ASSESSING THE READINESS OF NIGERIAN PUBLIC SECTOR CLIENTS TO ADOPT BIM TECHNOLOGIES IN CONSTRUCTION PROJECT DELIVERY

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Abstract
One of the major challenges facing the construction industry is the issue of fragmentation and lack of collaboration in the delivery of construction projects. To address this, several approaches have been employed with Building information Modelling (BIM) technologies as one of the recent approaches currently in use. Previous studies have reported successful implementation of BIM at different levels ranging from project, organisation, to industry level in many parts of the world especially the US and some part of the Nordic countries. However, to successfully implement BIM at any level, the drivers and barriers that influence effective adoption needs to be carefully examined and also all relevant industry stakeholders must be carried along in the implementation process. In Nigeria, studies have investigated the readiness of Building Design firms and contracting organisations to adopt BIM and have reported them to be appreciably ready. This study assesses the readiness of the public sector to adopt BIM technologies in its construction project delivery. A Questionnaire survey was administered to a sample of government Ministries, Departments and Agencies (MDAs) within Federal Capital Territory (FCT) Abuja. The questionnaire sought the perception of the respondents on the factors affecting BIM adoption in the Nigerian construction industry, and subsequently their level of readiness to adopt BIM technologies in their practices was assessed based on four core areas; management, people, process and technology. Arithmetic mean values were used to assess the drivers and barriers on BIM adoption. Results show that the public sector clients have achieved management, process and technology readiness but need to put in more efforts to improve people's readiness. Similarly, the agencies considered in the study have management and people's readiness but do not have process and technology readiness. The study concludes that the Nigerian public sector needs to improve its 'People readiness' to become fully prepared and ready to harness the potentials of Building Information Modelling in their services.

Key **words:** BIM, Public Sector, Readiness, Nigeria

INTRODUCTION

The Architectural, Engineering, Construction and Facilities management (AECFM) industry is widely regarded as a highly fragmented industry that hugely relies on traditional means of communications based on paper documents and 2D Computer Aided Design(CAD) (Sommerville *et al.*, 2004). This approach is mostly associated with errors, omissions, and duplication of efforts which often cause unanticipated field costs, delays, and eventual lawsuits between the various parties on a project (Eastman *et al.*, 2011). Efforts to address this traditional approach to information management and exchange includes the development of alternative organizational structures such as the design-build method; the use of real-time technology such as project Web sites for sharing plans and documents; and the

implementation of 3D CAD tools. Even though these methods have improved the management and timely exchange of information, they have done little to reduce the severity and frequency of conflicts caused by paper documents or their electronic equivalents (Eastman *et al.*, 2011). Recently, the emergence of Building Information Modelling (BIM) has greatly addressed most of the deficiencies of the information management approaches and is seen as a promising innovation capable of addressing the inefficiencies in information management which affects the overall productivity of the industry.

Building information modelling (BIM) according to National BIM Standard (NBIMS) (2007) is the digital representation of the physical and functional characteristic of a facility and a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle. BIM addresses the fragmentation problem by providing a platform that supports collaborative means of working for the various construction stakeholders over the entire lifecycle of facilities. Collaborative BIM platforms support the addition, retrieval, updating or modification of information throughout the entire lifecycle of a facility (NBIMS, 2007). The construction industry in the last decade has witnessed the application of BIM to its various processes such as design management; planning and controlling, cost estimating, scheduling, clash detection, constructability analysis, quality management, safety, and facilities management, with huge implementation benefits documented and reported by researchers (Eastman *et al.*, 2011 and Reddy, 2012). Eastman *et al.* (2011) reported some of the benefits of BIM adoption to include; efficient visualization, speed and accuracy, improved productivity, and significant cost reductions among others.

In recent times, the AECF industry has witnessed huge efforts and investments into BIM implementation by both the private and public sectors all over the world. The industry has globally recorded tremendous success in BIM adoption. For example, McGraw-Hill (2012) BIM implementation survey reported the highest and most rapid rate of BIM adoption in the North American and Scandinavian regions where BIM is applied at all the phases of construction project. In the US, BIM implementation is at a 75% rate of adoption (Wong *et al.*, 2009). These successes were achieved via the collaborative drive and efforts of both the public and private sectors in the industry.

The public sector particularly has been a major driver of BIM adoption and implementation globally. For example, the United States being the pioneer and leader in BIM development and implementation recorded most of its successes through its various public sector bodies that provided tremendous contributions in terms of establishing BIM programs, setting up BIM goals and implementation roadmaps, and publishing BIM standards (Cheng and Lu, 2015). Also, the publication of National Building Information Modelling Standard (NBIMS) by the United States National Institute for Building Sciences (NIBS) in the year 2007 was solely driven by a government agency. Similarly, governments of several other countries such as Singapore, Malaysia and Hong Kong have developed BIM guidelines and industry level implementation

roadmaps in their countries (Cheng and Lu, 2015). The United Kingdom government mandates the use of BIM in all its projects early this year (2016) (Cabinet Office, 2011). The Mainland Chinese government also included BIM-related topics in the country's 12th National Five Year Plan in 2012 (Cheng and Lu, 2015).

Despite the huge successes achieved towards BIM implementation in many parts of the world, studies in Nigeria have reported a fair level of BIM awareness and knowledge(65%) with low level of implementation by the industry professionals (Hamisu, 2009). To facilitate BIM adoption in Nigeria, Abubakar *et al.* (2014) investigated the readiness of Nigerian Design firms to adopt BIM and revealed that, Nigerian design firms are appreciably ready for adopting BIM technologies in their practice, with some slight variation in their respective levels of readiness. Furthermore, Isa (2015) developed a road map that guides BIM implementation by theses design firms. However, the public sector readiness to adopt BIM technologies in Nigerian construction industry is not known. This is despite the fact that, successful BIM adoption can only be achieved if all segments and major stakeholders of the industry such as contractors, clients, suppliers, and manufacturers also adopt BIM in their processes. Therefore, this research assesses the readiness of 'public sector' to adopt BIM technologies in Nigerian. The paper started by reviewing the efforts made by the governments worldwide in ensuring BIM adoption in their various countries. Subsequently, the results of the assessment of the major drivers and barriers to BIM adoption; and the readiness evaluation of some government organs in Nigeria are presented.

Efforts of the Public Sector towards BIM Adoption

The public sector in many parts of the world is believed to play a primary role in leading industry towards BIM adoption. In many countries, government is the major driver of BIM adoption. Cheng and Lu (2015) found the United State to be the most mature and leading country in BIM adoption in the world. In the US, BIM implementation spreads from the top national level down to the city and public university level. Government agencies, institutions and even universities make tremendous effort towards ensuring that BIM is adopted in their project delivery systems. In the Europe, UK's early and strong commitment especially in declaring take-off dates and the development of 18 out of the 34 BIM standards currently in use in the whole of Europe makes it the leader in BIM adoption (Cheng and Lu, 2015; NBS, 2015). Similarly, the public sectors in other parts of the world such as Singapore, Korea, Hong Kong, Australia, etc., have advanced towards successful adoption of BIM in the construction industry through; setting up BIM goals and promises; implementation roadmaps, guides and standards.

The Role of the Public Sector to BIM Adoption

Cheng and Lu (2015) identified six roles that the public sector plays to ensure successful BIM adoption based on a critical review and synthesis of the roles of various countries rated as leading BIM implementers in the world. These roles are the public sector as an initiator; a regulator, an educator; a funder; a demonstrator and a researcher.

The public sector as an initiator:
The public sector as an initiator and driver for BIM adoption sets BIM goals and promises; BIM roadmaps; BIM working groups; and strives hard towards the achievement of their set targets. For example, the UK government set 2016 as their target date for implementing level 2 BIM on all public projects (Cabinet Office, 2011). BIM working groups or committees such as the BIM task group in the United Kingdom, the BIM Steering Committee in Singapore are common examples of these committees set for BIM adoption. Also, in some cases roadmaps such as that of the United States Army Corps of Engineers are published to provide strong drive for BIM adoption.

Public sector as a regulator
The public sector could serve as a regulator to BIM adoption through the development of guidelines and standards for implementation which can be universal or region specific. Standards such as the US National Building Information Modelling Standards developed in 2007 (NBIMS, 2007); and the bi-national Australian and New Zealand Revit Standards (ANZRS) are examples of documents used by the US and New Zealand respectively to regulate the application of BIM in their countries. The UK Construction Industry Council (CIC) and BIM Task Group co-produced several BIM guidelines in response to the United Kingdom government's 2016 BIM implementation goals (CIC, 2013).

Public sector as an Educator
Also, as educator, the public sector in many countries organize in-house BIM trainings for its staff, publish BIM training methods for other organisations on how to develop training modules and long term training plans. These trainings in addition could be extended to other private organisations who are key stakeholders in the AECF industry. Governments should take the lead role of educating the entire industry on the benefits, application and other technically based issues associated to BIM implementation.

Public sector as a Funder
Governments can also provide funding to support BIM related projects to ensure successful adoption in the industry. For example, the Taiwanese government funded many BIM research programs and projects. In the US, the USACE alone funded seven (7) Research and Development laboratories, one of which is CAD/BIM Technology Center (ERDC, 2012).

Public sector as a Demonstrator and Researcher
As a demonstrator, public sectors in some countries conduct pilot projects to showcase the application of BIM in the various construction management process. Lessons learnt from these pilot studies are documented and shared among other organizations in the industry. The RWS in Netherlands tested BIM products in four projects, and used the project results to demonstrate various BIM.

The roles played by the various nations where BIM is seen to be successful shows that these countries played the various roles attributed to public sector as initiators, regulators, educators, funders, demonstrators or a combination of two more roles to promote and standardize BIM adoption (Cheng and Lu, 2015). Also, the public sector in most of the European countries, such as Japan, Mainland China, Hong Kong and

Australia seldom plays as educator and funding agency (Cheng and Lu, 2015). Similarly, the UK, Finland, and Mainland China, have been reported to be lacking in playing the roles of demonstrator and researcher towards BIM adoption. Therefore for successful BIM adoption, depending on the context of implementation, a combination of the various roles is suggested to be the center of focus of the public sector towards successful implementation. The industry generally has high need for training and financial support of BIM implementation and research, therefore, public sector in these nations should be more active on training and funding BIM projects. Also as BIM technology is evolving rapidly, pilot projects and R&D projects become quite necessary to help improve the knowledge of BIM.

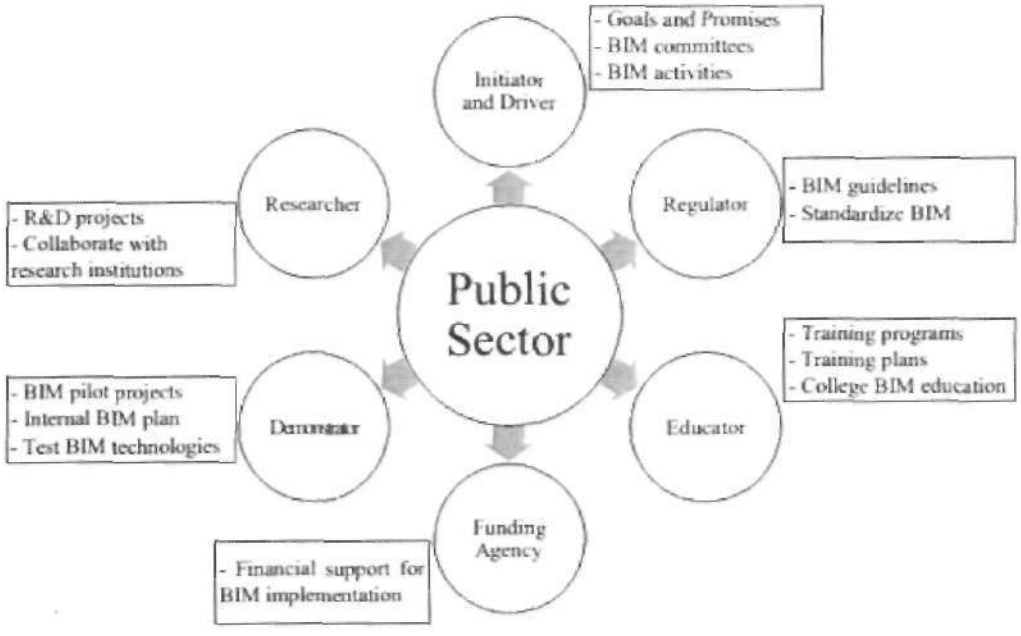


Figure 1: Role of the Public Sector to BIM implementation:
Source: Cheng and Lu (2015)

RESEARCH METHODS

To achieve the aim of this study, a combination of research techniques was used. The first stage of the study involved a review of literature, basically to identify the drivers and barriers to BIM adoption and the assessment parameters used in developing the readiness assessment criteria employed. The second stage involved a questionnaire survey. The questionnaire survey was carried out to assess the readiness of the various sections of Nigeria's public sector, particularly on the extent to which some readiness assessment parameters are satisfied by some public institutions. The complete questionnaire comprised three sections: questions about respondents'

and their organisational background; questions assessing the barriers and drivers to BIM adoption; and finally questions assessing the readiness of the Nigeria public sector to adopt BIM.

The study centrally focused on both construction based (such as Ministry of Works and Housing, Federal Road Maintenance Agency (FERMA), Bureau for Public Enterprise(BPP)) and non-construction based (Ministries of Finance, Agriculture and Communications) government Ministries, Departments and Agencies (MDAs) resident in the Federal Capital Territory (FCT). The non-construction based institutions were considered in this study because all government institutions have in-house construction professionals that maintain their existing facilities and spearhead their procurement processes. The target respondents who were construction professionals with vast experience in construction responded to the questionnaires by rating the extent to which their organisations satisfy a list of readiness parameters using a Likert scale of 0-5, with 0 implying 'not satisfied', and 5 'Highly satisfied'.

According to Abuja Gallery (2016) a total number of one hundred and fifty (150) Federal Ministries and Government Agencies have their headquarters resident in the federal capital city. Using Krejcie and Morgan (1978) formula, a sample size of one hundred and eight (108) MDAs was computed and purposive sampling technique was used to select firms involved in the study on the basis that only those institutions that carry out heavy construction activities were considered. The choice of Abuja was due to the heavy concentration of these government agencies and parastatals and on the basis that all Federal Ministries of Nigeria are currently resident in Abuja. The head offices of all the federal ministries of Nigeria are located in Abuja. Similarly, most agencies and parastatals with branch offices across the country have their head offices centrally located in Abuja. A total of 39 usable responses representing 36% response rate were used for analysis. The drivers and barriers; and the readiness parameters were both ranked based on arithmetic mean value scores. Averages were also determined for each of the four components of the readiness assessed (Management, Process, People and Technology). The VERDICT model developed by Ruiker et al. (2006) was adopted and applied to finally evaluate the readiness of the government institutions to adopt BIM in their project delivery systems.

RESULTS AND DISCUSSION

A summarized profile of the public institutions, and the respondents is presented in Table 1. Architects and Quantity surveyors constitute the largest portion of the sample with 36% and 33% respectively. Moreover, the respondents (43%) had over 10 years work experience in construction works. In addition, most of the respondents (54%) are from the top management level of their respective institutions. The respondents' background in terms of their disciplines, experiences and relative positions in their organisation indicate some reliability, and quality in the responses.

Table 1: Profile of the public institutions and the respondents

		N	Percent
Respondents	Architects	13	33%
	Quantity Surveyors	14	36%
	Engineers	10	26%
	Others(Project managers/Planners)	2	5%
Respondents' Position	Top management	21	54%
	Middle Management	18	46%
Respondents Years of Experience	0-5years	11	28%
	5-10years	11	28%
	10-15years	5	13%
	15-20years	6	15%
	Over 20years	6	15%
Public Institution	Ministry	13	33%
	Agency	26	67%
Nature of organization	Construction based	18	46%
	Non-construction based	21	54%
Size of Projects Awarded	Small (0-50m)	12	31%
	Medium (51-250m)	17	44%
	Large (above 250m)	10	26%

Assessment of Drivers and Barriers to BIM implementation by the Nigeria Public Sector

Tables 2 and 3 shows the extent of agreement of public client (Federal government Ministries and Agencies) on factors termed as drivers/facilitators of BIM adoption. For the BIM drivers and facilitators, a range of mean values of ***4.23-3.5*** were produced. All the drivers assessed had mean values greater than 3.0 indicating their significance as facilitators to successful BIM adoption. Also, the fact that the mean values are all above 2.5 indicates that the respondents agreed that these factors could serve as drivers for the successful BIM implementation in their respective organisations. As shown in Table 2, *'Clients' interest to and demand for BIM (4.56)'; 'Education and training policy (4.26)'; and 'the availability of well trained professionals to handle the tool'* are the top three most important drivers capable of supporting BIM implementation in their organisations. This is very evident in the success stories of BIM adoption reported in some parts of the world, especially in the United States of America where the first BIM standard was developed by NBIMS (NBIMS, 2007); public projects are executed using BIM and various guidelines and strategies for successful adoption are developed by the government (McGraw-Hill, 2012). The roles of the US government in various capacities; as initiators, regulators, educators, funders, demonstrators or a combination of two more roles to promote and standardize BIM adoption

has been the major reason for its high ranking as the leading BIM implementer (Cheng and Lu, 2015). In addition, this result corroborates the findings of Abubakar (2014) and the study of Texas College and University Facilities Conference [TCUF] (2008) on the state wide BIM adoption. It also reflects the idea of focusing on education and training for the transformation of the UK construction industry advocated by Latham (1994) in the United Kingdom. Other important facilitators of BIM adoption as rated by the respondents are; *'Government support through legislation'* and *'Cooperation and commitment of professional bodies to BIM implementation'; and 'Availability of BIM software'* ranked 4th, 5th, and 6th respectively. The least ranked drivers although also important are; *'Collaborative BIM decision framework' and 'Collaborative procurement methods'*. These were likely ranked low because they are more active when BIM has already been implemented and continuous improvement and maturity is the major focus (Abubakar, 2014). Therefore, public sector as the major controller of affairs and the major provider of infrastructure in Nigeria has a vital role to play by enacting legislations that ensure the implementation of BIM in the Nigeria construction industry.

Table 2: Drivers of BIM adoption in public sector

Drivers/Facilitators	Mean	Std. Deviation	Rank
Clients' interest in the use of BIM in their projects	4.56	0.09	1
Education and training policy	**4.26**	0.82	2
Availability of well trained professionals to handle the tools	**4.22**	0.01	3
Government support through legislation	**4.18**	1.09	4
Cooperation and commitment of professional bodies to BIM implementation	**4.10**	1.72	5
BIM Software availability	**3.99**	1.90	6
Emphasis on research and development	3.90	1.94	7
Collaboration with partners	3.74	1.94	8
Collaborative BIM Decision framework	3.74	1.93	9
Collaborative Procurement methods	3.59	1.94	10

Table 3 displays result on the extent of agreement of the respondents on the barriers that militate against the adoption of BIM in their respective organisations. The barriers to the adoption of BIM are considered under two headings as classified by Eastman *et al.* (2011); the process and technology barriers.

'Lack of awareness of BIM technologies' and 'Lack of knowledgeable and experienced partners' were indicated by the respondents as the most important process barriers to the adoption of BIM technologies with mean scores of 4.23 and 4.15 respectively. These factors were followed by 'lack of trained professionals to handle the tools', 'Lack of client demand' with mean scores of 4.03 and 3.82 respectively. The least important barriers as indicated by the respondents is 'Social and habitual resistance to change' and 'High cost of training'. On the side of technology barriers 'Frequent power failure' and 'High cost of integrated software/models for all professionals' were identified as the most significant barriers with very high mean values.

Table 3: Barriers to BIM adoption in public sector

Barriers	Mean	Std. Deviation	Rank
PROCESS BARRIERS			
Lack of Awareness of the technology	4.23	0.87	1
Lack of knowledgeable and experienced partners	4.15	0.9	2
Lack of Trained Professionals to handle the tools	4.03	0.67	3
Clients are not requesting the use of BIM on projects	3.82	1.05	4
Lack of Enabling Environment(government policies and legislations) to guide implementation	3.64	1.09	6
No proof of financial benefits	3.62	1.09	7
Legal and Contractual Constraints	3.59	1.09	8
Social and Habitual Resistance to change	3.56	1.05	9
High Cost of Training	3.50	1.05	10
TECHNOLOGY BARRIERS			
Frequent Power Failure	4.18	1.12	1
High Cost of Integrated software/Models for all professionals	4.08	1.22	2
Lack of Standards to Guide Implementation	3.97	1.04	3
Poor Internet Connectivity	3.79	0.89	4

Source: Field survey (2016)

Readiness Assessment of the Nigeria Public Sector for BIM Implementation

The readiness assessment was done using the four basic readiness parameter developed by Ruiker *et al.*, (2006) in the VERDICT model. These parameters are; Management readiness, People readiness, process readiness and technology readiness.

Management Readiness

The respondents were provided with a list of nine (9) parameters that determine management's readiness and were asked to rate the extent to which these

parameters are satisfied in their respective organisations. Table 4 shows the extent of application of the (9) management readiness parameters; the results revealed overall mean values ranging from 4.15 to 2.77; and 3.62 to 3.12 for the federal ministries and agencies respectively. The results indicates a fair state of readiness by the Nigerian public sector in virtually all the management readiness parameters except for *'We have provided adequate financial resources to facilitate BIM' implementation in our practices'* which has a mean value of 2.95. Overall, for the entire public sector, *'Management is aware of BIM technology and its benefits to the construction industry'* with the mean value of 3.99 was ranked first, *'Management is keenly interested in working with BIM technologies'* (3.95) ranked 2nd, and *'Management aware of the successes recorded by using BIM tools in construction business'* (3.89) ranked 3rd. However, at the sub-levels, results clearly show that the federal agencies have higher level of readiness compared to the federal ministries. This is possibly due to the nature of these organisations (agencies) being more organized with fewer processes and people capable of managing its activities.

Table 4: Management Readiness for BIM adoption

Readiness Parameters	Mean Score					
	Overall	Rank	Ministries	Rank	Agencies	Rank
Our management is aware of BIM technology and its benefits to the construction industry	3.99	1	3.97	3	4.00	2
Our management is keenly interested in working with BIM technologies	3.95	2	3.85	4	4.04	1
We are aware of the successes recorded by using BIM tools in construction business	3.89	3	4.15	1	3.62	5
We have recognised the importance and benefits of adopting and using BIM tools in our practice of building design and construction	3.83	4	3.92	2	3.73	4
We are ready to align our business processes to achieve BIM implementation in our practice	3.56	5	3.31	7	3.81	3
We have developed business strategies that will drive successful BIM adoption in our organization	3.44	6	3.46	5	3.42	7
We have a policy for training and capacity building to keep our staff up to date with BIM tools	3.27	7	3.08	8	3.46	6
We have change management strategies that will ensure successful migration to BIM based practices	3.25	8	3.31	6	3.19	8
We have provided adequate financial resources to facilitate BIM implementation in our practices	2.95	9	2.77	9	3.12	9

Source: Field survey (2016)

People's Readiness

One of the major drivers for the implementation of new innovations and technologies in organisations is the preparedness and capabilities of the staff of the organisation to accept, embrace and adopt the new innovations. On that basis, respondents were asked to examine people's readiness in their institutions. Thirteen (13) parameters that determine the people's readiness were assessed and the results produced overall mean values ranging from 3.96 to 3.16. As depicted in Table 5, the three areas with high level of readiness are; '*People with the ability to implement change and move quickly to adopt and use BIM tools*' (overall mean= 3.96), '*Staff fully understand the importance of training required for using BIM tools*' (overall mean= 3.91), and '*Staff have recognised the importance and benefits of adopting and using BIM tools in our practice*' (overall mean= 3.87). However, the results shows lack of well trained staff as the areas of low readiness '*Staff have the necessary CAD literacy, functional expertise and skills to use BIM tools*' and '*We have qualified IT staff that can manage BIM operations with other professionals*' were the two lowest performing areas with virtually the lowest set of mean values of 2.17 and 2.03 respectively. This simply implies the absolute need for concerted effort into the training of public sector employees responsible for the delivery of projects.

Process Readiness

This section assesses the readiness of the public sector procurement processes for BIM integration. Table 6 depicts respondents' opinion regarding the extent of readiness of their organisational processes for BIM adoption. The results revealed mean values of eight (8) CFF best practices ranging from 4.31 to 1.68. Results show that the top 3 readiness parameters scored an average of 4.31, 4.22 and 4.05 and had mean values above 4.00, while the remaining parameters had mean scores higher than 3.0 except for '*We have designed new web based information sharing system that supports collaboration of design team members from all disciplines*' which had the lowest overall mean value of 1.68 in the entire readiness assessment data. Ayaraci (2009) asserts that successful BIM implementation at the top maturity level 3 requires a collaborative web based information system where all project stakeholders interact among each other.

Technology Readiness

Technology as a major driver for BIM adoption was also assessed and as shown in Table 7. All the four parameters assessed were found to be at a satisfactory level. The highest ranked parameter while '*familiarity with the use of specialist software applications related to our expertise' (overall mean=3.60)' effective intranet and extranet facilities to facilitate information sharing and interoperability in working with BIM tools' (Overall mean=3.35)* was the least satisfied readiness parameter in terms of technology readiness.

Table 5: People Readiness for BIM adoption

Readiness Parameters	Mean Score					
	Overall	Rank	Ministries	Rank	Agencies	Rank
We have people with the ability to implement change and move quickly to adopt and use BIM tools	3.96	1	3.92	1	4.00	2
Our staff fully understand the importance of training required for using BIM tools	3.91	2	3.77	4	4.04	1
Our staff have recognised the importance and benefits of adopting and using BIM tools in our practice	3.87	3	3.92	1	3.81	3
We have identified and clearly defined roles and responsibilities of staff who use (or will use) BIM tools	3.79	4	3.85	3	3.73	4
Our design professionals have adequate knowledge on the use of 3D CAD/BIM tools	3.62	5	3.54	5	3.69	5
We encourage all our staff to learn and use BIM tools in all applicable practices	3.62	6	3.46	6	3.77	6
Our current organizational structure provides an environment that is well suited for BIM adoption and use	3.43	7	3.23	7	3.62	7
We have provided our design department with the necessary manpower to handle BIM applications and tools	3.37	8	3.15	8	3.58	9
Our BIM managers/users have adequate knowledge of the business processes with BIM tools	3.3	9	3.08	9	3.52	10
We are committed to addressing any issues/inhibitions that staff may have about using BIM tools	3.23	10	2.85	10	3.6	8
We have devised training procedures that will enable our staff to effectively use BIM tools	2.19	11	2.25	12	2.13	11
Our staff have the necessary CAD literacy, functional expertise and skills to use BIM tools	2.17	12	2.23	12	2.11	12
We have qualified IT staff that can manage BIM operations with other professionals	2.03	13	2.00	14	2.06	13

Source: Field survey (2016)

Table 6: Process Readiness for BIM adoption

Readiness Parameters	Mean Score					
	Overall	Rank	Ministries	Rank	Agencies	Rank
Our use of BIM tools will improve integration of design and construction processes	4.31	1	4.12	2	4.50	1
We have identified the bottlenecks and inefficiencies in our current business process	4.22	2	4.24	1	4.19	2
Our use of BIM tools will facilitate faster and more cost effective business process	4.05	3	4.11	3	3.98	3
Our existing business processes are flexible enough to accommodate BIM technologies	3.91	4	4.08	4	3.73	4
We can make changes to our current business (where necessary) to facilitate the adoption of BIM technologies	3.81	5	4.08	4	3.54	5
Our business process supports and encourage interdisciplinary/inter- organisational collaboration	3.41	6	3.54	6	3.27	6
We use some BIM tools to exchange design information internally (within our organisation) and externally with other professionals in the design and construction supply chain	3.14	7	3.15	7	3.12	7
We have designed new web based information sharing system that supports collaboration of design team members from all disciplines	1.68	8	2.13	8	1.22	8

Source: Field survey (2016)

Table 7: Technology Readiness for BIM adoption

Readiness Condition	Mean Score					
	Overall	Rank	Ministries		Agencies	
We are familiar with the use specialist software applications related to our expertise	3.60	1	3.85	1	3.35	3
We have adequate infrastructure (computer systems and software) to support BIM adoption in our organization	3.50	2	3.46	3	3.54	1
We have well defined IT policy in our organization	3.39	3	3.62	2	3.15	4
We have effective intranet and extranet facilities to facilitate information sharing and interoperability in working with BIM tools	3.35	4	3.23	4	3.46	2

Source: Field survey (2016)

Readiness Assessment using VERDICT Model

According to VERDICT Model (Ruikar *et al.*, 2006), an average score greater than or equal to zero and less than 2.5 is represented in red colour indicating that several aspects (within a category) need urgent attention to achieve readiness; an average score greater than or equal to 2.5 and less than 3.5 is represented in amber

colour, and that indicates that certain aspects (within a category) need attention to achieve readiness; and an average score greater than or equal to 3.5 is green, and indicates that the end-user organization has adequate capability and maturity in these aspects and therefore is ready.

Table 8 presents the mean average scores indicating the level of readiness of the public sector client based on the four components of readiness assessment (management, process, people and technology. As evident in Table 8, the average scores for the categories; Management, Process as well as Technology are all greater than 3.5 (green) for all the ministries while the Agencies had scores greater than 3.5 (green) in the management and people's category. This indicates that Ministries and Agencies in Nigeria have adequate capability and maturity in these aspects and are therefore ready to adopt BIM technologies in their project delivery systems. However, on the overall, the Nigeria public sector is ready in all the readiness components except for the Technology aspect where some attention is needed in some of the readiness parameters for BIM adoption.

Also, for all the ministries considered, 'People readiness' was the only category in which an average score greater than 2.5, but less than 3.5 (amber) was obtained. This depicts lack of readiness of the people in Nigeria ministries to adopt BIM practices. However, as further illustrated in the people readiness assessment results in Table 7, seven (7) readiness parameters with mean values lower than 3.5 indicates the need for urgent intervention in these areas to successfully achieve people readiness in the Nigerian federal ministries. Similarly, in the case of the agencies, two categories to include 'Process' and 'Technology' had scores greater than 2.5, but less than 3.5 (amber). This clearly shows that both the ministries as well as the agencies in Nigeria require some additional efforts and attention to achieve full readiness for adopting Building Information Modelling.

Table 8: Readiness Assessment results of the public sector

Sectors	Readiness Parameter	Average Score	Situation Based on VERDICT Model	Readiness Status
Overall	Management	3.57	Green	**Ready**
	Process	3.56	Green	**Ready**
	People	3.58	Amber	**Not ready**
	Technology	3.46	Green	**Ready**
Ministries	Management	3.54	Green	**Ready**
	Process	3.68	Green	**Ready**
	People	3.44	Amber	**Not ready**
	Technology	3.54	Green	**Ready**
Agencies	Management	3.60	Green	**Ready**
	Process	3.44	Amber	**Not ready**
	People	3.72	Green	**Ready**
	Technology	3.38	Amber	**Not ready**

Source: Field survey (2016)

Conclusions

This paper has assessed the readiness of the Nigeria Public sector client to adopt BIM in its project delivery system. Results *revealed 'Education and trained policy and cooperation; and 'Commitment of professional bodies towards BIM implementation'* as the most important drivers of BIM adoption. Also, Nigerian public clients' consider all the barriers as factors which hinder the adoption of BIM. However, *'lack of awareness of BIM technologies' and 'lack of knowledgeable and experienced partners'* are the most significant process barriers to the adoption of BIM in Nigeria. *'Frequent power failure' and 'high cost of integrated software/models for all professionals'* were ranked the most significant technology barriers to BIM adoption in the Nigeria public sector. The results further shows that the federal ministries of Nigeria have achieved management, process and technology readiness but need to improve its people's readiness. The agencies considered in the study have management and people's readiness but do not have process and technology readiness. It is apparent that the Nigerian public sector needs to improve its 'People readiness' to become fully prepared and ready to harness the potentials of Building Information Modelling in their services. The study recommends that the Nigeria Public sector should begin formal preparation with achievable milestones and targets for the implementation of BIM in its project delivery process.

REFERENCES

Abubakar, M., Ibrahim Y.M, and Bala, K. (2013). Readiness of Nigerian Building Design Firms to Adopt BIM Technologies. Paper presented at the 5th International Conference on Construction Engineering and Project Management (ICCEPM), Anaheim, California, US.

Abubakar, M., Ibrahim Y.M, Bala, K., and Kado, D. (2014). Contractors Perception of the Barriers and Drivers of Building Information Modeling (BIM) Adoption in the Nigerian Construction Industry. Paper presented at the International Conference on Computing in Civil and Building Engineering (ICCCBE), ASCE, Florida, US.

Abuja Gallery (2016). List of Nigerian Ministries and parastatals available at http://www.abuja-ng.com/parastatals-agencies-in-abuja.html, accessed on 12th, January, 2016.

American General Contractors (AGC) (2006). The contractors' guide to BIM *(1st Ed.)*. USA: Associated General Contractors of America.

AIA (2007). *Integrated project delivery: A guide* (1st Ver.). California: The American Institute of Architects (AIA) California Council, version 1

Ayarici, Y., Khosrowshahi, F, Ponting, A.M, and Mihindu, S. (2009) *Towards Implementation of Building Information Modelling in the Construction Industry*. Fifth International Conference on Construction in the 21st Century (CITC-V) "Collaboration and Integration in Engineering, Management

Azhar, S., Khalfan, M., & Maqsood, T. (2012). *Building Information Modelling (BIM): now and beyond.* Australasian Journal of Construction, 12(4), 15-28.

Cabinet Office (2011). *Government construction strategy*. Efficiency and Reform Group of the Cabinet Office and the Construction Sector Unit of BIS, UK.

CIC (2013). Best Practice Guide for Professional Indemnity Insurance When Using Building Information Models First Edition, London WC1E 7BT, Construction Industry Council.

Cheng, J.C.P and Lu, Q. (2015). A review of the Efforts and Roles of the Public Sector for BIM Adoption Worldwide, Journal of Information Technology in Construction, Vol. 20, 442-478.

Eastman, C., Teicholz, P., Sacks, R., & Liston, K., (2011). *BIM handbook:* A Guide to Building Information Modelling for Owner, Managers, Designers, Engineers, And Contractors. *(2nd Ed.) New Jersey: John Wiley and Sons, Inc.*

Hamisu, S. (2009). Investigating the application of Building Information Modeling in the Nigerian construction industry. Unpublished thesis, Department of Quantity

Isa, M. (2015). Developing a Roadmap for the Implementation of Building Information Modeling (BIM) in the Nigerian Construction Industry. Unpublished M.Sc Thesis Submitted to the Department of Quantity Surveying, Ahmadu Bello University, Zaria, Nigeria.

Krejcie, R.V and Morgan, W.E (1970). Determining Sample Size for Research Activities. Educational and Psychological Measurements. Vol. 30, 607-610.

Latham, M. (1994) Constructing the Team. Final Report on Joint Review of Procurement and Contractual Agreements in the UK Construction Industry, HMSO, London.

McGraw-Hill (2010). The Business Value of BIM in Europe, In: E. Fitch (ed.). McGraw-Hill Construction.

McGraw-Hill (2012). The Business Value of BIM for Infrastructure: Addressing America's Infrastructure Challenges with Collaboration and Technology, Smart Market Report, In: E. Fitch (ed.). McGraw-Hill Construction.

National Institute of Building Science (2007). U.S National Building Information Modeling Standard: Version 1-Part 1, Overview, Principle and Methodologies. *U.S: National Institute of Building Science.*

National Building Information Modelling Standard (2007). U.S National Building Information Modeling Standard: Version 1-Part 1, Overview, Principle and Methodologies. *U.S: National Institute of Building Science.*

NBS (2015). NBS National BIM Report 2015. The UK: National Building Specification (NBS), RIBA Enterprises Ltd.

Reddy K. P. (2012) BIM for building owners and developers: making a business case for using BIM on projects. *New Jersey: John Wiley & Sons*

Ruikar K, Anumba CJ, Carrillo PM (2006). *VERDICT--An e-readiness assessment application for construction companies.* Automation in Construction, 15(1): 98-110.

Sommerville, H., Randi, K., & Richard, P. *(2004). Inefficiency of Construction Industry and the means of communication.* Australasian Journal of Construction, 14(2), 10-18.

Wong A.K., Wong F.K. and Nadeem A. (2009). Comparative Roles of Major Stakeholders for the Implementation of BIM in Various Countries, the International Conference on Changing Roles: New Roles, New Challenges. Noordwijk Aan Zee, The Netherlands