Journal of Positive School Psychology
2022, Vol. 6, No. 3, 357–365 http://journalppw.com

Challenges and Strategies to Integrate Building Information Modelling (BIM) into Quantity Surveying Programme in Sarawak Higher Education Institutions

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Abstract

Building Information Modelling (BIM) is being promoted in Malaysia by the Construction Industry Development Board (CIDB) and the Public Works Department (PWD) via seminars, and the BIM roadmap is being used as a reference. Moreover, there is a requirement from some organizations that requires the graduates to equip with BIM. However, the application of BIM knowledge and abilities is limited in terms of its usefulness in terms of cooperation and execution. Furthermore, higher education institutions participating in the QS programme are not aligned with industry needs, and the information and skills they supply are inadequate in comparison to the needs of the business. This study will thus be concerned with assessing the difficulties encountered and techniques used in integrating BIM into the QS curriculum at Sarawak higher education institutions. This research used a questionnaire survey aimed at academics from higher education institutions in Sarawak that offered the QS programme at the time of the study. The information gathered was analysed using the mean score, standard deviation, factor analysis, and ranking methods. The findings of the research highlighted twenty issues and ten solutions. The study results were organised into a few significant elements based on factor analysis of the problems identified. According to the authors, this research is vital to the QS programme and other related disciplines in architecture, engineering, and construction (AEC).

Keywords: Challenges; Strategies; Building Information Modelling (BIM) Integration; Quantity Surveying Programme; Sarawak Higher Education Institutions

1 Introduction

Public Work Department (PWD) and Construction Industry Development Board (CIDB) in Malaysia have encouraged construction contributors to incorporate BIM into the construction sector via the BIM roadmap and seminar that has been developed to serve as a framework for implementation (Latiffi et. al., 2015; Latiffi & Tai, 2019). According to the BIM Roadmap (2014 – 2020), in order to meet the needs of the construction sector, Built Environment and Engineering programmes must create 300 to 600 graduates who are well-versed in BIM capabilities (Aziz, et al., 2019).

Building Information Modelling (BIM) is more than simply a transition from paper-based design to electronic design; it represents a paradigm change in construction. Aside from that, Building Information Modeling (BIM) is a cutting-edge new way to building management, construction, and design that was published by Autodesk in 2002 in order to transform how professionals around the world think about how technology can be used to the management, construction, and design of buildings (Mamter et. al., 2018).

Referring to Latiffi et. al., (2016), building information modelling (BIM) is a methodology that may accelerate the project design process by up to 70% compared to traditional methods. Furthermore, building information modelling (BIM) may increase communication and coordination among construction participants, improve the overall quality of projects, and improve the public perception of the construction sector (Latiffi et. al., 2016; Wang & Lu, 2019). Due to the fact that quantity surveyors (QS) are one of the most important major professions in the building business, it could be stated that they should have appropriate and suitable BIM skills and knowledge.

Nowadays, as our construction industry continues to expand and progresses toward the use and adaptation of information and communications technology (ICT) for building projects, certain organizations are requiring Quantity Surveying (QS) graduates to be ready in BIM. As a result, there is an increasing need for higher education institutions (HEIs) that provide Quantity Surveying programmes that include BIM into their course curriculum in order to provide their QS graduates with BIM knowledge and expertise. According to McGraw Hill (2010), supported by Han and Bedrick (2015) and Babatunde et. al., (2018), conforming BIM into the QS course syllabus is vital which help to prepare BIM ready QS graduates for employment in the industry. This is because BIM adoption will suffer without integration into QS education.

In addition, several organisations demand Quantity Surveying (QS) graduates to be BIM-ready before they can work for them. As a result, there is an increasing need for higher education institutions (HEIs) that provide Quantity Surveying programmes that include BIM into their course curriculum in order to provide QS graduates with this expertise. To put it another way, according to McGraw Hill (2010), who is backed by Han and Bedrick (2015), incorporating BIM into the QS course curriculum is critical in training BIM-ready QS graduates for employment in the industry since, if it is not integrated into QS education, BIM adoption will suffer.

Higher education schools are expected to include BIM into the curriculum of the QS programme, with the cooperation of business and the government as a prerequisite (Puolitaival and Forsythe, 2016). Several scholars have undertaken studies on the integration of BIM, especially in the QS programme in West Malaysia, and have published their findings. Examples include research undertaken by Yusuf et. al., (2017) and another by Zainon et. al., (2016), both of which investigated the challenges to BIM incorporation into the QS course curriculum. However, there has been no research on the integration of BIM into quality assurance courses in Sarawak higher education institutions. As a result, the emphasis of this study will be on the problems and options associated with integrating BIM into the QS programme at Sarawak higher education institutions.

2 Literature Review

The pencil sketch was the beginning of the development of drafting in the construction industry, and it has been around for thousands of years. The procedure then progressed from 2D and 3D AutoCAD to the application of Building Information Modelling, which is now in its final stages (BIM). When it comes to construction projects, such as buildings and infrastructure, BIM is characterised as a procedure that includes digitally creating and running the project. BIM facilitated the exchange of information and data among the many experts participating in a project, hence facilitating decision-making throughout the construction life cycle (Babatunde & Ekundayo, 2019).

In other nations, such as the United Kingdom, the United States, Singapore, and Hong Kong, the application of BIM has been shown to increase productivity and efficiency throughout the building process (Babatunde & Ekundayo, 2019). According to Becerik-Gerber et. al., (2011) cited by Babatunde and Ekundayo (2019), the most significant knowledge areas that must be achieved in CM programmes are constructability, 4D scheduling, model-based estimation, and sustainability, with design, visualisation, and sustainability following closely after. Furthermore, building information modelling (BIM) is considered to be the most widely used technology in the construction sector. In response to these new paradigm changes, there has been a surge in the need for Quantity Surveyors who are proficient in and knowledgeable about building information modelling.

Quantity surveying (QS) is a profession well-known in the United Kingdom and

Commonwealth countries, where it is responsible to manage the contracts and costs in the industry (Babatunde & Ekundayo, 2019; Bowen et. al., 2008; Yean and Hui, 2008). This occupation is referred to as construction economics, a more formal designation all around the world. The profession is also referred to as the term cost engineering in China, North America, South America, and certain parts of Europe, among other places (E.F* et al., 2021; Babatunde & Ekundayo, 2019).

As cited by Babatunde and Ekundayo (2019) and Diaz (2016), Ashworth and Hogg (2007) asserted that the introduction of BIM would allow quantity surveyors to perform their traditional roles more effectively and efficiently. These roles include measurement, procurement advice, estimating and cost planning, and the preparation of bills of quantities, among other things. According to Olatunji et. al., (2021) and Gier (2015), building information modelling (BIM) has the potential to automate or assist in mundane elements of traditional quantity surveying, such as taking off and producing bills of quantities, thereby increasing efficiency, eliminating human error, and encouraging collaboration (Babatunde & Ekundayo, 2019).

According to the Royal Institution of Chartered Surveyors (2011) cited by Babatunde and Ekundayo (2019), creation of the bill of quantities in hours/days are enables by BIM for the quantity surveyor which can save the time and money. Referring to Babatunde and Ekundayo (2019) and Whatmore (2012), one of the most significant advantages of BIM is that it empowers quantity surveyors to devote more time to other value-adding services for their projects instead of spending up to eighty percent of their time measuring quantities, as they did in the previous generation of construction software. It has long been recognised that building information modelling (BIM) can affect every aspect of the quantity surveying sector, including the construction industry (Babatunde & Ekundayo, 2019). Quantity surveyors should embrace BIM to the most significant degree feasible to increase the cost-effectiveness and value of the construction process. Babatunde and Ekundayo (2019) and Olatunji et. al., (2010) suggested that a complete application of BIM across all disciplines was essential.

Consequently, the Malaysian government has vigorously encouraged the use of building information modelling (BIM) to raise the country's construction industry to a more sophisticated level. Many initiatives, such as the Building Information Modeling Roadmap (2014-2020) and Construction Industry Transformation Program (CITP) 2016-2020 have been adopted to attain these objectives (Babatunde & Ekundayo, 2019; CIDB Malaysia, 2015). Based on the BIM Roadmap (2014-2020), three hundred to six hundred graduates from Engineering and Built Environment courses who are well-equipped with BIM skills are required to be produced to meet the demand of the industry (Babatunde and Ekundayo, 2019; CIDB Malaysia, 2017).

2.1 Challenges and Strategies to Integrate Building Information Modelling (BIM) into Quantity Surveying Programme in Sarawak Higher Education Institutions

There is currently no definitive empirical research on the problems and solutions associated with the integration of BIM into QS programmes in Sarawak higher education institutions that has been published to our knowledge. This study provides a new perspective on what is occurring in the Sarawak AEC industry in terms of BIM adoption and the issues associated with incorporating BIM into construction education curriculum. While some of the obstacles and methods for BIM implementation are universal throughout the industry, others are unique to Sarawak, which is the largest state in Malaysia, even though progress are made in integrating BIM into AEC curricula nationwide.

According to the 2013 NATSPEC study cited by Babatunde and Ekundayo (2019), numerous nations, including Australia, Canada, China, Finland, Hong Kong, the New Zealand, Singapore, Netherlands, the United Kingdom, and the United States, have done studies to determine the present level of BIM education. These nations have made significant efforts to incorporate BIM into their educational systems in order to raise BIM awareness among students and prepare graduates to be well-versed in BIM capabilities after graduation (Babatunde & Ekundayo, 2019; Puolitaival & Forsythe, 2016). However, the United Kingdom has begun investigating the BIM education requirements for those wishing to acquire Level 2 and Level 3 BIM certifications, respectively.

BIM education encompasses more than just the ability to use BIM technologies; it also involves the cooperation of multidisciplinary teams on a project that may include the quantity surveyor, engineer, architect, and other parties involved in the project's implementation (Babatunde & Ekundayo, 2019; Waziri et. al., 2015). In 2016, an education framework about BIM implementation were established by the Royal Institution of Surveyors Malaysia (RISM) for the QS graduates in that year to achieve the targeted BIM Roadmap (2014-2020). The framework is used to be a guideline for the student to make sure they are prepared and equipped with BIM skills when delivering the project within the industry (Babatunde & Ekundayo, 2019).

3 Methodology

This study started with extensive literature evaluations that focused on BIM education, which included evaluating relevant papers, books, journals, reports, conference proceedings, and dissertations. The research team then conducted interviews with experts in the field. All of the accessible materials that are relevant to this study will be evaluated and interpreted over the course of the research process. Quantitative research approach was then used in identifying the challenges and strategies of BIM implementation in Quantity Surveying programme in Sarawak higher education institutions. For this, a questionnaire was designed based on the findings. The questionnaire was divided into four (4) sections; section 1: demographic details of respondents, section 2: overview of BIM exposures, section 3: challenges of integrating BIM into QS Programme and section 4: strategies of integrating BIM into QS Programme.

The respondents for this questionnaire were Sarawak higher education institutions that offers degree in Quantity Surveying and accredited by the Board of Quantity Surveyors Malaysia (BQSM). A total 6 universities had been identified: 2 public universities and 4 private universities. The questionnaire was sent to the academicians. The targeted respondents were contacted via email with attached URL link to the questionnaire.

4 Results and Findings

4.1 Demographic Details

Table 1 showed the demographic details of the respondents. Majority of the respondents are female (70%), Master's degree holders (75%) and have more than five years of academic experiences (60%). This indicate that female seems to be dominant in the quantity surveying departments of higher education institutions (HEIs) in Sarawak. There seems to have an overall coverage of respondents from different level of experiences and academic qualifications. The study managed to reach to the respondents in all higher education institution of Sarawak.

Table 1: Demographic details of respondents

Aspect	Criteria	Percentage (%)
Gender	Female	70
	Male	30
Highest academic qualification	Master's Degree	75
	Doctor of Philosophy (PhD)	25
Years of academic experiences	Less than 5 years	40
	5 to 10 years	30
	More than 10 years	30

(Source: Authors)

4.2 Overview of BIM's Exposures

The respondents were then asked on a few general questions of BIM, to explore their level of knowledge on BIM and the uptake of BIM implementation in the HEIs. The results showed that all respondents are aware about BIM (refer to Table 2). This indicate that all respondents had certain level of understanding about BIM and hence may provide insightful input into this study. Sixty percent and 25% of the respondents indicated that BIM implementation to QS programme were very relevant and relevant respectively, while the remaining 15% of the respondents indicated that such implementation was somehow relevant to the QS programme.

Table 2: General information on BIM's exposures

Aspect	Yes	No
Have you ever heard of BIM?	100%	0%
Has your institution implemented BIM into QS programme?	75%	25%
Have you ever involved/attended any BIM courses training?	95%	5%

(Source: Authors)

As shown in Table 2, 75% of the respondents indicated that BIM had been implemented into QS programme in the respective HEI. Based on the respondents who stated on BIM being implemented, 80% of them indicated that BIM had been implemented 0 to 4 years in their HEIs, while 20% of the respondents indicated 5 to 10 years that BIM had been implemented. None of the respondents selected the option of more than 10 years for BIM implementation in their HEIs. This seems to indicate that HEI in Sarawak are still at the early stage of implementing BIM into QS programme.

Ninety-five percent of the respondents specified that they had been involved and/or attended BIM courses training. Eighty-five percent and 15% of the respondents involved and / or attended less than five trainings and five to ten trainings respectively. This may indicate that HEI provided certain level of opportunity for the lecturers to be involved in the trainings, in enhancing their knowledge on BIM. Therefore, the majority of the respondents seems to have the basic knowledge on BIM.

4.3 Challenges of Integrating BIM into QS Programme

The respondents were asked to rank their level of agreement on the challenges of integrating BIM into QS programme (refer to Table 3).

Table 3: Mean, SD and rankings on challenges of integrating BIM into QS programme

Challenges	Mean	SD	Rank
BIM Curriculum			
Lack of accreditation criteria or requirements to guide the integration of BIM into a curriculum.	4.300	1.345	13
Difficulties of integrating different curriculum areas to realise the multidisciplinary aspect of BIM.	4.150	1.276	15
Limited of BIM-specific materials, textbooks, and other educational resources for students.	4.150	1.526	17
Difficulties in choosing an appropriate BIM software.	4.050	1.244	19
Difficulties in incorporating BIM element into the existing curriculum that has long been established.	4.150	1.352	16
Difficulties in finding a qualified expert in advising the development and delivery of a BIM curriculum.	4.700	1.453	4
Knowledge and Skills			
There is a challenge to employ new teaching method for BIM subjects.	4.600	1.281	6
Difficulties in educating lecturers due to rapidly evolving technology.	4.150	1.388	17
Required lecturers with practical experience in construction where undergraduates would have difficulties to relate BIM knowledge with construction context.	5.200	0.872	1
Lecturers have limited general IT skills.	4.300	0.900	12
Prior to engaging in BIM, students must have a solid foundation of BIM fundamental knowledge.	4.350	1.276	10
Lack of qualified lecturers to teach BIM course.	4.850	0.910	3
Support and Resources			
Needs to continually upgrade the BIM software as BIM is resource intensive.	5.000	0.949	2
High cost of training the lecturers.	4.600	1.020	5
Lack of space and facilities to accommodate BIM.	4.150	1.236	14

Lack of IT infrastructure.	4.500	1.466	8
Poor internet connectivity.	4.550	1.564	7
Difficulty to appoint due to lack of collaboration with industry expert.	4.450	1.359	9
Lack of university management supports due to lack of vision on BIM tangible benefits.	3.950	1.322	20
Lack of government initiative to assimilate BIM elements into tertiary educational framework	4.350	1.492	11

(Source: Authors)

The respondents opined that the most challenging part of integrating BIM into QS programme is that the lecturers who will be assigned to teach BIM, would need to have practical experiences in construction industry, with mean value of 5.200. This finding seems to be tally with the findings in Puolitaival and Forsythe (2016), who stated that lack of expertise among lecturers is the key challenges of implementing BIM into QS programme. Integrating BIM QS programme would require construction experts to deliver practical construction knowledge, as some terminologies may not be easily understood by the students in Nigeria (Babatunde & Ekundayo, 2019).

The challenge that had the second highest mean value of 5.000 was the "needs to continually upgrade the BIM software". This seems to imply that the respondents are concerned on the high costs associated with the BIM software initial purchasing and continuous upgrading. Khiyon (2016) supported that the high cost of BIM associated databases, software and hardware are the challenges of integrating BIM into QS programme in Malaysia. In Nigeria, Maina (2018) stressed on the high cost of BIM specified computers.

The third ranked challenge of BIM integration into QS programme was "lack of qualified lecturers to teach BIM course" with the mean value of 4.850 and SD of 0.910. Hedayati et al (2015) stressed that one of the challenges of implementing BIM in Malaysian HEIs is the lack of trained staffs. Khiyon (2016) further elaborated that some staffs in HEIs may face the limitation of BIM-related knowledge and skills in delivering BIM syllabus to the students. Yusuf et al (2017) found that lack of available lecturers with necessary BIM knowledge was ranked as the most significant challenges for incorporating BIM in HEIs.

It is worth noting that 16 out of 20 challenges in this study had the SD of more than one. This seems to indicate that the respondent may have quite a bit of variations in their opinions on the challenges of integrating BIM into QS programme. Such variations might also be contributed by the different level of exposures to BIM training as well as understanding on the current BIM status in QS programme. The six-point Likert scale might contribute to this situation, as the respondents would be able to classify their level of agreement in more detailed as compared to four or five-point Likert scale.

The Cronbach's alpha was used to ensure research reliability. The value between 0.60 and 0.80 are regarded as moderate but acceptable, while the value in the range of 0.80 and less than 1.00 are regarded as good (Creswell & Guetterman, 2020; Nunnally & Bernstein, 1994). The value of Cronbach's alpha of each of the three categories of challenges were: "BIM curriculum" = 0.86; "Knowledge and skills" = 0.74; "Support and Resources" = 0.93. As all the Cronbach's alpha are all more than 0.60, the results could be considered as acceptable.

4.4 Strategies to Integrate BIM into QS Programme

The respondents were asked to rank their level of agreement on the ten statements of strategies of integrating BIM into QS programme, with one being strongly disagree to six being strongly agree (refer to Table 4).

Table 4: Mean, SD and rankings on strategies of integrating BIM into QS programme

Strategies	Mean	SD	Rank
Collaboration with other higher education institution(s) with full incorporation commitment.	5.000	0.949	9
Collaboration among the industrial players and the lecturers.	5.400	0.735	3
Collaboration with professional bodies because professional bodies know what are the needs of construction industry.	5.250	0.829	7

The curriculum of the QS programme should be based industrial oriented so that graduates are BIM-ready.	5.300	0.843	6
Create a standalone BIM course that discusses all different uses of BIM with a focus on the use of software.	4.950	0.740	10
Determine the exact level of BIM competency that the students must achieve.	5.100	0.700	8
Provide an intensive BIM training to lecturers so that they will become a certified trainer, to incorporate BIM fully into the curriculum.	5.450	0.669	1
Conduct BIM software training workshop for students especially on the fundamental knowledge on BIM.	5.350	0.572	4
University to provide sufficient amount of resources to set up laboratories, and to purchase computer hardware and to BIM software.	5.400	0.663	2
Provide an open learning online platform for students and practitioners to learn at their own pace and share knowledge and problems.	5.300	0.557	5

(Source: Authors)

The highest ranked strategy for BIM integration into QS programme was related to providing an intensive BIM training to lecturers to allow the lecturers to become a certified trainer (mean value = 5.450). This seems to be tally with the findings in Table 3, as the first, third and fourth ranked challenges of BIM integration were related to the knowledge and skills of lecturers in delivering BIM in QS programme.

The second highest ranked strategy was that university has to provide sufficient amount of resources for setting up BIM-related hardware and software. Forsythe et al (2013) suggested that technical support is required for the incorporation of BIM into the Construction Project Management programme in one of the Universities in Australia. Ojo et al (2020) stressed on the importance of integral and integral involvement of different institutions to assist with the technological development in BIM. Therefore, it is undeniable that the involvement of universities in providing sufficient resources is crucial for the integration of BIM into the QS programme.

The third ranked strategy was related to the "collaboration among the industrial players and the lecturers" with a mean value of 5.400. Forsythe et al (2013) stressed that industrial players and other accreditation bodies had certain level of influence on integrating BIM into the Construction Project Management programme. Smith (2014) further explained that BIM could benefit the construction firms' efficiency, and this might require a fundamental shift of the firms' business strategies. Therefore, it seems undeniable that the earlier distribution of BIM knowledge to tertiary students are vital, to allow the future graduates in meeting the industrial demands.

It is worth noting that the SD of all ten strategies were less than one. This seems to point out that the respondents could have similar level of opinions on the strategies of incorporating BIM into QS programme. The Cronbach's alpha of the strategies of incorporating BIM was 0.92, which is more than 0.80, the general rules of thumb for the good research reliability.

5 Conclusion

Further investigation into the conclusions of this study will give more in-depth understanding and empirical data on the key problem of integrating BIM into the QS programme in Sarawak higher education institutions in the future. Aside from that, this study is significant not just to the QS programme, but also to other related disciplines within the framework of architecture, engineering, and construction (AEC). Those who work in the Sarawak higher education institutions' academic departments and management boards would find these results very useful in developing strategies for incorporating BIM into their course curricula.

Acknowledgement: This research is supported by the University of Technology Sarawak Research Grant (URG) (Grant ID: UCTS/RESEARCH/4/2020/04).

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