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Analysis of the drivers and benefits of BIM incorporation into quantity surveying profession: Academia and students' perspectives

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Abstract

Purpose –Building information modeling (BIM) inclusion in education pedagogy is crucial in preparing skilled graduates for employment in the construction industry. Against this backdrop, studies on BIM education abound in Architecture, Engineering and Construction (AEC) programmes in Higher Education Institutions (HEIs). However, there is limited empirical studies on BIM potentials in the quantity surveying (QS) profession in HEIs, particularly in developing countries. The purpose of this study is to identify and assess the BIM drivers and benefits as important to the QS profession using an empirical approach.

Design/methodology/approach – A comprehensive literature review was conducted to identify the BIM drivers and benefits in relation to the QS profession, which was employed to design a questionnaire. In order to capture a broad perception, a questionnaire survey was carried out which targeted the academia and final year undergraduate students from two selected universities offering QS honour degree programmes in Nigeria. Data collected were analysed using mean score, standard deviation, and Mann-Whitney test.

Findings – The study identified 12 BIM drivers in relation to the QS profession and the analysis of the ranking revealed that almost all the identified BIM drivers are considered by respondents as important. The study further identified 14 BIM benefits and the analysis of the ranking indicated that all the identified BIM benefits are considered as important. The results of the Mann-Whitney test indicated a very slight statistically significant difference, particularly in one of the selected universities on the ranking of the BIM drivers and benefits as important to the QS profession.

Practical implication –The findings of the study provide empirical evidence on the current perceptions of the drivers and benefits of BIM to QS academia and students as they explore the concept for the advancement of QS profession.

Originality/value – This study would provide practical insights to utilize BIM for QS practice. Also, this study would contribute to improving the QS graduates and professional quantity surveyors understanding of the BIM knowledge applicable to QS profession.

Keywords BIM, drivers, higher education institutions, quantity surveying, Nigeria

Research Paper

Introduction

Building Information Modelling (BIM) has been a growing trend in the construction industry, although BIM in some forms has existed over 20 years. Liu and Hatipkarasulu (2014) described BIM as an emerging trend in the construction industry and a much-desired skill for Architecture, Engineering, and Construction (AEC) students as they are preparing for their professional careers. Lee *et al*. (2013) described BIM as a process of creating an intelligent virtual model which integrates the project data from design to construction and operation. Thus facilitates project documentation, project quantification, and estimation. Lee and Dossick (2012) asserted that BIM takes a major role during the design and construction phases of a project, and there is a growing focus on the use of BIM for operations and maintenance. For example, Young *et al*. (2009) found that about 50% of the construction

industry in the United States are using BIM and its adoption will increase the positive returns from the use of BIM. BIM has become a central issue in the construction industry and many researchers currently explore the potential of BIM as a new ICT to improve productivity in the construction industry (Kim, 2012).

McGraw Hill (2010) reported that BIM inclusion in education pedagogy is crucial in preparing skilled graduates for employment in the industry. This is affirmed by Han and Bedrick (2015) that BIM adoption will suffer without its incorporation into education. Executing a BIM project requires new strands of expertise for all disciplines compared to more traditional projects (Puolitaival and Forsythe, 2016). This creates an obvious need for AEC students to know more about BIM in order to be knowledgeable in an arising area of relevance to both modern projects and the profession. Therefore, the incorporation of BIM in higher education is not only served the increasing demand for BIM professionals but also produce new opportunities for students in their professional careers in the form of their ability to deal with new occupational challenges with high efficiency achieved by applying BIM (Wong *et al*., 2011).

Studies on BIM education abound in Architecture, Engineering, and Construction (AEC) programmes in HEIs (see Taylor *et al*., 2008; Clevenger *et al*., 2010; Lee and Dossick, 2012; Panuwatwanich *et al.,* 2013; Sacks and Pikas, 2013; Shelbourn *et al*., 2017). Other relevant studies include Olawumi and Chan (2018) evaluated the perceived benefits of integrating BIM and sustainability practices in construction projects and authors found that the ability to enhance overall project quality and efficiency, and improve the ability to simulate building performances are the most important benefits. Wong and Yew (2017) investigated barriers to implementing BIM in quantity surveying firms in Sarawak, East Malaysia, and the authors found that high initial cost, lack of training and knowledge as the top ranked barriers. Ghaffarianhoseini *et al*. (2017) examined current benefits associated with the use of BIM and found that BIM definitive benefits have not been fully capitalized by industry stakeholders. Ali *et al*. (2016) developed BIM educational framework for quantity surveying students in Malaysia. In Nigeria, few studies have been conducted on the issues of BIM implementation. For instance, Abdullahi *et al*. (2011) assessed the application of BIM in the Nigerian construction industry and the authors found a low level of knowledge of BIM in the Nigerian construction industry. Abubakar *et al*. (2013) examined the readiness of building design firms to adopt BIM technologies and the study showed that the design firms are very ready to implement BIM technologies in their practices. Abubakar *et al*. (2014) investigated the level of BIM awareness and barriers to its adoption in the Nigerian construction industry from the contractors' perspectives. In spite of these previous studies, there is a limited occurrence of research into BIM potentials in the QS profession in HEIs (Fung *et al*., 2014). Also, prior studies that considered BIM drivers and benefits into QS profession from perspectives of academia and students are not very common. Therefore, this study was guided by the following derived objectives:

- identify the BIM drivers and benefits in relation to QS profession, and
- assess the perceptions of the academic and students on the ranking of identified BIM drivers and benefits in the order of perceived importance

It is anticipated that this study would contribute to improving the QS graduates and professional quantity surveyors understanding of the BIM knowledge applicable to QS profession. Hence, this study would connect QS graduates more effectively to the industry.

Literature review

BIM drivers and benefits relating to quantity surveying profession

Quantity Surveying (QS) is a profession that is well established in the British Commonwealth as being responsible for the management of cost and contracts in the construction industry (Pheng and Ming, 1997; Bowen *et al*., 2008; Ling and Chan, 2008). The profession is also known as construction economics in some European countries and in other parts of the world. Further, the profession is term cost engineering in the North and South America, China and some parts of Europe (Pathirage and Amaratunga, 2006; Smith, 2009). Due to the emergence of BIM, Ashworth and Hogg (2007) asserted that the traditional role of quantity surveyors, which include estimating and cost planning, procurement advice, measurement, preparation of bills of quantities among others could be more effectively and efficiently achieved using BIM. This is affirmed by Olantunji *et al*. (2010) and Zhou *et al*. (2012) that BIM has the potential to remove mundane elements of traditional quantity surveying, such as taking off and the production of bills of quantities, by automating or assisting in these tasks removing human error, increasing efficiency and promoting collaboration. RICS (2011) reported that BIM enables the quantity surveyor to produce the bill of quantities in hours/days rather than weeks/months. This is supported by Whatmore (2012) that one of the key benefits of BIM is that it allows quantity surveyor to focus more on other value-adding services for their projects-rather than spending up to 80% of their time measuring quantities.

It has been recognized that BIM has a high potential to inspire every aspect of the quantity surveying profession (Pittard, 2012). Hence, the quantity surveyors should fully embrace BIM in order to increase the cost-effectiveness and value of construction processes. Olatunji, *et al.* (2010) advocated the need for the full adoption of BIM across all disciplines. Therefore, it is important to understand the drivers for adopting BIM in quantity surveying practice. Thus, Table I indicates the selected drivers for BIM adoption in the quantity surveying profession.

>>>>>>>>>> Insert Table I >>>>>>>>>

It is important for the quantity surveyors to appreciate BIM, understand its potential, and develop effective processes to integrate BIM into their current practices (Cartlidge, 2011). This is supported by Wu *et al*. (2014) that quantity surveyors should aware of the opportunities that BIM could bring in relation to their current and future roles. Therefore, Table II presents the selected BIM benefits relating to the quantity surveying profession.

>>>>>>>>>> Insert Table II >>>>>>>>>

Existing studies have highlighted the reasons for integrating BIM into the QS profession (Sabol, 2008; Eastman *et al*., 2011). For instance, Thomas (2010) identified some reasons as follows:

- 30% of the projects do not meet the original programme or budget
- 37% of materials used in construction become waste
- 10% of the cost of a project is typically due to change orders
- 38% of carbon emissions are from buildings not cars

Sabol (2008) described that during conventional (e.g. manual) project development, accurate, actionable costing information has been difficult to define during preliminary project phases.

This process is prone to human error and tends to propagate inaccuracies. The quantification is time intensive, which requires 50% to 80% of a cost estimator's time on a project. However, the development of early cost estimates is widely facilitated by BIM (Sabol, 2008). This is supported by Nagalingam *et al*. (2013) that BIM reduces the resources needed for a construction project and costs are saved on the reduction of resources. This is affirmed by Gier (2015) that BIM is a helpful teaching tool for construction estimation, quantity take-off and highly contribute to design comprehension skills and understanding of construction materials, methods, and processes.

Research methodology

The target population for this study comprised the academic staff and students in final year at undergraduate level from two selected public federal universities in Southwestern Nigeria to include Obafemi Awolowo University, Ile-Ife, and the Federal University of Technology, Akure offering quantity surveying honours degree programmes. The basis for selecting only this group (i.e. academics and students), for example, Perera *et al*. (2013) identified the key stakeholders with influence on QS education and practice as academics, industry and professional bodies. Academic stakeholders were deliberately selected for this study due to their accurate knowledge of QS programme and students in their final year were chosen because of their appreciation of the QS programme learning outcomes. Academics also play a significant role in designing and maintaining the curriculum used to teach QS students (Perera *et al*., 2016). This study established the drivers and benefits of BIM incorporation into quantity surveying by evaluating academic and student perceptions. A similar approach was adopted in a construction-related research conducted (see Ekundayo *et al*., 2011; Tan *et al*., 2017). In addition, this approached was similar to previous studies on BIM education. For instance, Clevenger *et al*. (2010) administered questionnaires to students when exploring the incorporation of BIM into the construction management curriculum. Hedayati *et al*. (2015) surveyed both the students and lecturers when exploring the obstacles to implementing BIM in the educational system. Abbas *et al*. (2016) sampled only academic staff when exploring the current state of BIM in the construction management programme at the engineering universities in Pakistan.

The rationales for selecting these two universities are as follows: (1) they are the leading universities offering quantity surveying honours degree programmes in Southwestern Nigeria; (2) their QS programmes are fully accredited by both the National Universities Commission and the Quantity Surveyors Registration Board of Nigeria; and (3) they have the highest number of quantity surveying students' enrollment at undergraduate study. This study adopted a literature review and questionnaire survey, which are detailed as follows.

Literature review

An extensive literature review was conducted to identify the BIM drivers and benefits as important to the QS profession. These were identified from the significant literature. The outcome of the literature review produced 12 BIM drivers and 14 BIM benefits relating to the QS profession (see Tables I and II for details). These were used to design the questionnaire survey. This is, therefore, form the basis of inquiry for the data collection and analysis.

Questionnaire survey

The data for the study were collected through the administration of questionnaires to both the academic staff and final year students from the two selected universities to include quantity surveying department at Obafemi Awolowo University (OAU), Ile-Ife, and quantity surveying department at the Federal University of Technology Akure (FUTA). The total

number of academic staff in the quantity surveying department from the two universities is 39 academic staff comprised 13 academic staff at OAU and 26 academic staff at FUTA. Due to the small sample size of the academic staff from both universities, the entire 39 academic staff were sampled. Out of which 27 completed responses were received comprising 10 responses from OAU and 17 responses from FUTA. Similarly, in 2016/2017 academic session, the total number of final year undergraduate students in the quantity surveying department from the two universities was 161 students comprised 62 students at OAU and 99 students at FUTA. A total of 81 students were randomly selected to include 31 students at OAU and 50 students at FUTA. The survey received 28 completed responses from OAU and 45 completed responses from FUTA. This resulting in a total of 73 fully completed responses from students. The high response rate obtained in this study was due to the fact that the questionnaires were distributed face-to-face (i.e. hand delivery) and follow-up through telephone contacts and text messages are carried-out to remind the respondents to complete the questionnaires.

The questionnaire designed for the study was structured and multiple-choice type. The questions were asked on a five-point Likert scale with 5 being the highest of the rating. A reliability test using Statistical Package for the Social Sciences (SPSS) was conducted. The result indicated the reliability coefficient values of Cronbach's alpha 0.901 and 0.890 for the BIM drivers and benefits, respectively. These Cronbach's alpha values signifying that the questionnaire used for the study is reliable and indicates evidence of good internal consistency. This is corroborated by George and Mallery (2003) that Cronbach's alpha value of greater than 0.6 is considered acceptable. This is affirmed by Pallant (2007) that the value for Cronbach's alpha should be higher than 0.7 for the scale to be reliable. In this study, both the descriptive and inferential statistics were conducted for the analysis. The descriptive statistics techniques used include the mean score and standard deviation. The mean score was used for the ranking of identified BIM drivers and benefits relating to quantity surveying practice. Also, the inferential statistics employed was the Mann-Whitney test. This is supported by Field and Miles (2012), and Field (2013), which stated that the Mann-Whitney test was based on ranked data. In addition, Fellows and Liu (2008) asserted that the Mann-Whitney test is used when there are two samples. Therefore, the Mann-Whitney test was conducted in this study to determine whether there is a statistically significant difference in the ranking of the identified BIM drivers and benefits between the academic staff and students. The Mann-Whitney test was undertaken at a significance level of 5%. This implies that the p-value for each factor is significant if it is less than 0.05 (see Table III and Table IV). This approach was supported by earlier studies. For example, Olawumi and Chan (2018) carried-out Mann-Whitney test for both the academics and practitioners' groups as well as the West versus the East groups, when evaluating the perceived benefits of integrating BIM and sustainability practices in construction projects. Famakin *et al*. (2012) conducted the Mann-Whitney test to determine the difference in the sample means of two groups comprised consultants and partners in the ranking of success factors for a joint venture in Nigeria.

Results and discussion

Background information of respondents

Figure I indicates the background information of the academic staff in quantity surveying (QS) department from the two selected universities comprised OAU and FUTA. It can be seen from Figure I that the background information of academic staff only was indicated. It is because the other category of respondent was final year undergraduate students in the QS department from the aforementioned two universities. Therefore, there is no need for any

further background information regarding the students. Figure I reveals the background information of the academic staff in terms of academic qualification, designation of academic staff and year of service as an academic staff undertaken by the respondents in the two selected universities. The academic qualifications of respondents revealed that the majority of the respondents had PhD, followed Master's Degree. It can also be seen from Figure I that the designation of the respondents cut across the academic staff cadre in a university (see Figure I a-c for details).

>>>>>>>>>> **Insert Figure 1a-c** >>>>>>>>>

Ranking of the BIM drivers in the order of perceived importance to QS profession

Table III indicates the ranking for each of the 12 identified BIM drivers from two different groups comprised academic staff and students in the two selected universities. Based on a five-point Likert scale, an attribute was deemed important if it had a mean value of 3.5 or more (Badu *et al*., 2012; Babatunde *et al*., 2016). In each two group ranking, given two or more identified factors (see Table III) with the same mean value, the one with the lowest standard deviation was assigned highest importance ranking (Field, 2005). In addition, based on the total ranking, the identified factors that have the same total mean values were given the same rank (see Table III). The analysis of the ranking in terms of the total mean score values for the 12 identified BIM drivers ranging from 3.42 to 4.07, this indicates that almost all the identified BIM drivers are considered by respondents as important. For instance, it can be seen from Table III that 11 (out of 12) identified BIM drivers had total mean values between 3.63 and 4.07, which are considered as important drivers for the BIM implementation by the respondents. Also, as shown in Table III, the top five ranked BIM drivers are: desire for innovation to remain competitive; improving the capacity to provide whole life value to client; enabling environment-provision of IT infrastructure; awareness of BIM tangible benefits; and availability of trained staff from academia and industry with their total mean values of 4.07, 3.85, 3.81, 3.80 and 3.79, respectively.

The only factor that ranked least was clients' demand for the use of BIM in their project with the total mean value of 3.42 (see Table III). This is not surprising because the adoption of BIM is still at the infant stage in the Nigerian construction industry and the majority of the clients comprised public and private clients are not fully aware of BIM benefits, as it is difficult to find the completed projects where BIM was used in Nigeria. This study finding is in contrast with previous studies, particularly in the UK and Australia. For instance, in the UK and Australia, the government is widely cited as the key driving force for BIM adoption. For example, both the UK and Australia governments have set a target of 2016 for compulsory BIM use on public sector projects (BuildingSMART Australasia, 2012; Eadie *et al*., 2013). In addition, National Building Specification (NBS) (2012) reported that from the year 2010 to 2011 in the UK, construction professionals using BIM were more than doubled (from 13% to 31%). This rapid uptake of BIM is largely attributed to proven business benefits from its implementation, e.g. increased profits and positive returns on investment (NBS, 2012). Similarly, in the UK, Eadie *et al*. (2013) found that the three most important drivers for BIM implementation are clash detection, government pressure, and competitive pressure.

In order to determine whether there is a statistically significant difference in perceptions of the respondents on the ranking of 12 identified BIM drivers. The Mann-Whitney test was

conducted at a significance level of 5%. Based on the results of the Mann-Whitney test at OAU, there is no statistically significant difference in perceptions of the academic staff and students on BIM drivers as important to QS profession. Since their p-values are greater than 0.05 (see Table III). On the other hand at FUTA, the results of the Mann-Whitney test indicated a very slight statistically significant difference on three (out of 12) identified BIM drivers. These three drivers are: BIM software availability and affordability; awareness of BIM tangible benefits; and clients' demand for the use of BIM in their project. This little significant difference could be attributed to the maturity of the respondents in relation to the BIM implementation.

>>>>>>>>>> Insert Table III >>>>>>>>>

Ranking of the BIM benefits in the order of perceived importance to QS profession

Table IV shows the analysis of the ranking in terms of the total mean score values for the 14 identified BIM benefits ranging from 3.77 to 4.34; this indicates that all the identified BIM benefits are considered by respondents as important benefits of BIM implementation in relation to the QS profession. This is supported by Badu *et al*. (2012) that an attribute was deemed important if it had a mean score value of 3.5 or more on a Likert scale of 5 point. It can be seen further from Table IV that six (out of 14) identified BIM benefits have mean score values between 4.03 and 4.34, and the remaining eight BIM benefits have mean score values between 3.77 and 3.98. In addition, the top six ranked BIM benefits that displayed mean score values ranging from 4.03 to 4.34 are: BIM provides fast, effective and efficient quantity take-off and cost estimation; improve cost database management which reduces loss of information; produce reliable and accurate quantities as well as competitive cost estimates; enhance communication and collaboration amongst team members; time savings in the preparation of estimating costs; and it generate accurate cost estimates for various design alternatives, respectively. This study finding affirms the previous studies, especially Stanley and Thurnell (2014) who asserted that there is huge potential for BIM use by quantity surveyors for such tasks as quantity take-offs, estimation and cost management, in a collaborative project environment. This finding is not surprising because the top six ranked BIM benefits are perceived importance of BIM in relation to the QS profession by the respondents. Therefore, the QSs both in the industry and academia including quantity surveying students need to improve their knowledge and skills in BIM and apply BIM into their daily practices. This is supported by Nagalingam *et al*. (2013) who claimed that understanding the BIM is compulsory for QSs and incorporation of BIM into the QS profession would make the QSs perform their practices better in a sustainable manner. Moreover, in order to test if there is any significant difference in the perceptions of the respondents on the ranking of 14 identified BIM benefits in relation to QS profession. The Mann-Whitney test was conducted at a significance level of 5% cut-off. The results of the Mann-Whitney test (see Table IV) indicated that there is no statistically significant difference in perceptions of the respondents at OAU on the ranking of the BIM benefits as important to the QS profession. While at FUTA, there is a statistically significant difference on three (out of 14) identified BIM benefits in relation to the QS profession. Since their p-values are less than 0.05 (see Table IV for details).

>>>>>>>>>> Insert Table IV >>>>>>>>>

Conclusions

This study provided empirical evidence on the current perceptions of the drivers and benefits of BIM implementation in relation to the QS profession. The study identified 12 BIM drivers and the analysis of the ranking in terms of the total mean score values for the 12 identified BIM drivers indicated that almost all the identified BIM drivers are considered by respondents as important. The study further revealed the top five ranked BIM drivers as follows: the desire for innovation to remain competitive; improving the capacity to provide whole life value to the client; enabling environment-provision of IT infrastructure; awareness of BIM tangible benefits; and availability of trained staff from academia and industry, respectively. The only factor that ranked least was clients' demand for the use of BIM in their project. This is not surprising because the adoption of BIM is still at an infant stage in the Nigerian construction industry and the majority of the clients comprised public and private clients are not fully aware of BIM benefits, as it is difficult to find the completed projects where BIM was used in Nigeria. This study finding is in contrast with previous studies, particularly in the UK and Australia, where the government is widely cited as the key driving force for BIM adoption.

Similarly, the study identified 14 BIM benefits and the analysis of the ranking in terms of the total mean score values indicated that all the identified BIM benefits are considered by respondents as important benefits for the BIM implementation in relation to the QS profession. In addition, the top six ranked BIM benefits that displayed mean score values ranging from 4.03 to 4.34 are: BIM provides fast, effective and efficient quantity take-off and cost estimation; improve cost database management which reduces loss of information; produce reliable and accurate quantities as well as competitive cost estimates; enhance communication and collaboration amongst team members; time savings in the preparation of estimating costs; and it generate accurate cost estimates for various design alternatives, respectively. This study finding affirms the previous studies that alluded to the huge potential for BIM use by quantity surveyors for such tasks as quantity take-offs, estimation and cost management, in a collaborative project environment. Therefore, the QSs both in the industry and academia including quantity surveying students need to improve their knowledge and skills in BIM and apply BIM into their daily practices. Hence, understanding the BIM is compulsory for QSs and incorporation of BIM into the QS profession would make the QSs perform their practices better in a sustainable manner.

In addition, the results of the Mann-Whitney test was conducted on both the BIM drivers and benefits as important to the QS profession. The result indicated that there was no statistically significant difference in perceptions of the respondents at OAU. While at FUTA, a very slight statistically significant difference was found. This could be attributed to the lived experience of the respondents and their familiarity with quantity surveying practice in the industry. This study is not without limitations. For instance, the respondents considered in this study were academic and final year undergraduate students, considering respondents from the industry would have enhanced the credibility of the findings. Also, the use of questionnaire survey allows a large sample to be captured, other methods such as interviews might have been conducted to complement questionnaire survey with a view to revealing the country-specific BIM drivers and benefits as important to the QS profession, which may enrich the findings. However, the findings of this study provide useful insights about BIM to the QS professionals and students as they explore the concept for the advancement of the QS profession. Also, this study contributes to improving the QS graduates and professional quantity surveyors understanding of the BIM knowledge applicable to the QS profession; thereby enable the QS understands the benefits of BIM to their role. Further studies should be

conducted in other countries to derive the specific country's BIM drivers and benefits as important to the QS profession.

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Table I: BIM drivers as important to quantity surveying profession

S/n	BIM drivers	Reference
1	Desire for innovation to remain competitive	Ruikar *et al*., 2005; Eadie *et al*., 2013
2	Improving the capacity to provide whole life value to client	Azhar *et al,* 2011; Deutsch, 2011; Eadie *et al*., 2013
3	Availability of trained staff (from academia and industry) using BIM to teach the students	McDonald, 2012; Badrinath *et al.,* 2016
4	BIM software availability and affordability	Macdonald 2012; Eadie *et al*., 2013
5	Enabling environment-Provision of IT infrastructure	Oladapo 2007
6	Cooperation and commitment of professional bodies to its implementation	Oladapo 2007; Becerik-Gerber *et al*., 2011
7	Government support through legislation	Efficiency and Reform Group, 2011; buildingSMART Australasia 2012; Eadie *et al*., 2013
8	Awareness of BIM tangible benefits	Demirdoven 2015
9	Strong support from university management and industry	Becerik-Gerber *et al*., 2011; Badrinath *et al*., 2016
10	Accreditation standards and requirements to guide the implementation of BIM within the curriculum	Becerik-Gerber *et al.,* 2011; Macdonald 2012; Panuwatwanich *et al*., 2013; Badrinath *et al*., 2016;
11	Awareness of the IT among quantity surveyors	Oladapo 2007
12	Clients' demand for the use BIM in their project	Liu *et al.,* 2010; Eadie *et al*., 2013

Table II: BIM benefits relating to quantity surveying profession

S/n	BIM benefits	Reference
1	BIM provides fast, effective and efficient quantity take-off and cost estimation	Aouad *et al*., 2007; Sabol, 2008; Cartlidge; 2011; Eastman *et al*., 2011; Zhou *et al*., 2012; Choi *et al*., 2014; Stanley and Thurnell, 2014
2	Produce reliable and accurate quantities as well as competitive cost estimates	Azhar 2011; Deutsch, 2011; Stanley and Thurnell, 2014; Thurairajah and Goucher, 2013
3	It update cost plans with more details as design is developed	Sylvester and Dietrich, 2010
4	It generate accurate cost estimates for various design alternatives	Eadie *et al*., 2013; Thurairajah and Goucher, 2013
5	Time savings in the preparation of estimating costs	Nassar, 2012; Bryde *et al*. 2013; Eadie *et al*., 2013; Wu *et al*., 2014
6	Reduction of requests for information	Smith, 2014; Franco *et al*., 2015
7	Clash detection to reduce design errors	Eadie *et al*., 2013; Fung *et al*., 2014; Franco *et al*., 2015
8	Simplify cost checking and update	Sylvester and Dietrich, 2010; Fung *et al*., 2014
9	Improved visualization for better understanding of designs for measurement and minimize omissions	Sylvester and Dietrich, 2010; Thurairajah and Goucher, 2013
10	Automatic quantification of BOQs preparation	Aouad *et al.,* 2007; Autodesk, 2012; Zhou *et al.,* 2012
11	Data storage in central coordinated model	Sylvester and Dietrich, 2010; Franco *et al*., 2015
12	Enhance communication and collaboration amongst team members	Shen and Issa, 2010; Efficiency and Reform Group, 2011, Ahmad *et al*., 2012; Zhou *et al*., 2012; Bryde *et al*., 2013; Smith, 2014; Franco *et al*., 2015
13	Improve cost database management which reduces loss of information	Shen and Issa, 2010; Bryde *et al*., 2013; Fung *et al*., 2014
14	Rapid identification of design changes	Azhar, 2011; Fung *et al*., 2014

Table III: Ranking of the BIM drivers as important to quantity surveying profession

BIM drivers	Obafemi Awolowo University, Ile-Ife								Federal University of Technology, Akure								Total Mean	Total Rank
	Academic staff			Students			Mann-Whitney		Academic staff			Students			Mann-Whitney			
	Mean	SD	Rank	Mean	SD	Rank	Z-value	Sig.	Mean	SD	Rank	Mean	SD	Rank	Z-value	Sig.		
D01. Desire for innovation to remain competitive	3.80	1.55	1	3.89	0.80	5	0.694	0.488	4.41	0.71	1	4.18	0.72	1	1.188	0.235	4.07	1
D02. Improving the capacity to provide whole life value to client	3.30	1.42	4	4.00	0.92	2	-1.398	0.162	4.24	0.66	2	3.86	0.67	3	1.950	0.051	3.85	2
D03. Availability of trained staff (from academia and industry) using BIM to teach the students	3.30	1.64	6	3.96	0.90	4	-0.926	0.354	4.06	0.83	7	3.82	0.98	4	0.696	0.486	3.79	5
D04. BIM Software availability and affordability	3.30	1.83	8	3.74	1.23	10	-0.642	0.521	4.24	0.83	4	3.64	1.06	9	2.124	0.034*	3.73	6
D05. Enabling environment-Provision of IT infrastructure	3.40	1.71	2	3.81	1.08	7	-0.534	0.593	4.12	0.70	5	3.90	0.89	2	0.760	0.447	3.81	3
D06. Cooperation and commitment of professional bodies to its implementation	3.20	1.62	10	4.00	0.88	1	-1.322	0.186	3.94	0.75	11	3.78	0.84	6	0.482	0.630	3.73	6
D07. Government support through legislation	3.40	1.90	3	3.63	1.01	11	0.123	0.902	4.06	0.90	8	3.78	1.06	7	0.897	0.370	3.72	8
D08. Awareness of BIM tangible benefits	3.30	1.57	5	3.89	0.94	6	-0.924	0.355	4.24	0.67	3	3.78	0.79	5	2.063	0.039*	3.80	4
D09. Strong support from university management and industry	3.30	1.70	7	3.78	1.05	8	-0.619	0.536	3.94	0.66	10	3.62	0.97	10	1.106	0.269	3.66	10
D10. Accreditation standards and requirements to guide the implementation of BIM within the curriculum	3.20	1.81	11	3.74	1.13	9	-0.618	0.537	4.06	0.75	6	3.50	1.09	11	1.780	0.075	3.63	11
D11. Awareness of the IT among quantity surveyors	3.20	1.48	9	4.00	0.96	3	-1.524	0.128	3.88	1.11	12	3.72	1.09	8	0.670	0.503	3.70	9
D12. Clients' demand for the use BIM in their project	3.00	1.70	12	3.44	1.09	12	-0.703	0.482	4.06	1.09	9	3.18	1.17	12	2.789	0.005*	3.42	12

** Significant at $p < 0.05$

Table IV: Ranking of the BIM benefits as important to quantity surveying profession

BIM benefits	Obafemi Awolowo University, Ile-Ife								Federal University of Technology, Akure								Total Mean	Total Rank
	Academic staff			Students			Mann-Whitney		Academic staff			Students			Mann-Whitney			
	Mean	SD	Rank	Mean	SD	Rank	Z-value	Sig.	Mean	SD	Rank	Mean	SD	Rank	Z-value	Sig.		
B01. BIM provides fast, effective and efficient quantity take-off and cost estimation	3.90	1.10	5	4.52	0.70	1	-1.994	0.046	4.53	0.51	2	4.40	0.73	1	0.379	0.705	4.34	1
B02. Produce reliable and accurate quantities as well as competitive cost estimates	3.90	1.20	6	4.30	0.82	3	-0.902	0.367	4.59	0.51	1	4.00	0.64	2	3.218	0.001*	4.20	3
B03. It update cost plans with more details as design is developed	3.84	1.20	8	4.04	0.85	8	-0.036	0.971	4.12	0.99	10	3.92	0.63	5	1.625	0.104	3.98	7
B04. It generate accurate cost estimates for various design alternatives	4.00	1.15	3	4.11	0.80	5	0.110	0.912	4.24	0.66	7	3.78	0.71	13	2.245	0.025	4.03	6
B05. Time savings in the preparation of estimating costs	3.85	1.20	7	4.33	0.73	2	-0.983	0.326	4.29	0.59	5	4.00	0.88	3	1.115	0.265	4.12	5
B06. Reduction of requests for information	3.80	1.32	10	3.74	0.98	13	0.534	0.593	3.76	0.83	13	3.88	0.82	7	-0.477	0.633	3.80	13
B07. Clash detection to reduce design errors	3.80	1.40	11	3.81	0.92	12	0.416	0.678	3.71	1.16	14	3.74	0.75	14	0.420	0.674	3.77	14
B08. Simplify cost checking and update	3.70	1.16	13	4.00	0.78	10	-0.596	0.551	4.12	0.49	9	3.94	0.82	4	0.714	0.475	3.94	9
B09. Improved visualization for better understanding of designs for measurement and minimize omissions	3.70	1.33	14	4.07	0.96	7	-0.667	0.505	4.12	1.90	11	3.82	0.92	12	1.146	0.252	3.92	11
B10. Automatic quantification of BOQs preparation	3.80	1.55	12	4.04	1.02	9	-0.054	0.957	4.06	0.75	12	3.82	0.77	11	1.038	0.299	3.93	10
B11. Data storage in central coordinated model	3.80	1.23	9	3.85	1.10	11	-0.036	0.971	4.29	0.77	6	3.84	0.93	10	1.752	0.080	3.95	8
B12. Enhance communication and collaboration amongst team members	4.30	1.34	1	4.07	0.78	6	1.407	0.159	4.47	0.72	4	3.88	0.87	8	2.467	0.014*	4.18	4
B13. Improve cost database management which reduces loss of information	4.20	1.23	2	4.22	0.89	4	0.278	0.781	4.53	0.62	3	3.92	0.88	6	2.563	0.010*	4.22	2
B14. Rapid identification of design changes	4.00	1.25	4	3.56	1.09	14	1.350	0.177	4.18	0.64	8	3.86	0.93	9	1.225	0.221	3.90	12

** Significant at $p < 0.05$

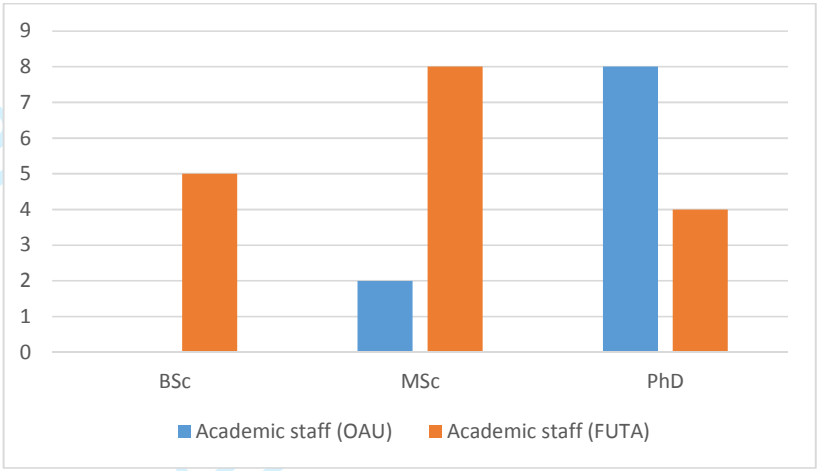

Figure Ia: Highest academic qualification of academic staff in the two universities

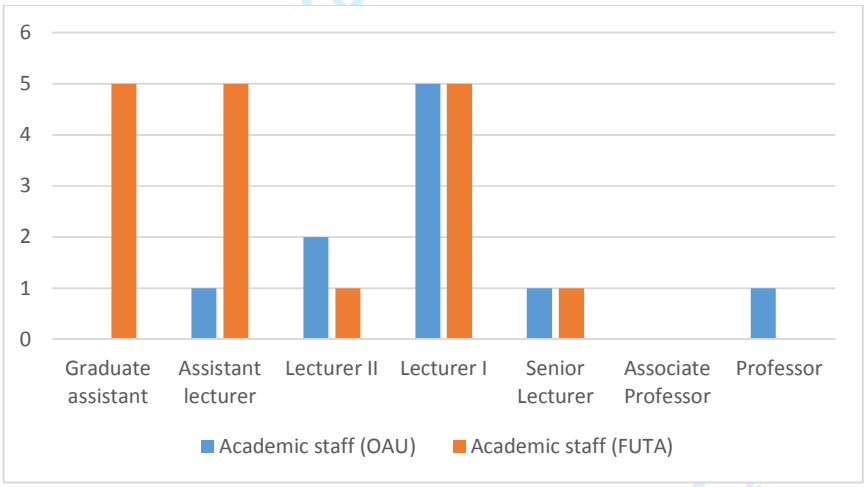

Figure Ib: Designation of academic staff academic staff in the two universities

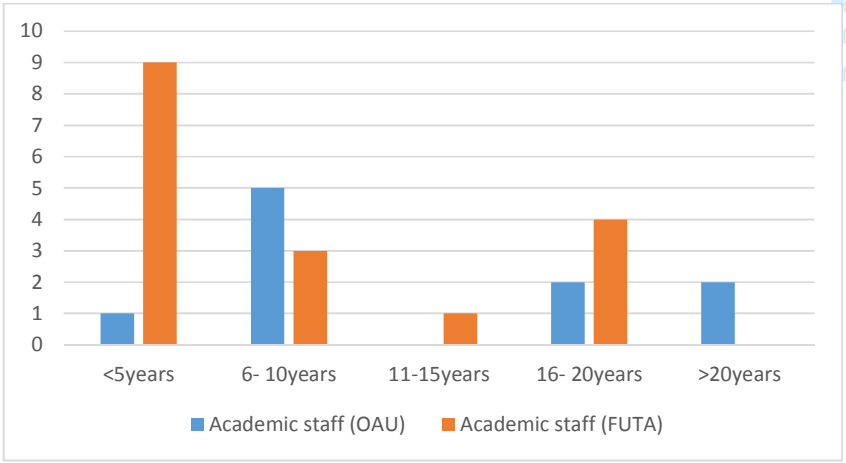

Figure Ic: Year of service as academic staff in the two universities

The authors thank the editor and the three anonymous reviewers for their constructive comments, which helped us to improve the manuscript. The comments have been addressed and incorporated into the manuscript in the colour text. Also, please see the attached "list of amendment table" for details.

List of amendment

Reviewer Comments to Author	Authors Response to Reviewer Comments
Reviewer 1	
Work on the test of significance again to improve quality of the paper	The authors are thankful for the comments. This has now been addressed. For instance, Mann-Whitney (U-test) test has now been conducted. (Please see colour text under Abstract, latter part of Research methodology, Tables III & IV and their discussions)
1. **Originality**: The paper hopes to provide useful insights and practical guide about BIM to QS professionals and students as they explore the concept for the advancement of QS profession	The authors are highly appreciative to the reviewer for his/her insightful comments
2**. Relationship to Literature**: The literature is well written. A good number of significant and up-to-date articles were cited.	The authors thank the reviewer for the diligent reading of the paper
3. Methodology: Yes. However, the authors should note that test of significance between academic staff and students (two independent sample sets) cannot be done using Kruskal Wallis. They should use any other non-parametric tool that meets the requirement such as Mann Whitney U test to re-run the analysis. They should also endeavour to state the decision rule for the test and make reference to past studies that have use similar tool in similar circumstance in the past.	Thank you for pointing these out. This has now been addressed. For instance, Mann-Whitney test has now been conducted (Please see colour text under Abstract, latter part of Research methodology, Tables III & IV and their discussions)
4. Results:….. Are results presented clearly, correct technically and analysed appropriately? Yes.	The authors are thankful for the comments
5. Implications for research, practice and/or society: …… Are these implications consistent with the findings and conclusions of the paper? Yes.	The authors are thankful for the comments
6. Quality of Communication: …… Has attention been paid to the clarity of expression and readability, such as sentence structure, jargon use, acronyms, etc.: Yes.	The authors are thankful for the comments.
Reviewer 2	
1. Originality: The paper explores a topic of interest for quantity surveying (QS) practitioners and educators. The purpose of the article is to assess key BIM drivers and benefits that are important to QS practice. However, there was a need to highlight how these drivers and benefits once identified would impact the AEC programmes in HEIs.	Thank you for pointing these out. The implications, particularly practical implication of the study has now been included in the conclusion section (Please see colour text in the latter part of conclusion section)
2**. Relationship to Literature**: The selected literature offers the basis for identifying the drivers and benefits for BIM, which provides strong backing for one of the objectives of the papers. However, it was not extensive, perhaps the inclusion of the following	The authors are thankful for the comments. This has now been addressed. (Please see colour text under the introduction and literature review sections)

Reviewer Comments to Author	Authors Response to Reviewer Comments
research (examples: Ali et al., 2016; Ghaffarianhoseini et al., 2017; Wong and Yeu, 2017) could offer more insights about these drivers and benefits.	
3. Methodology: The selected methodology is acceptable, and the approach of data collection and data analysis is described thoroughly. There is a need for a more methodical explanation to justify the reason for selecting the approach and respondents. Perhaps, offering a conceptual model would provide the reader with some insights.	The authors are thankful for the comments. This has now been addressed (Please see colour text under the first paragraph of Research Methodology section).
4. Results: The analysis demonstrates the ranking and significance of BIM drivers and benefits for quantity practice. While the objectives of the paper are met, the discussion of the results comes rather short suggesting it has only scratched the surface. Hence, there is a need for a more detailed discussion that contextuliases the findings by taking the focus and purpose of the paper into consideration. broader context.	The authors are thankful for the comments. The authors believed that the results are discussed in relation to previous studies, and it is well corroborated with external references. For instance, please see colour text for Table III and Table IV discussions. However, further detailed discussion might make the results look like guesswork
5. Implications for research, practice and/or society: There is no explicitly stated implication for the research as there is a disconnect between the literature, findings and conclusions.	Thank you for pointing these out. The implications of the study has now been included in the conclusion section (Please see colour text in the latter part of conclusion section)
6. Quality of Communication: The paper is well-written and will be understandable to a broader readership.	The authors are thankful for the comments
Reviewer 3	
It is recommended that the author(s) should re-look at the title of the paper to reflect the level of work done.	The authors are thankful for the comments. This has now been addressed (i.e. the title of the paper has now been revised)
1. Originality: The way and manner in which argument has been built up seems to defeat the orientation of the paper. The paper targets only academia and students and yet loosely refers to them as stakeholders. One wonders what about other stakeholders and also the basis for selecting only this group of people. The authors need to argue out this point and clearly outline the focus and direction of the study. It is also quite intriguing why a study needs to be conducted to ascertain the benefits of BIM as these are quite obvious and already in literature. The author(s) must advance argument in support of this action.	The authors are much more appreciative for the comments. This has now been addressed and the authors have provided justifications for selecting only this group of people (Please see colour text under the first paragraph of Research Methodology section). The authors thank the reviewer for the comment. The approach of using literature review to identify attributes in a wider context and incorporate it in designing the questionnaire survey was not new in construction management studies. For instance, the applicability of these identified BIM drivers and benefits was tested in knowing those that are important in Nigeria using questionnaire survey. This approach was widely adopted by many previous studies. However, this approach has its own limitation. Therefore, it has been considered as the limitation of this paper (please see colour text in the conclusion section for details). It is against this backdrop that this study identified area of further

Reviewer Comments to Author	Authors Response to Reviewer Comments
	study as follows: Further studies should be conducted in other countries to derive specific country's BIM drivers and benefits as important to QS profession.
2**. Relationship to Literature**: Whilst a plethora of literature has been cited. It is interesting that some studies in the region have not been identified. The author(s) needs to relook at this and include relevant studies in the region.	The authors are thankful for the comments. This has now been addressed (Please see colour text under the introduction section)
3. Methodology: The methodology of the study has been clearly outlined. However, one wonders how the study milieu is taken account of as the drivers and benefits identified are solely identified from literature. How does this reflect the sub-regions pecularities? For example, could the need to reduce cost overruns and issues associated with corruption be an important driver in the subregion. The driver awareness of BIM tangible benefits is very vague. These issues need to be addressed to make the study more robust.	The authors are thankful for the comments. The approach of using literature review to identify attributes in a wider context and incorporate it in designing the questionnaire survey was not new in construction management studies. This approach was widely adopted by many previous studies. However, this approach has its own limitation. Therefore, it has been considered as the limitation of this paper (please see colour text in the conclusion section for details). It is against this backdrop that this study identified area of further study as follows: Further studies should be conducted in other countries to derive specific country's BIM drivers and benefits as important to QS profession.
4. Results: The results are quite clear. However, there are a number of issues that need to be attended to. For example what was the basis for making an attribute critical if it had a mean of 3.5 or more. Just making reference to another article will not suffice as the scale ratings adopted are not known. The author(s) seem to have adopted a likert item and not a likert scale. The kruskal-Wallis Test is adopted for non-parametric data. One wonders why the data collated was assumed to be non-parametric especially when the necessary tests have not been conducted. It is suggested that the author(s) relook at this.	The authors are thankful for the comments. The authors have already stated that the questions were asked on a five-point Likert scale with 5 being the highest of the rating (please see colour red under questionnaire survey in Research Methodology). Also, the statement has now been revised. A five-point Likert scale was used. The Mann-Whitney test has now been conducted. The justifications for now conducting Mann-Whitney test has been included (Please see colour text in the latter part of Research Methodology). This has now been revised throughout the paper
5. Implications for research, practice and/or society: While interesting results are presented they are not substantial. It is not surprising that clear implications for the research, practice and society is quite missing from the study. The author(s) rather states the obvious for example page 7 line 24-26. Discussion of literature has been made with reference to extant literature but clearly disassociates itself from the study area. This is quite worrying. What are the implications for the study.	Thank you for pointing these out. The implications, particularly practical implication of the study has now been included in the conclusion section (Please see colour text in the latter part of conclusion section)
6. Quality of Communication: The authors quality of communication is quite satisfactory. Sentence structure and readli	The authors are thankful for the comments.