THE IMPACTS OF BUILDING INFORMATION MODELLING (BIM) ON QUANTITY SURVEYING PRACTICE

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ABSTRACT
Building Information Modelling (BIM) is gradually gaining grounds in the global construction industry. The aim of this research is to identify the effects of the adoption of BIM on quantity surveying practice. Questionnaire survey was adopted for eliciting information from respondents who were mainly quantity surveyors. The data obtained were analyzed using Mean Item Score. The findings show that BIM has the capabilities to enhance quantity surveyors' performances as well as poses a threat to the relevance of the profession in the face of the various capabilities of BIM. The study also found that there are various survival strategies that quantity surveyors can adopt in the face of the adverse impacts of BIM adoption in order to remain relevant in the construction industry. The research will serve as an eye opener on the nobility of BIM to quantity surveyors as well as an early warning signs of what can be of the profession should BIM be fully implemented and functional in the construction industry in Nigeria.
Keywords: awareness, benefits, quantity surveying, survival, threat

INTRODUCTION
Construction projects are complex endeavours that require the professional inputs of all professionals in the built environment for a successful execution. The task of meeting the requirements of clients of the construction industry has become complex because modern construction projects are becoming increasingly larger, more complex in design, takes longer time to complete and are becoming, on the whole, progressively more expensive (Ofori, 1990). Therefore, it is of utmost importance to manage information regarding the construction projects from inception to completion of the project for proper decision-making. Several activities performed by different project participants are performed using different models. Design information such as architectural drawings, structural drawings, services drawings, cost estimates; bills of quantities, etc. are usually presented in different media thereby making integration of project information for timely decision making a tedious exercise.

Building Information Modelling (BIM) offers the opportunity, although through large, complex and highly interdependent models, of preparing, storing, transferring, analysing and the management of all types of building information on one model or medium dedicated to the project irrespective of the nature of the data or information, whether graphical or numerical (Steel & Drogemuller, 2010; Alufohai, 2012). The concept of BIM, which is now rapidly adopted in Europe and America, has been described as a new paradigm in the thriving sustainable construction industry (Nagalingam,Jayasena & Ranadewa, 2013). As it is with many innovations, the BIM as an approach to execute and deliver construction projects is targeted at eliminating or reducing to the barest minimum, some of the difficulties being faced in the execution of construction projects using the previous information tools. BIM has been said to be more than just software because it has the capability of integrating, with the technical information required to execute projects, cost and duration, among other important factors, that may lead to successful project delivery. BIM is an approach to construction that supports the continuous and immediate availability of project design scope, schedule and cost information that is for high quality, reliable, integrated (Alufohai, 2012).

The major responsibility of the quantity surveyor on construction projects is to stringently control and manage cost to ensure that construction project clients have value for money invested (Oke, Timothy, & Olaniyi, 2010). Effective cost management is achieved by the

preparation of important documents, such as the bills of quantities, preliminary estimates, valuations, final accounts, etc., and their adoption as cost management tools (Wong, Salleh & Rahim, 2014). The accuracy of these cost management tools or documents is enhanced by the availability of sufficient and timely information from other contract document such as drawings (architectural drawings, structural drawings, services drawings), which are used by the quantity surveyor in generating cost information. Therefore, the adoption of Building Information Modelling (BIM), which is capable of storing all project information from inception through completion for easy accessibility, should present the quantity surveyor with an added advantage in carrying out his cost management duty effectively in shorter time and not put him out of relevance and business (Raphael & Priyanka, 2014).

Fear is being nurtured among concerned quantity surveyors about the possibility of having the profession of quantity surveying go into extinction in the construction industry.if eventually,BIM gain the anticipated grounds (Nagalingam, Jayasena & Ranadewa, 2013). However, if the introduction of software packages such as QSCAD, MB3 both from the Master bill brand and others like QS plus, Vector, etc., did not eliminate the roles, rather, enhanced the performance and productivity of the quantity surveyor, then, it is safe to assume that the introduction of BIM system will not threaten quantity surveying practice. It is also important to investigate, whether the BIM will force the redefinition of quantity surveying profession or whether it will enhance the productivity of the profession more than prevalent quantity surveying software or eradicate the need for quantity surveying services in the construction industry.

Nagalingam, Jayasena and Ranadewa, (2013) described the concept of BIM as the new paradigm in the construction industry with capabilities to achieve much more in lesser time. BIM is less error-prone in that, modifications made to one part of BIM-based designs are easily tracked and effected appropriately in other part of the designs throughout the project life cycle. The acceptance and/or adoption of BIM is still relatively low in the developing countries like Nigeria (Alufohai, 2012) although, it has been put to use in some significant international projects such as the Freedom Tower in New York, the Bart's and the London hospital project, refurbishment and acoustical retrofit of the world renowned Sydney opera house and the design of the Eureka tower in Melbourne, Australia (Howell & Batcheler, 2005). Despite the advantages and successful implementation of BIM in some projects, it also has its challenges (Alufohai, 2012; Howell &Batcheler, 2005; Eadie, Odeyinka, Browne, McKeown & Yohanis, 2014) but the focus of this study is on the challenges that BIM poses to the quantity surveying profession. Therefore, this study is concerned with investigating the awareness of BIM amongst quantity surveyors as well as how the quantity surveying practice can be re-modelled to stay relevant and benefit from its adoption in Nigeria.

WHAT IS BIM?

Many researchers have defined building Information Modelling (BIM) with focus varying from designers to constructors and operators. Raphael and Priyanka (2014) defined BIM as:

> *"a computable representation of all the physical and functional characteristics of a building and its related project/lifecycle information, which is intended to be a repository of information for the building owner/operator to use and maintain throughout the lifecycle of a building" (p. 195).*

The definition above depicts BIM's capability to minimise the adverse effects of the fragmented nature of the construction industry on construction project successful execution. A BIM package is capable of containing and used to manage information or data on the design, construction, logistics, operation, maintenance, budgets, schedules, and much more depending on the extent on its deployment on the construction project (Bryde, Broquetas & Volm, 2013). Each participants' such as clients, architects, structural/civil engineers, services

engineers, acoustics engineers, quantity surveyors, contractors, etc., involved in construction projects on which BIM is adopted, developed separate models in accordance with the services to be rendered by the participant. All models generated by these participants are then integrated or "federated" to create a single shared model for the project. The process described above was depicted by the Building and Construction Productivity Partnership in its New Zealand BIM Handbook (2014) with the following diagram:

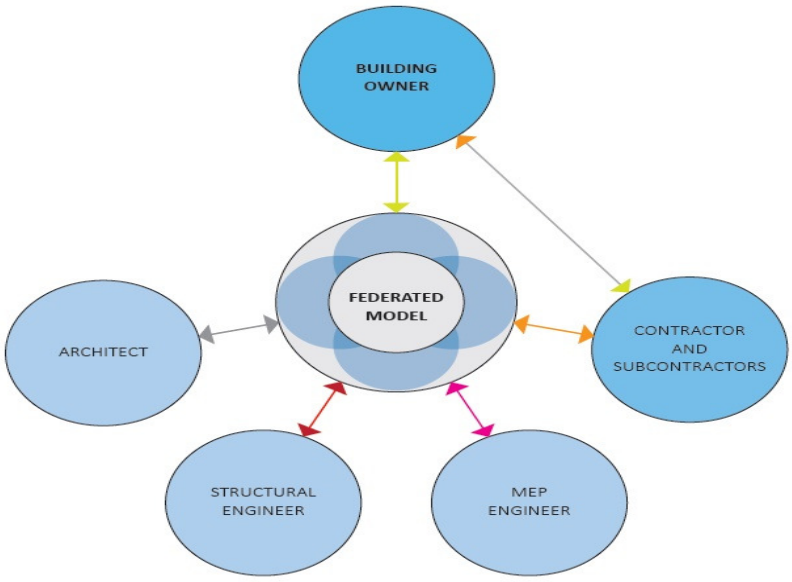

Figure 1: Model Federation Diagram Source: New Zealand BIM Handbook (2014, p. 9)

Sanctioned changes are effected in the individual discipline model while the federated model is used for interdisciplinary management of the model and, by extension, the management of the project.

In traditional construction projects, the client always conceives the idea of the project. In BIM approach to project execution, it start with the client as well as he prepares the project BIM brief before engaging the consultant team. The brief preparation is usually done with the supervision or consultation of lead consultants or executive project manager who is well grounded in the knowledge of the chosen BIM package. Presentation of information with Computer Aided Designs (CAD) software is strictly in two and three dimensions, e.g. plan, sections, elevations, etc., in which the presentations are independent of each other and, independent of the cost and schedule associated with them. Therefore, any change effected in any view, for example the plan, will necessitates thorough check of other information to adjust them to accommodate the change made; an error-prone and time consuming exercise. The parametric capabilities of BIM package, however, corrects this inefficiency and facilitates design and schematics all the way down to project completion and continued operation, maintenance and facilities management throughout a building's usable life (Joannides, 2011).

HISTORY OF BIM

Kulasekara, Jayasena, & Ranadewa (2013), reported that BIM was introduced to eliminate the shortcomings of the earlier means or tools of representing building components. Old tools such as tee-square, set-square, drawing boards, etc., were in rampant use before the 1980s when the development in computer science paved way for the development and adoption of geometry-based CAD. BIM was a product of construction industry players from the United

States, Western Europe and the Soviet Block competing to create software that is more sophisticated to disrupt 2-dimensional CAD workflows. In 1962, Douglas C. Englebart suggested object-based design, parametric manipulation and a relational database; a dream that was brought into being by the efforts of numerous design researchers such as Herbert Simon, Nicholas Negroponte, Ian McHarg and Christopher Alexander among others. (Bergin, 2015) The study further revealed that the world of BIM was revolutionized by Revit through the creation of a "platform that utilized a visual programming environment for creating parametric families and allowing for a time attribute to be added to a component to allow a 'fourth-dimension' of time to be associated with the building model."

BIM is a three letter acronym, Building, Information, Modelling coined by architect and Autodesk building industry strategist Phil Bernstein in 2002 who used the actual terms for BIM. However, the BIM concept can be traced back to about 30 years ago and credited to Chuck Eastman, who created it at the Georgia Tech College of Architecture and computing which he referred to as "Building product model". Eastman described Building product model as "the provision of rich, integrated information from conception through design to construction and demolition of a building over its life cycle" (Joannides, 2011: Kulasekara *et. al.,* 2013).

RESEARCH METHODS

In the course of this study, data were collected with the aid of a structured questionnaire, which elicited information from quantity surveyors. The population of the study were registered quantity surveying firms sanctioned by the registration board to practice quantity surveying. This list was obtained from the website of the Quantity Surveyors Registration Board of Nigeria (QSRBN). The instrument measures the level of awareness of BIM and the impacts of BIM's adoption on quantity surveying profession. Awareness level of BIM amongst quantity surveyors was measured using a nine (9) item construct measured on a Likert- type scale on a five point levels of awareness (Highly unaware to highly aware), while the impacts of BIM's implementation on quantity surveying profession were measured using a seven (7) item construct measured on Likert-type scale on a five point levels of likelihood (Most unlikely to Most Likely).

A hundred and three (103) copies of questionnaire were distributed to consultant quantity surveyors in Lagos state; only ninety (90) questionnaires were received back from the field, which represents 87% response rate, these returned questionnaires were evaluated for correctness and completeness and they were all found worthy to be analysed. One of the major problems of data collection encountered during the study was the difficulty in locating most of the firms at the addresses indicated on the register. So also, many principals refused to fill the questionnaires, citing challenges of works at hand and time constraints.

RESULTS AND DISCUSSION

Table 1: Basic information of all respondents

Characteristics	Sub-characteristics	Frequency	%
Designation of respondents	Managing partner	6	7
	Partner/senior quantity surveyor	20	22
	Quantity surveyor	64	71
Academic qualification of respondents	HND	10	11
	BSc./BTech.	64	71
	MSc.	10	11
	Others	6	7
Professional qualification of respondents	MNIQS	46	51
	FNIQS	4	4

	MRICS	4	4
	Others	36	40
Respondents' years of experience	1 – 10 years	76	84
	11 – 20 years	5	6
	21 – 30 years	9	10
	Mean	8	

Respondents' Characteristics

Table 1 shows the summary of basic information of respondents. It is observed from the table that the designation of the respondents revealed that 6 percent are managing partners, 22 percent are partners/senior quantity surveyors, while 71 percent are quantities surveyors in their respective organisations. Majority of the respondents are university graduates with first degree in quantity surveying representing 71 percent. 59 percent of the respondents are professionally qualified and are in various membership cadre of the Nigerian Institute of Quantity Surveyors (NIQS). The respondents have an average of eight (8) years' work experience practicing quantity surveying in the construction industry. The above information therefore suggests that the data provided by the respondents can be relied upon for the purpose of analysis.

Awareness level of BIM by quantity surveyors

Table 2 shows the level of awareness of Building Information Modelling (BIM) by quantity surveyors. Respondents were asked to indicate their degree of awareness of BIM by quantity surveyors with nine (9) constructs by ticking highly aware (assigned 5), aware (assigned 4), neutral (assigned 3), unaware (assigned 2) and highly unaware (assigned 1). The results revealed that the awareness of BIM by quantity surveyors is satisfactory. Top on the list is; "good understanding of definition of BIM" with mean value of 3.67. Eight (8) of the nine ranked factors have mean of above 3.00 with the ninth factor ranking the lowest with 2.98. This suggests that the majority of the respondents have good understanding of the definition and functions of BIM, while the adoption and use of BIM by quantity surveying organisations is yet to be fully embraced, this is ranked the lowest. On the overall, it is observed that quantity surveying organisations and quantity surveyors are well aware of BIM except for the facts that the incorporation of BIM into the curriculum by tertiary institutions and organisations' willingness to use it is at embryo stage.

Table 2: Awareness of BIM by quantity surveyors

BIM Awareness level	N	Mean	Rank
Good understanding of definition and functions of BIM	90	3.67	1st
Awareness on BIM's ability to serve as project information repository	90	3.49	2nd
Organisations agree to BIM's capability to reduce project conflicts	90	3.44	3rd
Good understanding of BIM's impacts on QS	90	3.42	4th
Organisations agree to BIM improving project management	90	3.36	5th
Organisations agree to BIM's capability to mitigate project risk	90	3.29	6th
Organisations can differentiate between 3D and BIM	90	3.27	7th
Tertiary institutions are willing to incorporate BIM into the curriculum	90	3.20	8th
Organisations are gradually embracing the use of BIM	90	2.98	9th

Impacts of BIM's implementation on the quantity surveying practice in the Nigeria construction industry

Table 3 presents the impacts of BIM's implementation on the quantity surveying practice in the Nigeria construction industry. Clash of duties among professionals in the construction industry with mean item score of 3.29 was ranked the highest. Resist/limit quantity surveyors to providing mainly management-based services and small quantity surveying firms may

wind up due to non-patronage" ranked 2nd and 3rd with the mean scores of 3.27 and 3.22 respectively. Loss of relevance of the profession due to automation in the preparation of Bills of Quantities (BOQ) was ranked lowest with mean score of 2.71.

Table 3: Impacts of BIM adoption on quantity surveying profession

Impacts of BIM on Quantity Surveying Profession	N	Mean	Rank
Clash of duties among professionals in the construction industry	90	3.29	1st
Resist/limit the quantity surveyors to providing mainly management-based services	90	3.27	2nd
Small quantity surveying firms may wind up due to non-patronage	90	3.22	3rd
BIM adoption could lead to structural unemployment among quantity surveyors	90	2.84	4th
Decrease in the number of quantity surveyors required in the industry	90	2.82	5th
Loss of traditional and core duties of Quantity Surveyors to other professionals	90	2.82	5th
Loss of relevance of the profession due to automation of BOQ preparation	90	2.71	7th

Strategies to protect quantity-surveying profession from adverse effects of BIM's adoption in the construction industry

In an attempt to remain relevant in the event of the full adoption and implementation of BIM in Nigeria construction industry, respondents were asked to indicate the effectiveness of suggested strategies to survive the adverse impacts of full implementation of BIM on the quantity surveying profession using nine (9) constructs, by ticking Yes (assigned 3), Indifferent (assigned 2) and No (assigned 1). The result as presented in table 4 reveals that the respondents strongly agreed with all the suggested constructs. All the listed strategies had mean item scores of above 2.00. Merger of quantity surveying firms to form bigger firms ranked last with mean item score of 2.44 while Organisation of training workshops, seminars, etc. by regulating bodies ranked first (1st) with mean item score of 2.82. Seeking knowledge on the new contractual aspects related to BIM, undergoing training on the management functions of BIM and software compatibility development and updating of existing ones were jointly ranked second (2nd) with mean item scores of 2.80 each. It can be deduced that all the factors according to the results are measures to ensure that the quantity surveying profession remain relevant in the event of the full implementation of BIM in Nigeria construction industry.

Table 4: Survival strategies of quantity surveying profession from adverse impacts of BIM

Survival Strategies	N	Mean	Rank
Organisation of training workshops, seminar, etc. by regulating bodies	90	2.82	1st
Seeking knowledge on the new contractual aspects related to BIM	90	2.80	2nd
Undergoing training on the management functions of BIM	90	2.80	2nd
Software compatibility development and updating of existing ones	90	2.80	2nd
Restructuring of quantity surveying curriculum in tertiary institutions to meet challenges brought about BIM	90	2.78	5th
Focus on management of cost, contracts, communication and claims	90	2.78	5th
Seeking favourable government policies on sustaining the profession	90	2.62	7th
Adjusting services and responsibilities	90	2.56	8th
Merger of quantity surveying firms to form bigger firms	90	2.44	9th

DISCUSSIONOF FINDINGS

The results as presented in table 2 confirms the findings of Mulchay and Chen (2014) which revealed that the use of BIM has experienced growth in countries like Finland, Denmark, Norway, Singapore, Hong Kong and China, this shows that Nigeria is not left out in the process of synchronising construction process by making it less tedious. The growth of BIM usage in the United States has increased following the establishment of the National 3D - 4D programme in 2003. It further strengthens the findings of Abubakar, Bala and Ibrahim (2014) who opined that lack of awareness of BIM technologies among professionals and lack of knowledgeable and experienced partners were the leading process barriers to BIM

technologies adoption in the Nigerian construction industry. Nonetheless, appreciable knowledge of BIM among construction professionals in Nigeria as evidence in the findings of this study will take away the barriers preventing the adoption of BIM in Nigeria. However, while it is observed that BIM is gradually gaining grounds amongst quantity surveyors, its incorporation into the curriculum by tertiary institutions and organisations' willingness to use will advance its speedy adoption and development. Young graduates of quantity surveying needs to be educated right from school on the benefits and use of BIM in construction. Although the cost of acquiring the packages might be high for small quantity surveying firms, its acquisition, use and benefits will outweighs its cost on the long run and will help in promoting the gradual but rapid adoption.

The risks identified because of the impact of BIM on quantity surveying practice as presented in table 3 above can be adduced to the capabilities of BIM. With the mean item scores of the first three constructs - clash of duties among professionals in the construction industry, resist/limit the quantity surveyors to providing mainly management-based services, small quantity surveying firms may wind up due to non-patronage having a mean of 3.29, 3.27 and 3.22 respectively, this substantiate the findings of Raphael and Priyanka (2014) which reported that, the implementation of BIM will not happen without adversely affecting the quantity surveying profession. It was reported that quantity surveyors would have to create for themselves, new responsibilities and opportunities, to remain relevant in the construction industry.

However, Smith (2014) did not see the adoption of BIM as a threat to quantity surveying practice rather, an opportunity for the profession to raise the quality of its services to a much higher and sophisticated level. This supports the low mean item score recorded for loss of relevance of quantity surveying profession and loss of traditional and core duties to other professionals. It is therefore of utmost important for quantity surveyors to be versatile in order to adapt to the changes that may be brought by the full implementation of BIM in Nigeria.

The positive responses of table 4 above, on the survival strategies to be adopted by quantity surveying profession are strongly supported by Raphael and Priyanka (2014). These researchers strongly supported the development of BIM-friendly software to aid extraction and input of data into BIM packages. In addition, adjusting services and responsibilities to remain relevant was suggested by Gee (2012). This is because the most time-consuming duty of the quantity surveyor would be automated thereby, enabling the quantity surveyor to focus on other cost management functions. Also, the knowledge and skill required to operate with various sophisticated software that run with BIM can be imparted through organization of training programmes, seminars, workshops, etc. Merger of small quantity surveying firms to form bigger ones, brighten their chances of providing services that are beyond the domain of SMEs. This finding is corroborated by Smith (2014) and was reported to enable the continual relevance of quantity surveying profession.

Despite the low adoption of BIM in Nigeria, the reason for the agreement of these findings and various literatures is not improbable; it is that most of the strategies suggested are also means of survival for Small and Medium Scale Enterprises, a category of organization in which most quantity surveying firms belong.

CONCLUSIONS

BIM is gaining adoption globally, however; its full adoption in Nigeria might not be immediate. From the information gathered in the course of this study and consequently, the comprehensive analysis of this information, this study has been able to elucidate that the awareness level of the Building Information Modelling (BIM) is high though, the willingness of quantity surveying and other construction professional firms, to adopt BIM is still low.

The major impacts of BIM on the practice of quantity surveying in Nigeria as regards the result of this research are; it resists and/or limits the quantity surveyors to providing mainly management-based services, causes clash of duties among professionals in the construction industry and small quantity surveying firms may wind up due to non-patronage. Other impacts worthy of consideration are the ability of BIM to cause structural unemployment among Nigerian Quantity Surveyors, loss of traditional and core duties to other professionals. Finally, this research reveals the agreement of the respondents to suggested survival strategies to be adopted by quantity surveying firms' in order to retain the relevance of the profession in the Nigerian construction industry. This means that the recommendations proposed by this objective were perceived to be potent enough to protect the quantity surveying profession from negative impacts that the adoption of BIM cause.

RECOMMENDATIONS

Subsequent to the findings revealed by this research work, it is pertinent that Nigerian government should encourage the adoption of BIM while the interests of the quantity surveying profession should be protected by enacting appropriate laws that will make them relevant as the only trained construction cost experts. In order to compete effectively and remain relevant in the construction industry, small quantity surveying firms should merge while the big ones acquire smaller firms to enhance opportunities to access more funds for expansion purposes. Professional bodies such as Nigerian Institute of Quantity Surveyors (NIQS) and Quantity Surveyors Registration Board of Nigeria (QSRBN) should as a matter of necessity, organise workshops, seminars, trainings, etc., to create awareness on BIM among Nigerian quantity surveyors and the public as well as, prepare Nigerian quantity surveyors for challenges that may be posed by the adoption of BIM. Tertiary and professional institutions should incorporate BIM into their academic curricula, as a good knowledge of BIM may be a key factor to employability of future Quantity Surveyors. Quantity surveying firms and quantity surveyors should be prepared to embrace new means of achieving the core duty of construction cost management that might be warranted by the adoption of BIM in Nigerian construction industry. Quantity surveying firms should be ready to invest in training their staff on the management functions of BIM. This will go a long way in reducing unemployment or loss of jobs that may arise as a result out of date skills and knowledge.

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