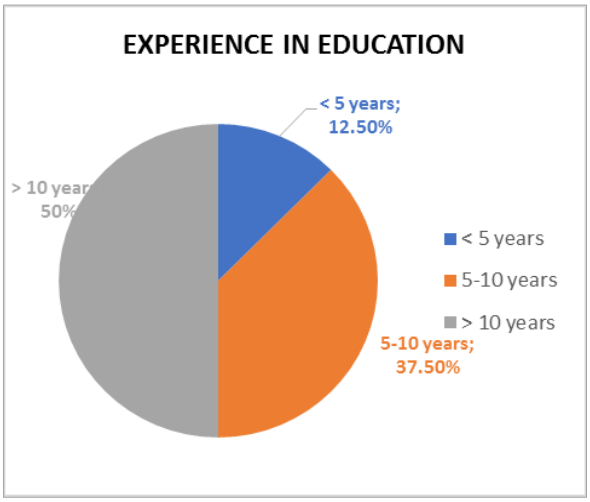


Figure 2. Respondents' experiences in education



BIM Education Implementation

The higher education institution is aware of the importance of incorporating BIM into their programme. Figure 23 shows that 12.5% higher education institution started to embed BIM in their programme since 2014 and 2015. Another 37.5% higher education institution started to embed BIM in 2016, 25% of the respondents in 2017 and another 12.5% in 2018.

Figure 3. Year of BIM Education Implemented

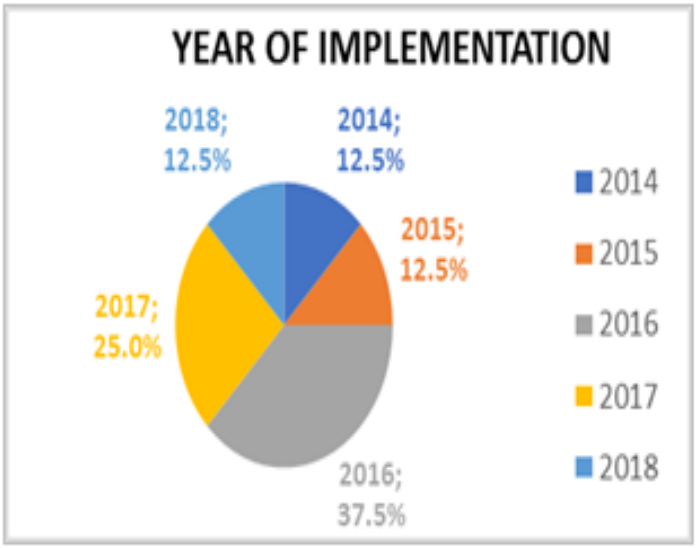
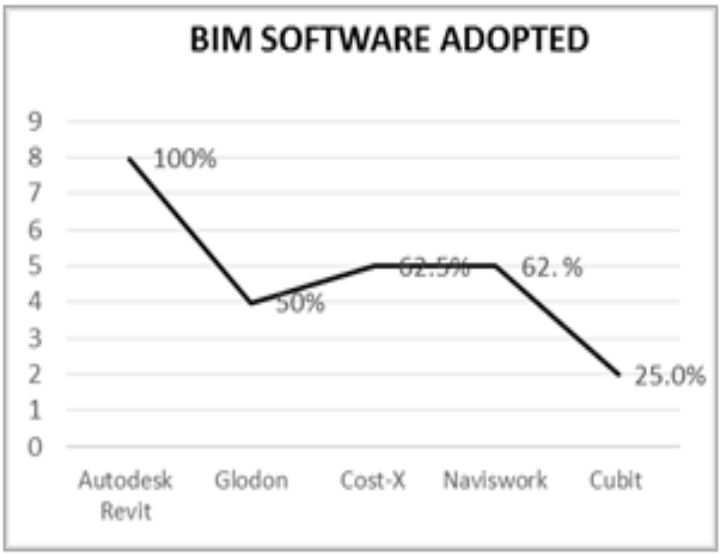


Figure 4. BIM Software Adopted



Method of Incorporating BIM

Majority of the universities which is about 62.5% have partially incorporated BIM into the curriculum. Another 37.5% universities have fully incorporated and embedded BIM into their quantity surveying module or program. In embedding BIM into their curriculum, several software's were introduced as illustrated in Figure 4. The common software is Autodesk Revit where all of the respondents have adopted it. This is followed by Cost-X and Autodesk Naviswork with 62.5%, Glodon with 50% and Cubit software with 25.0 %.

Current BIM Education Level

Respondents are required to determine their current BIM Education level based on the BIM Maturity Level and QS BIM Education Framework using the BIM Teaching Matrix. Findings were tabulated in Table 3 below:

Table 3: Current BIM Maturity Level

BIM Maturity Level	Percentage (%)			
	Absent	**Aware**	**Infused**	**Embed**
Level 0: Unmanaged CAD (2D drawings)	0	0	50.0	50.0
Level 1: Managed CAD (3D Models)	0.0	25.0	50.0	25.0
Level 2: File based collaboration (4D costing & 5D scheduling)	12.5	25.0	37.5	25.0
Level 3: Integrated BIM with multi disciplines up to 6D lifecycle	12.5	37.5	50.0	0.0

50% of higher educations have fully embedded BIM Maturity Level 0 into the curriculum, while another 50% were only at infused BIM Level 0. For BIM Maturity Level 1 (managed CAD, 3D Models), 25% of universities aware the needs of BIM Education, 50% has already infused BIM and another 25% has embedded BIM into their curriculum. BIM Maturity Level 2 (file based collaboration, 4D costing and 5D scheduling), 12.5% of the respondents did not incorporate and embed BIM element in their curriculum, 25% are aware on the needs, 37.5% were in infused stage and 25% had already embedded BIM into their whole curriculum. For BIM Maturity Level 3 (Integrated BIM with multi disciplines up to 6D lifecycle), 12.5% of higher education institution did not incorporate any BIM element up to this level. 37.5% of higher education institution aware on the needs of BIM Education to reach level 3 and 50.0% of higher education institution has fully embedded BIM Education into their curriculum.

Table 4: BIM Education Level on Visualisation, Quantification, Planning & Scheduling and Management

Categories	Outcome	Percentage (%)			
		Absent	Aware	Infused	Embedded
Visualization	Able to appreciate 2D design and Basic 3D Models	0.0	25.0	50.0	25.0
Quantification	Apply quantity take-off and spreadsheets using BIM software	0.0	12.5	37.5	50.0
Planning & Scheduling	Understand fundamental principle of cost planning, scheduling and cost analysis with BIM Software	0.0	12.5	50.0	37.5
	Evaluate economics of construction project using digital data through application of BIM software	0.0	25.0	50.0	25.0
	Integrate 4D scheduling and 5D costing	0.0	25.0	50.0	25.0
Management	Assess legal implication on the integrated project delivery system	0.0	25.0	62.5	12.5
	Assess the procedural aspects on the integrated project delivery system	0.0	12.5	62.5	25.0
	Managing interdisciplinary teams and collaborative design and production	0.0	37.5	62.5	0.0
	Manage construction project through visualisation of construction process	0.0	37.5	62.5	0.0

Based on table 4 above, 50% of the higher education institutions have infused Visualisation in the BIM Education. These higher education institutions have infused visualisation in the targeted modules where the students are able to appreciate 2D design and 3D models by generating, understanding, linking and interchange within one another but with restricted exploration. This is followed by 25% of higher education institutions aware of the needs of

enhance the ability of students in term of visualizing the 2D drawing and 3D models and the BIM knowledge have incorporated, but the skills required are yet to be developed in the future. 25% of the higher education institutions have fully embedded BIM into their curriculum. Changes were made in every module to ensure the students are able to understand, generate, link and interchange on 2D drawings and 3D models.

In term of Quantification, 50% of the higher education institution, have fully embedded it into the whole curriculum. With this, students are able to do their quantity take-off and spreadsheets in more efficient and accurate using the BIM software. Another 37.5% of higher education institution have infused Quantification in the BIM Education in targeted modules but with limited usage. While only 12.5% higher education institution are still in the awareness level on the advantages of using BIM software to enhance the taking off efficiency and accuracy.

Three different outcome were expected in the planning & scheduling categories, which cosist of (i) understand fundamental principle of cost planning, scheduling and cost analysis with BIM Software, (ii) evaluating economics of construction project using digital data through application of BIM software and (iii) integrating 4D scheduling and 5D costing. For the first outcome (understand fundamental principle of cost planning, scheduling and cost analysis with BIM Software, 50.0% of higher education institution have infused it in their modules, while 37.5% of higher education institution have fully embedded this aspects in their curriculum. However, only 12.5% of higher education institutions did not embed the principle into the curriculum but aware on the needs for students to understand the principle of applying BIM software for cost planning, scheduling and cost analysis. In term of evaluating the economics of the construction project, 25% of higher education institution have fully embedded the skills in their curriculum. 50.0% of the higher education institution have infused BIM element into their syllabus. BIM software has been applied to evaluate the economics of the construction project but with some limitation. Another 25% of of higher education institution have not developed the skills of evaluating project economics using BIM software but aware of the needs for the skills.The third outcome, which is linking 3D models with costing and scheduling information using BIM software, 50.0% of the higher education institution have infused BIM element into the syllabus but with limited exposure. However, 25% of higher education institution aware about the needs of the skills, but have not developed the skills to integrate 3D, 4D and 5D BIM. Only 25% of higher education institution that have fully embedded the skills into their curriculum which requires integration of 4D and 5D BIM on the 3D models.

Four outcomes were listed in the management categories; (i) assessing legal implication on the integrated project delivery system, (ii) assessing the procedural aspects on the integrated project delivery system, (iii) managing interdisciplinary teams and collaborative design and

production and (iv) managing construction project through visualisation of construction process. Table 4 shows that 12.5% of higher education institution have fully embeded the aspect of legal implication on the integrated project delivery system in their curriculum. 62.5% of higher education institution were still in the infused level and another 25% were aware about the importance of this aspect. In term of management in assessing the procedural aspects on the integrated project delivery system, 25% of higher education institution have fully embeded this element in their programme. Another 62.5% were in the infused level while 12.5% are still in the awareness level. For the third and fourth aspects which is the managing interdisciplinary teams and collaborative design and production and managing construction project through visualisation of construction process, none of the higher education institutions managed to fully embeded it in their programme.

Majority of the higher education institutions (62.5%) were in the infused level and 37.5% were in the awareness level. It can be seen that the third and fourth aspect of the management categories were hardly fulfilled by the higher education institution due to the difficulties to arrange a multidiscipline collaboration with other department such as architecture, planning, building surveying, engineering and other built environement related disciplines. A new module may need to be created that combine students from multidiscipline in equipping them with this skills. Students should be encourage to facilitate the digital data sharing process and appreciate the contribution of different disciplines in a project (Thomas, 2004). This module will become the basis in creating a mutual understanding on the principle of BIM, the process and the management standards throughout the construction process (Bozoglu, 2016). Besides that, the collaboration module provides a collaborative environment where students from different disciplines can share their own perspective in a project.

Conclusion

Higher education institutions should form the education landscape with regard to the national agenda to produce BIM-ready graduates. The current BIM Education level in the QS courses fall within the infused level where the BIM knowledge and skills are restricted in term of collaboration and applying BIM knowledge and skills practically. In moving towards the next level, different approaches of teaching strategies such workshop, collaboration, open-learning platform and project-based learning strategies should be adopted in embedding BIM into the curriculum. This is necessary in order to enhance the efficiency and accuracy of quantity surveying practice.

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