ASSESSMENT OF BUILDING INFORMATION MODELING (BIM) KNOWLEDGE AMONG THE NIGERIAN STUDENTS OF ARCHITECTURE

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Abstract

BIM is has gradually become a global standard to rate the efficiency and sustainability of building design, construction and maintenance. Application of knowledge of BIM in building industry is capable reducing the incident of building collapse to the barest minimum if not completely eliminated. It is a veritable tool through which critical stakeholders in the building business collaborate to perfect the outcome of building project. Above all, it helps the professionals to put to test even before the site work the reality of the design. The costs are almost ascertained along the design process. With all of its known potentials, there are little or no indications that it has impacted much on the Nigerian students particularly the students of Architecture. The negative implication of this in the training of students of architecture and the development of the profession is very grave. It amount to raising architects who are not tune with current technological advancement in the building industry. Therefore, this research is aimed at assessing the level of knowledge of BIM among Nigerian students of Architecture. The study employed qualitative research approach through literature review on the subject matter and also conduct interview on students of architecture in Nigerian tertiary institutions using random sampling technique. The interview was done using structured open ended interview guide. The responses were analyzed through thematic method. The results were discussed, conclusion was drawn there from and recommendations were made also from the findings.

Keywords: Assessment, BIM, Awareness, Knowledge, Architecture Students

1.0 Introduction

Architecture Education in Nigeria has evolved over the years with several innovations and strategies towards solving architectural challenges and the likes. This has occurred along with its own attendant challenges. However, there has been relatively new trend of digitization in architectural design through computer aided design towards solving some fundamental challenges. One of the advancement and innovative trend in the field of architecture Engineering Technology is BIM. It is commonly understood as intelligent 3D modeling but a dipper search revealed that, it includes 4D time, 5D cost 6D as built operation and even 7D. BIM is a complete work flow that usually start with snacking procedure. It structurally analyse building design to ascertain its fitness, material suitability, cost evaluation and holistic reality of the design. With BIM building structural failure could be averted, cost variation can be minimized and a host of other salient benefits.

In the quest to measure up with trend and global best practices in architectural education, some department of architecture in Nigeria went digitalhaven been adopted to support the execution of construction procurement activities. Consequently, the architecture profession is now able to conceptualize and translate building designs and data into detailed construction information through new processes and techniques made available via the building information modeling (BIM). According to Berard, Vestergaard and Karlshøj (2002), BIM is a collection of interlinked domains of model with all necessary information for the design, construction, and maintenance of building and/or infrastructure projects. BIM is essentially a 3-Dimensional digital representation of a building and its intrinsic characteristics features in different models such as architectural design, construction, schedule, cost model, fabrication and operation model used in the delivery of building and other physical infrastructure projects (Hergunsel, 2011; Onungwa, Uduma-Olugu & Igwe 2017).

There is a growing consensus in the literature that the use of digital tools like BIM has a great potential for improving the quality of services provided by professionals in the design, engineering, construction and real estate industry (Dossick and Neff, 2010; Fadeyi, 2017). Specifically, the architecture profession has been greatly impacted since the introduction of computer and its associated technologies to the architectural practice (Ibem, Aduwo & Ayo-Vaughan, 2017). The study by Celanto (2017) reveals that architects are using BIM mainly because it enables them visualize their designs before the actual construction work commences on site; and thus contribute to reducing ambiguities, errors leading to saving some money for their clients as changes made to either the digital model or the database are automatically updated and coordinated in the entire model. In addition, the advent of BIM has enhanced effective collaborations among architects, client, engineers, building services, manufacturers, contractors and other consultants involved in the procurement of building and infrastructure projects, which was hitherto very difficult (Yan, Culp and Graf, 2011) .

Among the several benefits of using BIM is that professionals involved in the procurement of building projects are able to transfer building modelled information virtually from the design team, including the architect, civil engineers, surveyors, structural, mechanical and electrical engineers to the main contractors, sub-contractors and suppliers onthe project (Yan et al., 2011), therefore reducing information loss and delays that usually occur using the manual design and drafting tools and processes (Fadeyi, 20127; Nadeem *etal*.,2008; Muhammad, Abdullah, Ismail and Takim, 2018). In fact, the literature is replete copious evidences of the benefits of the adoption of BIM in the architecture, engineering and construction industry globally.

Although there is a growing body of research on the use of BIM among design, construction and real estate professionals, very few studies on the extent of its teaching and learning in a developing country like Nigeria. It is observed from the literature that several fragmented studies have been carried out on BIM in the context of the Nigerian tertiary institutions as regards it incorporation in the Nigerian educational curriculum. There has been haphazard and distorted teaching of the term hence affects the level of awareness. Some of these existing studies (Abubakar, Ibrahim, Kado & Bala, 2014; Akerele & Etiene, 2016; Ologboyega, 2016; Ologboyega & Aina, 2016; 2018; Okoye, Ezeokonkwo and Ezeokolie, 2016; Onungwa *et al*., 2017) have attempted to investigate the level of awareness Building Information Modeling (BIM). However, one major flaw of these studies is that they all viewed the construction industry as a monolithic entity as they failed torecognize the higher institutions from where this professionals are trained. The architecture profession plays a leading role in the design of building projects, and thus, adequate knowledge is required on the level of adoption of BIM in the training of architecture students. Notably, apart from the study by Dare-Abel, Igwe and Ayo (2014) that iidentified the availability of BIM literate staff in architectural firms in Nigeria, studies on the knowledge and awareness of BIM, particularly as it affect the learning of it higher institutions is very minimal.

In view of the foregoing, this study sought to assess the knowledge of BIM with focus on awareness among the Nigerian architectural students. The study attempted to address the following research questions.

- Have you offered course (s) on BIM as student?
- To what extent do you understand the term BIM?
- Do you think BIM is popular among the Nigerian students of Architecture?
- What do you think is responsible?
- Do you think there is need to create more awareness?
- Are students more productive using BIM?
- Do you think the knowledge of BIM has been fully understood by the students?
- How does the availability of quality of human and physical infrastructures affect the students knowledge on BIM?
- Do you think that BIM has been effectively incorporated into the Nigerian educational system?

This research is based the interview of Nigerian students of Architecture. It gives an insight into the level of awareness of BIM among Nigerian students of architecture. It makes contribution by improving understanding of the different BIM software packages used by architects to support the execution of design, drafting, and visualization, simulation, and analyses tasks. The study also provides a fresh insight into the direct benefits of using BIM in architectural practice from the Nigerian perspective.

2.0 Literature Review

Origin and meaning of BIM

Historical facts show that the conceptual development of BIM dates back to the earliest days of computing. It is on record that Charles Eastman was the first man to successfully create a building database known as building description system (BDS). This system, which was developed based on a graphical user interface, orthographic, perspective views describes individual library elements of buildings and allowed its users to retrieve information by attributes and add it to an existing model (Eastman, 2011). As result of its drafting and analysis efficiencies, it had great potentials to reduce the cost of design by over 50% (Eastman, 2011). It was based on the BDS technology that in 1984, Radar CH was developed for the Apple Lisa Operating System, and this later became ArchiCAD, which is today recognized as the first BIM software used on personal computers (Jack, 2008).In the last few decades, there has been increasing interest on BIM by authors, scholars and practitioners (Fadeyi, 2017; Muhammad *et al*., 2018). Consequently, several definitions and interpretations have been ascribed to BIM. Whereas Eastman (2011) described BIM as a repository of data and information for building design, erection, and maintenance available toall project stakeholders, some authors **(**Ibem, and

Laryea, 2014; Akerele and Etiene, 2016)have described BIM as a design and collaborative tool used in the procurement of construction projects. Autodesk (2016) also views BIM as an intelligent 3D model-based process that helps professionals in the AEC industry to efficiently plan, design, construct, and manage buildings and infrastructure projects. From the foregoing definitions, it can be inferred that BIM has been viewed from four main perspectives, namely as a structured dataset describing a building; as a tool for creating building and project information; the act of creating a building information model; and a business structure or system for effective management of activities related to the design, planning, erection, management and operation of building and infrastructure projects.

BIM and Architectural Practice

Although the term "architecture" has been defined in diverse ways in the literature, in the context of this study, architecture is defined as the profession that deals with the art and science of design, construction, commissioning, maintenance, management and coordination of all professional activities involved in a building project, layout and master plan of a building or groups of buildings and any other organized enclosed or open space, required for human activities (ARCON, 2004). By this definition, it is clear that architectural practice encompasses the provision of services related to the design, planning, and supervising the erection of buildings and their surroundings for human activities such as living, working, worshiping and recreation/sporting. Therefore, Oluwatayo and Amole (2012) described architectural firms as business-orientated organizations established to provide professional architectural services to their clients.

As is true in other countries of the world, architects render a wide range of services to their clients. In Nigeria for instance, architects are known to render various kinds of design, supervision and coordination/management services at the design, tendering, construction and post construction phases of building projects (ARCON & NIA, 2011). Hallberg (2010) has observed that BIM as a tool is capable of supporting the execution of various services rendered by architectural firms in both in the real and virtual environments. The author further explained that among other things, the use of BIM enables the creation of 3D design model that helps architects to visualize their proposed structure in three dimensions; suggesting that BIM is not just a design tool but a master data source of a structure and the foundation for ensuring that business functions are driven in a place (Autodesk, 2016; Fadeyi, 2017). In addition, BIM is also seen as a virtual collaborative tool that allows for the use of more realistic scenarios that better represent real-life challenges (Succar 2009; Ologboyega & Aina, 2018). In fact, Goldberg (2005) and Ologboyega and Aina, (2018) have insisted that with BIM, virtual models building are developed and the construction process simulated, studied and experimented with adjustments made where necessary before the building project is constructed. BIM tools can be classified into in three broad categories based on the task they can be used to execute. These are computer-aided architectural design (CAAD), simulation, and visualization tools (Goldberg, 2005). The CAAD tools are software developed for the purpose of replacing the traditional means of drafting, which involves the use of drafting boards, paper, pen, or pencils and allow architects to develop architectural drawings on the computer before presentation to them to their clients (Ibem, and Laryea, 2014; Dare-Abel, Igwe & Ayo, 2014; Al-Matarneh and Fethi, 2017). Examples of CAAD software packages used by archietcs include Abis, Allplan, ArchiCAD, AutoCAD, Accurender, Blender, Bricscad, Caddie, Maya, formZ, Spirit, Revit, Lumion, 3Ds Max, CINEMA 4D, Digital Project, SolidWorks, Rhinoceros 3D, Vectorworks and Google SketchUp (Clayton *et al*., 2002).

On the one hand, the simulation tools are used in predicting, validating, and optimizing architectural drawings developed by architects by using accurate data and analysis produced by software packages. They have the capacity of providing mechanical simulations, computational fluid dynamics, and manufacturing simulations. Some of them include: bSol,DAYSIM, Ecotect, eQUEST, IDA ICE, EDG II, T*Sol, EliteCAD, IES VE, LESOSAI, DesignBuilder, Design Performance Viewer (DPV) and Green Building Studio (Clayton *et al*, 2002). On the other hand, the visualization tools help architects to visualize the architectural, structural and mechanical, electrical and plumbing components of buildings to ensure that

each contains the right and adequate information in terms of size, shape and location amongst others (Yan, Culp, and Graf, 2011). Clayton *et al*. (2002) identified some of the visualization tools to include V-Ray, Artlantis, POV-Ray, YafaRay, Mental Ray, LuxRender, Flamingo, LightWave, RenderZone, RenderMan, Photoshop, Kerkythea, RenderWorks, Maxwell Render and Adobe After effects.

Benefits of BIM in Architectural Practice

The adoption of BIM has resulted to several benefits in the AEC industry. For instance, Nadeem *et al*. (2008) reported that BIM use was associated with benefits such as the removal of unbudgeted variations, improving accuracy of cost estimation; reduction in turnaround time for the production cost estimate and delivery time of a project. There is also evidence in the literature indicating that BIM helps architects to resolve issues at the design stage that would not have been possible using the traditional design tools of pen, paper, and boards (Ologboyega & Aina, 2018). It also helps in review of designs; engenders cost and schedule savings in design and construction works; and allows for effective integration of the inputs of contractors and suppliers at the design stage leading to improving the constructability of projects. Succar (2009) also identified the benefits of BIM to include identification of conflicts between various building systems instantaneously; reduction of the fragmentation of the construction industry in prompting seamless linking of the different segments of the industry; improving the efficiency in the industry; lower the costs of exchange and use of information associated amongst construction project stakeholders; and providing an alternative solution for coordinating design as designs can be reviewed in a virtual model. In addition to these, it has also been found by Linderoth (2010) that at the conceptual development phase of a building project, the use of BIM facilitates rapid visualization and accurate updating of changes; increased communication across the entire project development team; offers improvement in architectural and engineering design quality in terms of error free drawings leading to a steady improvement in productivity. Linderoth (2010) also added that the end result of using BIM is improved project coordination, minimization of errors as well as reduction in unnecessary delays and conflicts, which could lead to a potential cost savings of between 15% to 40%. Clayton *et al*. (2002) also reported that in a country like the USA, over 80% of BIM users had indicated a very positive impact on their firm‟s productivity and project outcomes improved project outcomes. In Nigeria, Olugboyega and Aina (2016) reported that construction professionals were using BIM because simply because they wanted to impress their prospective clients and improve on the quality of their services. Another study by Olugboyega (2016) on the development of Eko Atlantic City, Lagos Nigeria, revealed that the geometries and the structural systems of the city and its buildings were developed made using BIM; and that BIM was also used to develop animation of districts, water supply, and drainage design model, and simulation of sea wall construction for the city. In addition, a recent study in Nigeria by Onungwa *et al*. (2017) also revealed that BIM has a significant impact on the effectiveness of the supervision of projects, programming, and resolution of conflicts and improving efficiency in the design and construction stages of projects. In sum, Fadeyi (2017) concluded that BIM has thus far produced a significant positive impact on building and infrastructure project delivery by improving information and knowledge management the entire project life cycle.

3.0 Research Methods

The research method adopted in this work is qualitative through the instrumentality of opened structured interview questions to be conducted on respondents. Stratified Convenient sampling technique was employed to select respondents which are focused on Nigerian Architectural students in Nigerian tertiary institutions. Over fifteen (15) respondents were interviewed. The interview was recorded using smart phone and was later transcribed. The students interviewed are mostly University students in their 500 level, they constitute 60% of the respondents. Other respondents are students studying National Diploma architecture in the Nigerian Polytechnics, this group constitute 26.67% of the respondents while the smallest group of respondents were University postgraduate students which constitute just 13.33% of the population interviewed.

4.0 Analysis of the Interview

The interview revealed that majority of the respondents has poor knowledge of the term BIM. While many believe that its just a 3D software used to produce aesthetically pleasing design images, very few respondents know it beyond just 3D software. Some of the respondents has never offered course using BIM software as students, they are only previledge to have learnt outside the classroom. There is no uniform response from the respondents though there are similar points made.

On whether the respondents have ever been taught a course on BIM only 13.33% answered in affirmative, the rest of 86.7% have never been offered course on BIM. The interview revealed that comprehensive teaching of BIM course is lacking, it clearly shows that most students have not taught the course and even in the institutions where they were taught emphasis are placed on the design drafting part of the software.

As to what extent do students understand the term BIM, majority of the respondents to the tune of 57% know it to just be for making 3D of drawings while 38% said that they don't know anything about BIM. On 5% know the detail of how BIM is used and all its application.
87% of the respondents believe that BIM is not popular among the Nigerian students while only 13% believe that, the popularity depend on different factors. The factors include the geopolitical zone that is they believe that in the southern part Nigeria, particularly southwest, the knowledge of BIM is popular. Some of these respondents also believe that in some private high institutions BIM is popular.

Majority believe that lack of holistic incorporation of BIM into the tertiary institutions curriculum are factor responsible for its unpopularity, 42% of the respondents went for this while 31% of the respondents believe that lack of quality human and physical infrastructures account for low awareness among the students. 27% also believe that lack of awareness is due to the low level of adoption in the practice of architecture, that is firms do not adopt the use of BIM extensively.

As regards the need for awareness, 87.6% of the respondents say that there is need for awareness while only 12.4% said that there is no need, that what is needed is the holistic approach to the teaching of BIM software in tertiary institutions.
Whether students are more productive using BIM, 89% agreed that students are more productive using BIM considering the versatility and ease of doing the work while 11% of the respondents believe that some students take undue advantage of the software to be lazy.
As to fully understanding of the knowledge of BIM by the students, a good percentage of 83% of the respondents believe that the students have not fully grab the detail knowledge of BIM, emphasis for now is still on the use of the software for drafting with little emphasis on

simulation building, structural analysis, cost analysis and a host of other uses of BIM. However, 17% of the respondents agreed that, the students have fully understood the extent to which BIM can be used.

On the effects of quality of human and physical infrastructures on the students knowledge of BIM, 85% of the respondents believe that if quality human and physical infrastructures are available, the students knowledge of BIM will be greatly enhanced while 15% said that without much awareness on the important and the use of BIM available quality of human and physical infrastructures cannot enhance the students knowledge on BIM.

As to the adoption and full incorporation of BIM in Nigerian education system, 96% agrees that a lot still needs to be done on the full and proper incorporation of BIM in Nigerian education system. While only 4% believe that it has been well incorporated into Nigerian school system.

5.0 Conclusion and Recommendations

This study assesses the extent of BIM knowledge among the Nigerian Architecture students with focus on its level of awareness. The research concludes that there is poor awareness and inadequate knowledge of BIM among the Nigerian architecture students across the Nigerian public Universities and Polytechnics. The following recommendations were also made:

i. There is urgent for curriculum redevelopment in order to give adequate priority to BIM such that the course can be taught right from the elementary level of study of architecture across the Universities and Polytechnics in Nigeria.

ii. That there is need to creates BIM club or group among the Nigerian students of architecture with view to raise the awareness among the students in order to educate them on the importants of BIM to the students and in the general practice of the built environment professions.

iii. That with BIM fully incorporated into the Nigerian education curriculum some fundamental challenges of structural failure, non-functional roof, cost of buildings will be envisaged and corrected even at the design stage.

iv. That Nigerian public tertiary institutions have not fully keyed into the teaching of BIM though computer aided design (CAD) courses are taught mainly the drafting part of it with less focus on the BIM.

v.

References

Abubakar, M, Ibrahim, Y. M., Kado, D and Bala, K.Contractors Perception of the Factors Affecting Building Information Modelling(BIM) Adoption in the Nigerian Construction Industry. *Computing in Civil and Building Engineering* 8(2), 2014, pp. 167-178

Akerele, A. O., & Etiene, M. (2016). Assessment of the Level of Awareness and Limitations on the use of Building Information Modelling In Lagos State. *International Journal of Scientific and Research Publication*, 6(2),2016, pp. 229-234.

Al-Matarneh, R. and Fethi, I. Assessing the Impact of CAAD Design Tool On Architectural Design Education, *Malaysian Online Journal of Educational* Technology, 5(1), 2017, pp.1-20

Architects Registration Council of Nigeria (ARCON) Decree No. 10 of 1969 further amended by Decree No. 43 of 1990) now Architects (Registration, Etc) Act CAP A19 the Laws of the Federation of Nigeria 2004. Lagos: ARCON

Architects Registration Council of Nigeria (ARCON) and the Nigerian Institute of Architects (NIA). Conditions of Engagement and Remuneration for Professional Architect's services, Abuja: ARCON, 2011, pp .1-32

Autodesk . *What is BIM ? | Building Information Modeling | Autodesk*. 2016 October 2016, from Autodesk Website: http://www.autodesk.com.

Berard, O. B., Vestergaard, F., & Karlshøj, J. Building Information Modeling for Managing Design and Construction: Assessing Design Information Quality. Kgs. Lyngby: Technical University of Denmark (DTU), 2012 *orbit.dtu.dk/files/51481374/Ole_Bengt_Berard_Thesis.pdf.*

Celanto, D. Innovate or Perish: New Technologies and Architecture‟s Future. *Harvard Design Magazine* 26, 2017. http://www.harvarddesignmagazine.org/issues/26/innovateor-perish-new-technologies-and-architectures-future.

Building Information Modeling (BIM) Adoption in Architectural Firms in Lagos, Nigeria http://www.iaeme.com/IJCIET/index.asp 914 editor@iaeme.com

Clayton, M.J., Warden, R. B., &Parker, T.W. Virtual construction *of* architecture using 3D CAD *and* Simulation. *Automation in Construction*, 11(2), 2002, pp. 227-234.

Dare-Abel, O. A., Igwe, J.M. & Ayo, C.K. Proficiency, and Capacity Building of Human Capital in Architectural Firms in Nigeria. *International Journal of Architecture and Design*, 25(2), 2014, pp.1133-1139

Dim, N. U., Ezeabasili, A. C. C., and Okoro, B. U. (2015) Managing the change process associated with BIM implementation by the public and private investors in the Nigerian Building Industry. *Donnish Journal of Engineering and Manufacturing Technology*, 2(1), 2015, pp.1-6

Dossick C. S. and Neff, G. Organizational Divisions in BIM-enabled Commercial Construction. *Journal of Construction Engineering & Management*, 136(4), 2010, pp. 459-467.

Eastman, C., Teicholz, P., Sacks, R, and Liston, K. BIM Handbook: A Guide to Building Information Modeling for Owners, Managers, Designers, Engineers and Contractors, New YorK: John Wiley and Sons, 2008.

Fadeyi, M.O. The Role of Building Information Modelling in Delivering the Sustainable Building value. *International Journal of Susatinable Built Environment*, 6, 2017, pp.711-722

Goldberg, H. Software Strategy: BIM Comparison: How Does BIM Software Stack Up with the 3D Model Concept?”. *CADalyst January 2005. http://findarticles.com/p/articles/mi_mOBLL/is_1_22/ai_n11836215/?tag=content;col1*

Hallberg, D. On the use of open BIM and 4D Visualisation in a predictive life cycle management system for construction works. *Journal of Information Technology in Construction*, 16, 2010, pp. 445-466.

Hergunsel, M. Benefits of Building Information Modelling for Construction Managers and BIM-based Scheduling. a thesis Submitted to the Faulty of Worcester Polytechnic Institute in partial fulfillment of the requirements for the degree of Master of Science in Civil Engineering, 2011 https://web.wpi.edu/Pubs/ETD/Available/etd-042011.../MHergunsel_Thesis_BIM.pdf.

Ibem, E.O, Aduwo, E. B. and Ayo-Vaughan, E. K. e-Procurement Adoption in the Nigerian Building Industry: Architects‟ Perspective. *POLLACK PERIODICA*, 12(3), 2017, pp.167-180

Ibem, E.O. and Laryea, S. (2014). Survey of Digital Technologies in Procurement of Construction Projects. *Automation in Construction*, 46, 2014, pp. 11-21

Jack. C. CAD history. *CAD History., 2008 http://www.eod.gvsd.edu/eod/design/design-*

133.html.

Linderoth, H. C. (2010). Understanding Adoption and Use of BIM as the Creation of Actor Networks. *Automation in Construction*, 19(1), 2010, pp.66-72 204-218.

Muhammad,W.N.S, Abdullah, M.R., Ismail, S and Takim, R. Overview of Building Information Modelling (BIM) Adoption factors for Construction Organizations. IOP Conf. Series: Earth and Environmental Science 140 (012107), 2018,pp.1-9

E.O. Ibem, U.O. Uwakonye, G.O. Akpoiroro, M. Somtochukwu and C.A. Oke http://www.iaeme.com/IJCIET/index.asp 915 editor@iaeme.com

Nadeem, A., Azhar, S., & Mok, J. Y. Building information modeling (BIM); A new paradigm for visual interactive modelling and simulation for construction projects. *Fifth International Conference on Construction in the 21st Century*, 2008, pp.435-446.

Okoye, *P*.U. Ezeokonkwo, J.U, Ezeokoli. F. O. Factors Affecting *the* Adaptability *of* Building Information Modelling *(*BIM*) for* Construction Projects *in* Anambra State Nigeria. *International* Journal *of Applied* Science *and Engineering* Research, 4 (5), 2015, pp. 671-691,

Olugboyega, O. Building Information Modelling-Based Projects in Nigeria: Evidences from Eko Atlantic City, PM World Journal, 5(10), 2016, pp. 1-14

Olugboyega, O and Aina, O. O. Analysis of Building Information Modelling Usage Indices and Facilitators in the Nigerian Construction Industry, Journal of Logistics, Informatics and Service Sciences, 3(2), 2016, pp.1-36

Olugboyega, O and Aina, O. O. Examination of the Levels of Development of Building Information in the Nigerian Construction Industry,*Journal of Construction Business and Management*, 2(2), 2018, pp.1-14

Oluwatayo, A. A, Amole, D. Characteristics of global architecture firms. *Engineering, Construction and Architectural Management*, 19(4), 2012, pp 393-405.

Onungwa. I.O. Uduma-Olugu, N., and Igwe, J.M (2016). Building information modeling in Nigeria and its impact on collaboration in schematic design stage and post contract stage of design. *WIT Transactions on The Built Environment* , 169 , pp. 25-33

Rogers E M. Diffusion of Innovations, 1995 The Fee Press New York: The Free Press, pp 204-251

Succar, B.Building Information Modelling Framework: A Research and Delivery Foundation for Industry Stakeholders. *Automatio in Construction*,18(3), 2009, pp. 357-375

Yamane, T., Statistics: An Introductory Analysis, 2nd Ed., New York: Harper and Row, 1967

Yan, W., Culp, C and Graf, R. Integrating BIM and Gaming for real-time Interactive Architectural Visualization. *Automation in Construction*, 20, 2011, pp. 446-454