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STATE OF BUILDING INFORMATION MODELLING (BIM) ADOPTION IN NIGERIA

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Construction Industry has had its biggest breakthrough since the development of Building Information Modelling (BIM). The industry has been changing over time; United States has been at the forefront of adoption and implementation of BIM while Australia, United Kingdom and some other developed nations are moving in full force concurrently. At the same time, developing countries are battling with BIM uptake. The BIM awareness and adoption in Nigerian Architecture Engineering and Construction (AEC) is significantly low; research to adopting this innovation has received very little attention. This piece of work (as part of preliminary investigation of a PhD work) is aimed at exploring the state of BIM within decision makers in Nigerian AEC. Semi-structured interviews were conducted with stakeholders in the industry (Contractor, Consultant and Clients); the transcribed interviews were analysed using qualitative content analysis. The information revealed that, the key players are generally not familiar with the term "Building Information Modelling" or "BIM" although mostly aware of some of its tools (i.e. AutoCAD, Revit etc.). Only a few uses some BIM tools at organisational level 'lonely BIM' and operating model based 'BIM stage 1.' Moreover, no legislative provision on BIM adopting or regulation. Nevertheless, the government is open for new concepts in promoting and advancing the industry only when they are convincing enough. Lack of experts on BIM is a major barrier to its adoption at all levels. Recommendations are made based on the findings based of the exploration for the industry to compete with its global counterpart.

Keywords: BIM, CAD, innovation, adoption, construction industry

INTRODUCTION

Engineering business is going digital and integrated; there still remain significant move and development to achieving it globally. Building Information Modelling (BIM) is the most recent paradigm shift in construction industry and the promising concept determine to shape the industry's fragmentation (Zhao *et al.,* 2016). BIM is defined as a set of interacting policies and processes being enabled by technologies in generating a methodology to procure building works from inception to completion down to the entire lifecycle of a building in a digital format (Succar, 2009).

There are numerous application of BIM, to mention but a few with: design coordination, energy performance simulation, scheduling and quantity take-off, clash detection and 3D visualisation (Cao *et al.,* 2014, Eastman *et al.,* 2011, Monteiro *et al.,* 2014). There are several arguments regarding BIM benefits over the years. Autodesk (2008) claimed a time saving up to 91% on checking and coordination, 50% on developing a design while using Revit® Architecture software compared with the conventional Computer Aided Design (CAD). However, countries have been adopting it with individual experiences (in

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benefits), depending on their level of adoption as such; and perhaps their challenges before the adoption. For example, McGraw Hill Construction (2014) study reveals the most significant immediate and long-term benefits derived by Australia and New Zealand; these include but not limited to: reduction in errors and omissions, reduction in rework; and business reputation, reduction of project duration and construction cost respectively. Even though every country has its reasons to adopt BIM, there are still some common goals amongst several countries. These include, improving the industry's productivity and unifying its standards by changing its way of working (BIM industry working group, 2011; NATSPEC, 2012; Hjelseth, 2017).

BIM adoption has gone far in the most developed countries; however, there remain a long way to go in the developing countries especially Nigeria. Despite several years of discussions and researches in the area of BIM concept and its adoption, Nigerian construction industry haven't receive attention till 2013 when the first conference paper title "Readiness of Nigerian building design firms to adopt building information modelling (BIM) technologies" by Abubakar *et al.,* (2013) came into the academic mainstream. It was the first grasp to study BIM in Nigeria; although, has its very limited in context (focused on designers only). Moreover, the study was mainly on assessing the readiness of the first line adopters of BIM in the industry. The assessment came up due to lack of clarity on whether the industry is ready or not in adopting the technology; not the process - this is a sign of starting point or "readiness ramp" (Succar and Kassem, 2015). Furthermore, the starting point wasn't evaluation on awareness or usage but searching for a significant match towards its adoption.

There is little or limited research on BIM on a general level beyond specific discipline and or city, also there is lack of direct input (interview) by key stakeholders of the industry. These can be noticed in the eleven available published works. The previous research concentrated on trying to assess BIM (within a limited profession or location) or assess BIM's roles and benefits in general - there was no meeting point into identifying the present stage of the key BIM fields (Technology, Process and Policy). Moreover, no any available Noteworthy BIM Publications (NBPs) within this study context (Kassem *et al.,* 2013). This paper presents pilot data related to the state of BIM adoption in Nigeria. We investigate its awareness and adoption level, discuss challenges and possibility of its adoption in Nigeria.

This piece of work aimed to determine the state of the above key BIM fields from the key players (designers, constructors and the client). The objectives are to evaluate: the BIM awareness and knowledge; as well as its adoption challenges.

LITERATURE REVIEW

BIM has gone beyond being just a drawing and documentation tool; and it is not solely about software, but represents a more collaborative method of working (NBS, 2015); most importantly, it remains the most potential development in the world of construction industry (Chan, 2014). There is significant adoption of BIM at design and construction stages in countries like United Kingdom (UK), United States (US), Germany, Australia and New Zealand. On the other hand, UK's BIM uptake could be seen as not meeting the expectations with the present alternating adoption rate. The 2018 National BIM report revealed a skyrocket adoption rate of 12% (total of 74%) after the substantial slowed down between 2014 and 2016 (NBS, 2017); several literatures reported huge move of awareness to adoption which appeared a big leap though the motivation comes from coercion (Dainty *et al*., 2017). The UK government's interest in leading BIM is not yet realised, albeit there is a significant boost a year after the expiration of the BIM level 2

mandate. The BIM adoption in the US was initially generated acceptance and get promoted by the Architects, American Institute of Architect (AIA) lead its adoption at its early stage and then government subsequently realises its potentials and therefore takes the control by developing standard between the year 2005 and 2008 (National Institute of Building Sciences 2015). The "NBIMS Version 1 - Part 1: Overview, Principle and Methodologies" released by facility information council (FIC) for public use was the first standard, and subsequently taken over to be overseen by buildingSMART alliance. The National BIM Standard-US is now the developer of standards and guidance documents for all aspects BIM. As of 2012, the US recorded an average of 71% BIM adoption leading the world in adoption rate (Construction, 2012). Moreover, large, medium-to-large and small-to-medium companies were found to be the most (in descending order) adopters, hence size of an organisation has significant influence on the likelihood of adopting BIM.

In the last five years, BIM research focuses largely on interoperable technology leaving collaborating people and integrated processes behind. Despite several reports lamenting the shortage of facilitators in promoting BIM process, more than 70% of publications from Automation in Construction (2013 - 2017) focused on interoperable technology perspective (Hjelseth, 2017) rather than promoting the adoption process or collaborating the people. Previous studies suggest that, national government and institutional frameworks is largely influencing BIM adoption (Edirisinghe and London, 2015); but in some cases (i.e. UK) it is the reflection of the mandate rather than the government (as major client) playing the capabilities driven role (Davies *et al.,* 2015). Moreover, developing policies by the European countries is considered as a strategic transformation of their construction sector. However, recent study by Dainty *et al.,* (2017) argue that so much emphases is given to BIM as a panacea to all the ingrained problems of the industry and also assumed BIM policy or mandate is a route to its adoption. Apparently, a diverse opinion can be seen in this regard, but there are still several case studies where policy added value and resolved snags around the world (Edirisinghe and London, 2015). Dainty *et al.,* (2017) considered the policy favourable to the large firms - 'Matthew Effect.' We see this argument as a means for transfer of directional pressure of diffusion from Top-Down to Middle-Out, hence the medium and small firms will subsequently benefit from the policy action (Top-Down).

BIM in Nigeria

There is a very limited awareness and knowledge of BIM technology in Nigeria (Onungwa *et al.,* 2017); and this is generally associated with lack of awareness of the concept, or lack of trained staff on the BIM tools or both (Abubakar *et al.,* 2013; Onungwa *et al.,* 2017). Kori (2015) reveals that large and medium firms were found to be leading the BIM adoption in the Nigerian AEC while the small firms are less advanced regarding policy and process adherence therefore has less adoption. On the other hand, the present adoption is traced at organisational level which is term as a "lonely BIM" (Hamma-adama *et al.,* 2017) and operate at Stage 1 BIM. Primarily, the Nigerian construction industry is fragmented: all the professionals are generating information and managing them separately (Onungwa *et al.,* 2017). Structural and services designs are still on conventional CAD (2D) system with few (mostly Architects) utilising 3D CAD system for visualisation purpose (mostly) or as a presentation drawing (Hamma-adama *et al*., 2017; Kori, 2015). Ultimately, the culture of the industry is very conventional, hence require behavioural change. The most difficult move amongst the change requirements for a successful BIM adoption is the behavioural change (Hardin and McCool, 2015), as it involves perception and process change. Change is possible only when people are aware

or possess knowledge of the subject matter; is the Nigerian construction industry needs the awareness or the minimum knowledge of the concept before it gets diffused?

RESEARCH DESIGN

The aim of the paper is to explore the state of BIM adoption in Nigeria from the key players (designers, constructors and the client). Industry professional interviews are as a primary data source. Professional interviews are used broadly as a direct source of information (e.g. Davies *et al.,* 2015). Thus, a qualitative approach to content analysis is considered as a suitable approach to this exploratory study (Carney, 1972). Generally, exploratory studies are based on nonprobability sampling of respondents; while its analyses have been frequently used to create hypotheses for further study (Guest, *et al.,* 2011, p. 8). And, it's focused on fewer respondents as reported by Marshall *et al*., (2013) is on the bases of single case qualitative methodology.

Bryman (2001) describes qualitative content analysis as a process of utilising a textual data systematically in the development of emergent themes. Thus, the concepts used are driven and generated through interpretation of respondents' statements (Wood, 2001). Carney (1973) describes this method as a destination for most exploratory studies as 'it gets the answers to the question to which it is applied'. Moreover, Roberts (1999) asserts that the ability of this approach to have coded revisited at any time for confirmation makes it reliable for qualitative data analysis. Upon these, this method best fits the intended study.

QUALITATIVE FINDINGS

This section focuses on the analysis of collected data that were generated through semi-structured interviews with consultant, contractor and the clients/authority who are the industry's stakeholders. These interviews were carried out face to face and audio recorded for the purpose of transcription. It is mainly to explore the inside of the industry in the key area "BIM". The method allows the interviewees to interact freely, express their views and comment on general aspect the key area, hence provides opportunity to the interviewer for generating a direct, relevant and addition information (Trumbull, 2005).

Data Collection

The study sample involves four parties whom are the critical stakeholders in the BIM adoption and implementation. This sample of four was selected by considering their importance in the industry's decision making as well as priority. The sample consists of three parties (consultant, contractor and client) each having one representative plus additional one from client who happened to be representing a development control body - Federal Capital Development Authority (FCDA). In the light of Ryen's (2016, 32) assertion of "research subjects have the right to know that they are being researched, the right to be informed about the nature of the research and the right to withdraw at any time". A number of interview invitations were sent via email with highlights on the research subject and objectives. The invited participants responded positively with a proposed schedule for the interview. Considering research ethics and privacy policy, the consent (with condition of anonymity) of the participated professionals were sought to audio-record the sessions which were granted and the interviews lasted between eight to twenty-two minutes. Table 1 presents the study interviewees profile.

Table 1: Demographic Profile of the interviewees (Author generated)

Interviewees	Organisation size	Organisational Annual fee volume	Organisation Role	Project type	Organisation location
Interviewee 1 (CPM)	>20 staff (large)	>$10M (large)	Contractor	Mainly building works, then road construction	Abuja, Bauchi, Gombe, Jigawa Kaduna, Kano and Lagos
Interviewee 2 (CLE)	>20 staff (large)	>$10M (large)	Client	Building and Infrastructure	Abuja
Interviewee 3 (CLA)	>20 staff (large)	>$10M (large)	Client/devel opment control	Building and development control	Abuja
Interviewee 4 (COA)	11-20 staff (Medium)	$500K-10M (small-medium)	Consultant	Building works	Kaduna

The interview questions were specifically made flexible enough to explore the participants' experiences and trends of innovation in their respective organisations. The questions were designed on the basis of previous researches and the current study objectives.

Data Analysis

Adopting the steps (Figure 1) identified by Creswell (2009), the fetched data were analysed thoroughly and rationally thereby achieving a precise interpretation of interviewees' knowledge and abilities (Spiggle, 1994).

Following the successful interviews, the transcribed interviews are considered the raw and primary data. The data are then coded based on the pre-identified themes from previous studies and the set objectives.
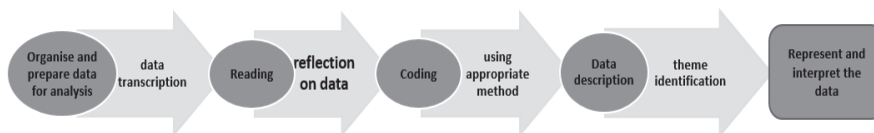

Figure 1: Data analysis process adopted from Creswell (2009)

STUDY FINDINGS

The study findings are presented in three main themes. The three themes are; Level of Awareness in the key areas of BIM, the evaluated capabilities of the stakeholders, and BIM adoption and challenges in the industry. Although the transcriptions language has not been tidied, quotations were used to justify this study assertions.

BIM Awareness and Knowledge

There is basically little knowledge of BIM even at awareness level. The practitioners' point of view is that, they have limited knowledge in terms of awareness of the BIM not to talk of adoption.

> My knowledge on Building Information Modelling is pretty below limited, is an area that I will say I heard of it virtually today through the research student and it appears quite exciting to me… CLE

> I only have general point of view, primarily from any work as an Architect…; …my knowledge is restricted to a general sense, and we don't have that here… CLA

On the other hand, some of the stakeholders debunked their level of BIM knowledge and they seem to lack clear understanding of what 'building information modelling' mean.

> Am not aware of anything Building Information Modelling. CPM

> To be honest, this is the first time am hearing about building information modelling. COA

Moreover, after going deep into the conversation, they mostly acknowledged to have used some of the lower level BIM tools (2D and 3D CAD systems). Hence, there is an indication of limited and lower level BIM tools utilisation: a little trice of 'file based collaboration' with 3D CAD for object visualisation and appreciation.

> …the one we are using is coming from consultants even, the consultants we are working with are using that 2dimensional AutoCAD, CPM

> …I have used AutoCAD, yes, Civil CAD, yes, but know it to have harmonise it into BIM I will say no, but as isolated software for design, yes… CLE

> …I do a design in AutoCAD, COA

There is an indication of 'lonely BIM' especially from the highly developed (multi-disciplinary) consulting firms; they are practicing collaborative BIM concept at organisational level only.

> …the firm has its own in-house engineers: Mechanical, Structural and everything; we come together within the office…; and do all the design within the same software that we have. Do that in-house not with any other consulting firms… COA

Stakeholders Capabilities

It was perceived that, the consultants are relatively using BIM tools (i.e. AutoCAD and Revit) however not knowing them as BIM tools and also not utilising to their full potentials (i.e. integrating the tools in their work not the opposite).

> I know software like Revit does that to some extend and then like 3D Home views COA

It was observed that, the contractors are reliant on the kind of tool consultant uses at the design stage. They mostly adopt what the consultants are using because of their interdependence. Thus, do not mind using whatever the consultant uses and provided them with - designers are then the first line of adopters (Abubakar *et al*., 2013).

> …the one we are using is coming from consultants even; …2D AutoCAD. CPM

Government is a major client for the construction sector in Nigeria; and also a client for big projects. One of the interviewees revealed that, the Federal Capital Development Authority (FCDA) is the pilot organisation for the adoption of e-governance as well as innovations in the building industry.

> … FCDA is the pilot agency in the entire country …because we are more likely to succeed, then other Agencies were to key in and learn from us… CLA

The members of the authority (FCDA) have been using some BIM tools for infrastructure (i.e. AutoCAD and Civil CAD) for infrastructural design; however, the usage level is not to integrating their system but sort of design and design checks only.

> …yes, AutoCAD yes, Civil CAD yes, but know it to have harmonise it into a BIM I will say no, but as an isolated software for design, yes I have used it severally for infrastructural design works… CLE

There is strong indication that, the knowledge of BIM tools and the concept is more prominent with the consultants (designers) than clients and contractors (Abubakar *et al*., 2013); and this vindicated the assertion in the BIM+ and construction manager's survey of 2017 in the UK that, local authorities did not understand BIM. …and that more than 70% said of clients in general did not understand the benefits of BIM".

BIM Adoption Challenges

None of the interviewees ever participated in a project where BIM was used. This can be seen as a clear lack of understanding and knowledge of the BIM concept. However, a 'lonely BIM' at modelling and collaboration stage can be noticed with the highly established consultancy firms.

> …the firm has its own in-house engineers: Mechanical engineers, Structural engineers and everything; …and do all the design within the same software that we have. Do that in-house not with any other consulting firm… COA

All the dynamic countries on adopting BIM have BIM policies and guidelines, and a sort of blueprint to the adoption process. For Nigeria, there is no clear legislative provision on the use of software and other innovative aids in the construction industry. Regulatory bodies and development control agencies are normally enforcing building codes (i.e. British Standards (BS), Code of Practice (CP) etc.).

> For a policy regarding use of software, explicitly stated no! CLE

> I will not tell you out rightly that am aware of any kind of legislative backup… CLA

> Legislatively, there is none! COA

There is a plan for adopting digital procurement, funded by World Bank and United Nations Development Programme (UNDP). The FCT minister then was fully committed and involved in doing it, but after he left, all the process subsequently stopped! Moreover, no planned implementation policy set in place as such every aspect of the programme virtually failed. Also, it was noticed that there is no policy to enforcing the use of new design or construction tools (i.e. BIM).

> …No legislative support and no any policy enforcement in relation to use of software. Since there is no policy, then the enforcement cannot come in. CLE

> …am not aware there is any legislation …e-procurement for now is just an option. CLA

> Legislatively, there is none! That is why am even looking at the institute (Institute of Architects) basically entirely… …Since there is no legislation in that regards, then no legislative backup to enforcing this process. COA

It was observed that funding is one of the challenges of digitalisation in the industry. However, there are few intervention from some government agencies which still doesn't work as the intended digitalisation in the pilot authority (FCDA) also stopped.

> ...I do know that federal ministry of science and technology is doing something in that regard, and then we have some Agencies that has been assisting, like NITDA... CLA

It became evident with the failure of the digitalization (e-procurement) process in the pilot agency. The earlier proposed e-procurement suffered a lot of setbacks, amongst which the refusal by contractors to register online - this is imminent for over a decade.

> Now when we wanted to launch a pilot for e-procurement, for example, one of the requirements entail having contractors to be registered in our electronic data base and that is where we were stocked because most of them were not compliant… CLA

For the authority, they have a strong interest and appear ready to adopting BIM, although their understanding is quite limited. Funding has been considered a big issue couple with lack of experts in the field of BIM adoption and implementation. On the other hand, there is a need for an articulated proposal to the government regarding its potential benefits to the country's construction sector. Those who know it very well are expected to play a vital role to informing the government, while strong pledge is required by the government heads to adopting and implementing BIM.

> I think the government is more than ready and willing to do that... ...there is no knowledge, no expertise along that area at all; I think BIM is when a proposal is articulated well and presented to the department of engineering (FCDA) I am sure we would work toward that line to make things much easier for us, we appreciate this. CLE

> Am a government person but unfortunately I have to speak to you from personal point of view, we need a champion, everything we achieved here it was because of Nasiru El-Rufai, he was personally interested, he was personally involved. CLA

Electricity is one of those factors associated with speedy ICT adoption everywhere including the construction industry. However, Nigeria is suffering from huge shortage of electricity which has been lingering for decades.

> ...there is a major problem of power; if you ask me, I think power was one of the major reasons that has stolen the development... ...we had issues even with the people we are supposed to be serving and the ever issue of power that will always remain the big problem if we are going to embark on any endeavour... CLA

Thematic Finding

Contractors associated lack of BIM tools utilisation with the type of training received by graduates of higher institutions (university). New innovative way of working is not taught in schools that is why the old ways still remain. Also, the trend of the adoption should start from training in schools, to designers and subsequently the contractors.

> The best way to adopting this system is marketing, and the marketing must start from school. Because whatever training I get from school will be what to be using until I get training with this BIM; ...the marketing will start from schools ...link with the construction company... CPM

There are also issues with built professional societies and regulatory bodies; the new innovations should have been driven by these societies and bodies, the example of this can be seen in the US. But many professionals are yet to be digitally compliant.

> ...by the way one need to understand that not everybody within the profession is also digitally compliant. COA

The professional organizations would have been the focal points for professional developments; centres where new innovations are introduced, marketed and even trained. Consultants perceived the same idea of BIM adoption as in the US where Architects originally lead its adoption and before the government intervention.

> It's quite a good initiative; ...presented and accepted by the professions within the industry before...the process of being legislated upon by the government... COA

Succinctly, lack of BIM trained personnel which is associated with training received in the higher institutions and also the lack of involvement of professional bodies coupled with low awareness contributed to the adoption challenges. No legislative provision on BIM adoption, as such no regulation. Moreover, no trace of BIM demand by clients (private or private) which is seen in Sweden (Davies *et al*., 2015).

CONCLUSION

The purpose of this paper was to determine the state of the key BIM fields (Technology, Process and Policy) from the key players (designers, constructors and the client) in the Nigerian AEC. The exploratory study reveals that: Lack of BIM awareness across the entire stakeholders, especially clients and contractors coupled with significant deficit of experts in the technology. Lack of accessibility of the technology and power (electricity) issues - Infrastructure; lack of streamlined BIM adoption process and professional bodies' involvement; no policy and guideline or regulation to adopt the technology and the

process; there is a trace of adoption within designers at organisational level only. To facilitate adoption, the following recommendations are made: Presenting a comprehensive proposal (by the professional bodies) to the government, proposing a government driven policy; developing an *all-in-one* blueprint for adoption through awareness and training by developing an effective adoption framework.

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