



Architects' Awareness and Benefits of Using Building Information Modelling in 21st Century Nigeria

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ABSTRACT

There is a growing demand for sustainable approaches in the architecture, engineering and construction (AEC) sector. It is a salient call for capacity building. Building Information Modelling (BIM) is one of the most recent technological innovations designed to provide solution to sustainable issues and capacity building opportunity in the modern-day dispensation. BIM offers a number of benefits that can help improve building design and construction processes. Architects are the most users of BIM globally, especially in developed nations. However, BIM adoption in among architect in Nigeria is at the early stage. This paper architects' BIM awareness and perception of BIM benefits in sustainable architectural practices in 21st Century Nigeria. Architectural firms in Kaduna state, Nigeria, are employed as a case. A questionnaire was developed and distributed to architectural firms via face-to-face. The result indicates that architects' level of awareness on BIM is low. Also, the most significant benefit of BIM is its ability to provide faster and more effective processes. The study concludes by recommending that government, architects, stakeholder such as Nigeria Institute of Architects, NIA embark on vigorous enlightenment campaign on BIM through the use of medium such as Television, radios, billboard to enlighten both architects, students, investors and building owners to improve awareness and adoption to embrace and for capacity building opportunities and sustainable in architectural practices 21st Century Nigeria.

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1.1 INTRODUCTION

There is a growing demand for sustainable approaches in the architecture, engineering and construction (AEC) sector. It is a salient call for capacity building. Building Information Modelling (BIM) is one of the most recent technological innovations designed to provide solution to sustainable issues and capacity building opportunity in the modern-day dispensation. One of the most recent technological innovations in the AEC sector is BIM. Building Information Modelling (BIM), a new innovation in technology helps bring order to the complexity involved in the project

life-cycle. It is an intelligent 3D model-based process that incorporates among others 4D (time) and 5D (cost) that gives architecture, engineering, and construction (AEC) professionals the insight and tools to more efficiently plan, design, construct and manage buildings and infrastructure, which allows users to manage information intelligently throughout the life-cycle of a project, automating processes such as programming, conceptual design, detailed design, analysis, documentation, manufacturing, construction logistics, operation and maintenance,

renovation and/or demolition (Autodesk, 2017; José, 2018).

BIM can be applied at various project phases. The major phases include project programming, design, preconstruction, construction, and post-construction-operations and maintenance (Aranda-Mena *et al.*, 2008; Ashcroft & Shelden, 2008; Eastman *et al.*, 2011; Kymmell, 2008 cited in Yahaya & Muhammad (2016).

BIM is as a new digital representation of physical_and functional approach to design creating shared knowledge source of information depending on collaboration between the Architects, Client, Engineers, Building services, Manufacturers, Contractors and other consultants. It is a team approach where inputs of all the professionals in the building industry are captured in the same model (Onungwa and Uduma-Olugu 2016; Hamada, Haron, Zakira and Humada, 2016; Snook, 2011). BIM improves safety factor in the construction project and planning efficiency to the construction projects (Hamada, Haron, Zakira & Humada, 2016); sections, perspectives, plan views and quantity take-offs could quickly (in many cases automatically) be updated to effectively ascertain potential costs. The parametric attributes allowed programming information to quickly be compiled for comparison to original authorization documents with a high degree of confidence in its accuracy, it enables visualization of what is to be built in simulated environment, accurate geometrical representation of the parts of a building in an integrated data environment, faster and more effective processes, better design, minimising cost of project, minimises time needed to complete project (Underwood and Isikdag, 2010, Azhar, 2011, CRC Construction Innovation, 2007; Underwood, 2009; Ali & Mohd Noor, 2012; Messner, Yerrapathruni, Baratta & Riley, 2002; Teicholz, 2004; Fazli, Fathi, Enferadi, Fazli & Fathi, 2014 and Qian, 2012; Underwood, 2009; Ali & Mohd Noor,

2012; Messner, Yerrapathruni, Baratta & Riley, 2002; Teicholz, 2004; Fazli, Fathi, Enferadi, Fazli & Fathi, 2014; Kassem, Brogden & Dawood, 2012; Barati, Charehzehi & Preece, 2013; Kanagasabapathi & Ananthanarayanan, 2004; Ali & Mohd Noor, 2012; CRC Construction Innovation, 2007; Eastman, Eastman, Teicholz & Sacks, 2011; Qian, 2012 and Gu & London, 2010).

Other specific benefits include *preconstruction benefits to owner*- access to concept, feasibility, and design benefits, it increases building performance and quality improved collaboration using integrated project delivery; *design benefits*-earlier and more accurate visualizations of a design, automatic low-level corrections when changes are made to designs, generation of accurate and consistent 2D drawings at any stage of the design, earlier collaboration of multiple design discipline, easy verification of consistency to the design intent, extraction of cost estimates during the design stage, improvement of energy efficiency and sustainability; *construction and fabrication benefits*-use of design model as basis for fabricated components, quick reaction to design changes, discovery of design errors and omissions before construction, synchronization of design and construction planning, better implementation of lean construction techniques, synchronization of procurement with design and construction and *post construction benefits*-improved commissioning and handover of facility information, better management and operation of facilities and integration with facility operation and management systems (Aranda-Mena *et al.*, 2008; Bernstein & Pittman, 2004; Eastman *et al.*, 2011; Pittard & Sell, 2016; RICS, 2014a in Yahaya & Muhammad, 2016). There is some evidence to suggest that the architectural profession is beginning to come under pressure to adopt BIM (Arayici, Coates, Koskela, Kagioglou, Usher and O'Reilly (2011). Owners are starting to insist that architects and other

design professionals, construction managers and construction companies adopt BIM (Mihindu & Arayici, 2008). Usman (2015) assessed the readiness of the Nigeria public sector (Federal Ministries and Departments and Parastatals) to implement BIM in its project delivery process. Results of the study show that the federal ministries in Nigeria have achieved management, process as well as 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.

In addition, in spite of the importance of BIM for sustainable architectural practice in Nigeria. However, very few local literature focus on architects' awareness and perception of the benefits of BIM adoption. Therefore, the objective of this study is to examine the level of awareness of BIM and its benefits in architectural practices in Nigeria.

2.1 METHODOLOGY

This is survey research. A questionnaire survey has been designed to meet the research objectives, which consist of three parts. The first section is on characteristics of respondent, the second section is on the level of awareness on BIM and the third section on benefits of BIM. The participants of this survey are limited to architects in Kaduna state, North-west Nigeria, West Africa. Data analysis was conducted by adopting the relative importance index RII to find out the importance of factors which represented the benefits of benefits BIM technique in architectural practices. The benefits were put in rank, the top-ranked is more important than the next and so on.

The RII value calculated as below:

$$\text{Relative importance index (RII)} = \sum w / (A \times N) - - , (0 \leq \text{RII} \leq 1)$$

Where: $\sum w$ = total sum of weighting given to each factor by the respondent

A = highest weight

N = total number of respondents

The total population of architectural firms in Kaduna State, North-west Nigeria is 74 (Architects Registration Council of Nigeria, ARCON, 2014). Therefore, the sample size was determined using Yamane's formula (in Singh and Masuku, 2014) below.

$n = N / 1 + N(e)^2$; Where: n = sample size,

N = total population, 74 firms

e = precision, 0.05

Therefore, $n = 74 / 1 + (5)^2$

$$= 74 / 1.185$$

$$= 62.44$$

The sample size is 62 firms. Therefore, 2 architects were randomly selected from each of 62 firms, to give a total of 124 population. 124 structured questionnaires were administered face-to-face, however, only 68 questionnaires were duly completed and returned.

3.1 RESULTS AND DISCUSSION

The data collected was analysed using SPSS and presented in table 1, 2 and 3.

3.1.1 Demographic profile of respondent and firms

The demographic profile of respondents and architecture firms is shown below in Table 1. The result shows that 52.94% of the respondents are male, while 47.06% are female, ARCON registration status reveals that 60.29% of the respondents are registered, while 39.71% are not registered, year of establishment of respondents reveals that 35.29% of firms selected have a mean of 20year, 6months, followed by 22.06% with a mean of 3year, with the least having 4.41% and a mean of 8years of the establishment. The respondents' job title shows that 57.35% are consultants, followed by 14.71% contractors, 13.24% designers, 10.29% supervisors and 4.41% who are project managers, respondents' type of firms. 50% are consultancy firms, 33.82% construction and 16.18% are academic, the forms of ownership respondents' firms shows that 51.47% are partners, 47.06% are sole proprietors and 1.47% are into limited liability company; with

82.35% of firms having the average number of 3 members of employees, followed by 14.71% 8, and 2.94% with an average of 13 employees. Finally, 48.53% of the project carried by the firms are residential, followed by

commercial-17.65%, religious building-14.71%, hospitality (hotels, restaurants, etc)- 11.76% and educational with 7.35%.

Table 1: *Demographic profile of respondent and firms*

Item	Response	Per centage (%)
Gender		
Male	36	52.94
Female	32	47.06
ARCON Registration status		
Registered	27	39.71
Not registered	41	60.29
Year of Establishment		
1- 5 years	15	22.06
6-10 years	3	4.41
11-15 years	11	16.18
16-20 years	9	13.24
21 years above	24	35.29
Job title		
Consultative	39	57.35
Designer	9	13.24
Supervisor	7	10.29
Project manager	3	4.41
Site engineer	-	-
Contractor	10	14.71
Type of firm		
Consultancy	34	50.00
Construction	23	33.82
Academic	11	16.18
Others	-	-
Forms of ownership		
Sole Principal	32	47.06
Partnership	35	51.47
Unlimited liability company	-	-
Limited liability company	1	1.47
Public company	-	-
Not Sure	-	-
No. of employees		
1–5 staff	56	80.88
6–10 staff	10	14.71
11–15 staff	2	2.94
Over 16 staff	-	-
Type of project		
Residential	33	48.53
Commercial (including offices)	12	17.65
Hospitality (hotels, restaurants etc.)	8	11.76
Educational	5	7.35
Healthcare	-	-
Cultural/ entertainment (theatres, museums)	-	-
Civic building	-	-
Religious buildings	10	14.71
Transportation (airports, garages) and urban projects	-	-

3.1.2 BIM awareness

The result in Table 2 indicates that 100% of the respondents revealed that they are aware of BIM, 5.88% have deployed BIM technology in their projects. On the other hand, only 2.94% of the respondents still use BIM software application.

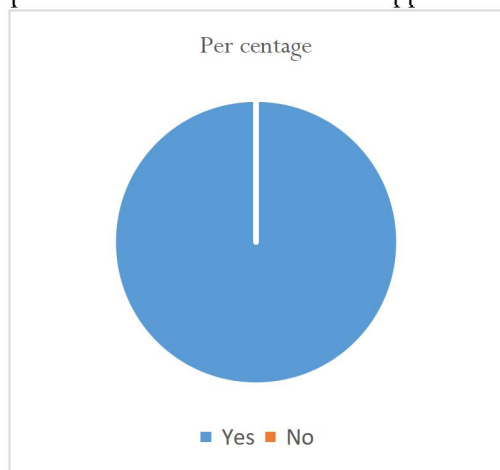


Figure 1: Architects having info on BIM

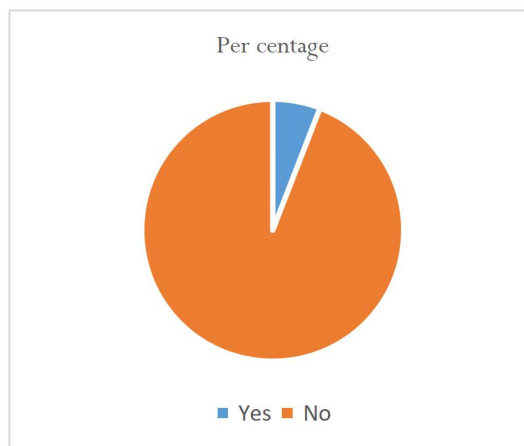


Figure 2: Architects who had used BIM

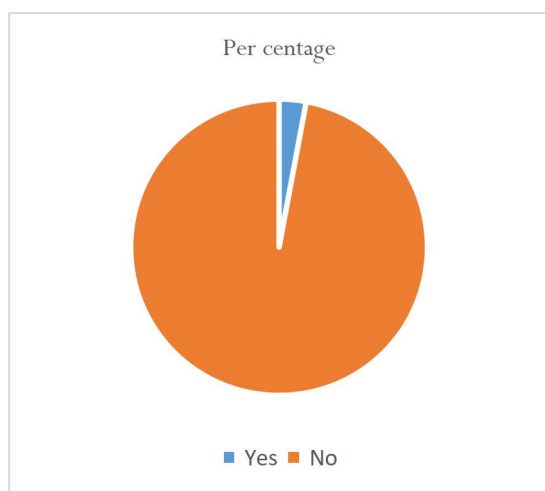


Figure 3: Architects still using BIM

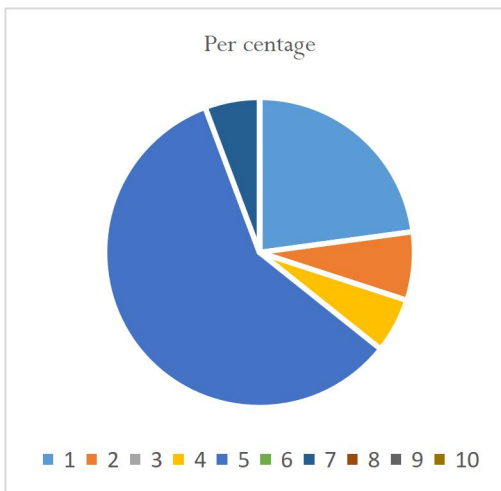


Figure 4: Level of awareness on BIM

Table 2: BIM awareness level

SN	Item	Response	Per centage (%)
i.	Have you heard of Building Information Modelling (BIM)?	Yes	68 100
		No	0 0
		Total	68 100
ii.	Have you ever used BIM for the projects above?	Yes	4 5.88
		No	64 94.12
		Total	68 100
iii.	If Yes to the question above, are you still using BIM	Yes	2 2.94
		No	66 97.06
		Total	68 100

Level of awareness on BIM

Those respondents that are aware of BIM were further asked to rate their level of awareness on the concept of BIM on a scale of 1-10, with 1 being the lowest and 10, the highest. The result as presented in Table 3 reveals that majority, 60.29% of the respondents are just a little above the half mark line in terms of their

knowledge of BIM. However, none of the respondents claims to have excellent knowledge of BIM. Despite the high level of awareness among Nigerian Architects, these results suggest a lack of adequate knowledge on BIM.

Table 3: *Level of awareness on BIM*

SN	Rating	Frequency	Per centage (%)
1.	1	16	23.53
2.	2	5	7.35
3.	3	0	0
4.	4	2	2.94
5.	5	41	60.29
6.	6	0	0
7.	7	4	5.88
8.	8	0	0
9.	9	0	0
10.	10	0	0
Total		68	100

Benefits of BIM

Table 4 shows the benefits of BIM in architectural practice. However, the 10 most significant benefits from this study include faster and more effective processes, better design, automated assembly, visualize what is to be built in a simulated environment to identify any potential design, construction, or operational issues, minimising from the cost of the project, better customer service, improved document management and integration, an accurate geometrical representation of the parts of a building in an integrated data environment, improve collaboration and communication and reduce missing data incident. This is seen from the ranking based on their means and relative importance index. Faster and more effective processes have the highest mean score of 4.94.

4.1 CONCLUSION

The aim of the research is to investigate the potentials of building information modelling (BIM) application in Architectural Practice

with focus on the design and services for the improvement of project delivery to meet up with international best practice. Base on the specific objectives of the pilot study, the following is the conclusions of the findings.

The result of this study shows practising architects in Kaduna state, northwest Nigeria is aware of BIM. However, the number of architects using it is negligible which could in part due to architects' average knowledge of BIM. Most significant benefits of using BIM is its potential to foster faster and more effective processes, with the highest mean score of 4.94 and ranked 1st (see Table 4).

Finally, this study reveals that BIM technology which is an innovation tools, a capacity-building opportunity in the in the 21st century Nigeria is not being adopted or implemented in architectural practice in Nigeria.

Table 4: *Benefits of BIM in architecture.*

SN	Item	Descriptive			
		Total score	Mean score	Relative index	Rank
i.	Improve safety factor in the construction project	215	3.16	0.632	14
ii.	Planning efficiency to the construction projects	217	3.19	0.638	13
iii.	The parametric attributes allowed programming information to quickly be compiled for comparison to original authorization documents with a high degree of confidence in its accuracy	203	2.98	0.597	15
iv.	Visualize what is to be built in a simulated environment to identify any potential design, construction, or operational issues	295	4.34	0.868	4
v.	Accurate geometrical representation of the parts of a building in an integrated data environment	278	4.09	0.818	8
vi.	Faster and more effective processes	336	4.94	0.988	1
vii.	Better design	332	4.88	0.976	2
viii.	Controlled whole-life costs and environmental data	188	2.76	0.553	19
ix.	Better customer service	288	4.23	0.847	6
x.	Automated assembly	305	4.49	0.897	3
xi.	Minimizing from cost of project	291	4.28	0.856	5
xii.	Minimizing of time needed to complete project	215	3.16	0.632	14
xiii.	Client demand	198	2.91	0.582	17
xiv.	Reduce safety risks in the design phase	193	2.84	0.568	18
xv.	Predictability of project time / Up to 7% reduction in project time	162	2.38	0.476	20
xvi.	Improve collaboration and communication	277	4.08	0.815	9
xvii.	Clash detection/ A savings of up to 10% of the contract value through clash detections	202	2.97	0.594	16
xviii.	Minimizing rework	264	3.88	0.776	11
xix.	Maximizing productivity	243	3.58	0.715	12
xx.	Reduce missing data	271	3.98	0.797	10
xxi.	Improved document management and integration	282	4.14	0.829	7

Based on the findings above, the Nigerian government in collaboration with Nigeria Institute of Architect, NIA, ARCON and other stakeholders in the AEC industry should set out a campaign to thoroughly create awareness and also educate practising architects on BIM technology.

Stakeholder in the AEC should organised affordable and accessible workshop and training for architects in the state on BIM tools and how to use it in order to improve the adoption and implementation status in Nigeria. The government should at this early stage subsidise cost of BIM tools- hardware and software and training to encourage practising architects to have access to BIM tools and

training ARCON and NIA alongside top management in organisation should support and also train architects on BIM tools and usage before registration. This will increase the number of practising architects using BIM.

ARCON and NIA should make BIM knowledge a prerequisite for the registration of architects. This will help curb personal barriers. The government should support and demand BIM services and standards from all practising architect participating in any project within the country.

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