Competencies and the penetration status of building information modelling among built environment professionals in nigeria

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SUMMARY

Literatures have proven a substantial increase in the awareness of Building Information Modelling (BIM) among built environment professionals in developing countries like Nigeria. However, the shortage of BIM competent professionals remains a significant challenge to the full utilization of this innovative construction process. These competencies deficiencies are in no small measure the catalyst for reduced productivity and the obsoleteness of recent construction graduates upon their emergence in the innovative construction world. This necessitate the need to assess the competencies of built environment professionals in the use of Building information modelling (BIM) with a view of suggesting strategies for improvement. The study mainly adopted an electronic questionnaire survey approach, which was targeted at built environment professionals in Abuja, Nigeria. Percentages, mean item score, relative importance index, and gap analysis were employed for the analysis of data. The study found out that built environment professionals in Abuja have a competency gap of 39% with an average possession of Administrative and Managerial BIM competencies and a high deficiency in Technical, Operational and Implementation competencies which are most required. Vocational training is currently most adopted for bridging these gaps. More so, the most effective strategies to improve the competency level of built environment professionals in the use of BIM are established to be: Attending BIM seminars, workshops, Trade shows, and Event; Enrolling for BIM software training and Incorporation of BIM into the Academic curriculum of higher institutions. This research will be needful in providing construction stakeholders as well as built environment educators with essential knowledge of the core competencies required as they develop and implement various BIM content in their domain.

COMPETENCIES OF BUILT ENVIRONMENT PROFESSIONALS IN THE USE OF BUILDING INFORMATION MODELLING IN NIGERIA

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1. INTRODUCTION

Across the world, new technologies are emanating daily which is revolutionising and changing all from the basic to the complex functions of life. The construction industry is no exception. As this technology evolves, humans are forced to evolve with it or run the risk of being left behind (Gee, 2010). Building Information Modelling (BIM) is one of such obvious aspects of a deep and fundamental change that is rapidly transforming the global construction industry, bringing about collaboration between project stakeholders and improvement of project outcomes (Abubakar *et al*., 2014; Olanrewaju *et al*., 2020a, 2020b).

A growing trend of new positions in the industry like BIM professor (a high ranking BIM academician), BIM manager, and BIM modeller further shows the increasing need of BIM competent professionals for the industry (Yakami, 2016). Executing a BIM project requires new strands of expertise for all disciplines compared to more traditional projects. As a transformative industry trend, BIM prefers more collaborative project delivery method such as Integrated Project Delivery (IPD), in which the roles and responsibilities of project team members are reconfigured, and new skill sets other than those of traditional positions are also expected (Hardin, 2009). . Mohd *et al*., (2013) mentioned that skilled BIM workforce in the industry helps in cost reduction and also in the better time management through clash detection between different disciplines. Despites all these prospect, BIM implementation around the globe have fallen short of its potential for a number of reasons including professional liability, intellectual property, interoperability, investment and training, among others (Won *et al*., 2013). Sacks and Barak (2010) are of the opinion that the shortage of people with BIM competencies has become one of the most significant challenge that delays and slows down the use of BIM worldwide. Succar (2016) also added that a significant reason for the poor adoption and implementation of BIM is the failure to recognise the user competencies required to manage BIM. Meanwhile, Zhang, Schmidt and Li (2016) stated that without BIM talent development, no real progress can be made towards construction's sustainability. This pressing demand is likely to urge the industry to rethink the skill sets a worker has to offer (McGraw-Hill Construction 2012).

Wu and Issa (2014) regards BIM education as a solution to brisk up the BIM skills learning curve which may help a company to hire ready-made graduated BIM personnel. Han and Bedrick (2015) further emphasizes that BIM adoption will suffer without its incorporation into education. At present, the lack of BIM education in tertiary studies has raised concerns around the world as the demand for BIM talent increases (Zhang, Schmidt and Li, 2016). The Risks of

using BIM are far outweighed by its benefits therefore proper understanding of its application can promote its efficiency. This provides the need to incorporate BIM in the University teaching syllabus to equip students on the concepts and skills required and also develop continuing education courses of BIM to transfer such knowledge to construction industry practitioners (Ogwueleka, 2015). In addition, Uwakonye *et al.* (2015) stated that BIM is the future of design construction, as already being realized in more advanced economies. Therefore, if educational institutions are poised to produce professionals that will solve our tomorrow's problems today, then they must be well equipped with relevant skillset. Succar and Sher (2014), emphasis that it is paramount to identify the competencies that need to be taught at higher educational institution or trained on the jobs in order to properly equip current and future industry professionals with the necessary knowledge and skills to engage in collaborative BIM workflows and integrated project deliverables. Hence, a need for this research.

Studies on BIM education and competencies abound in AEC programmes worldwide (Taylor *et al*., 2008; Clevenger *et al*., 2010; Lee and Dossick, 2012; Panuwatwanich *et al*., 2013; Sacks and Pikas, 2013; Shelbourn *et al*., 2017). However, the same could not be said about the AEC industry in Nigeria. To bridge these gaps, it is essential to assess the competencies of built environment professionals in the use of BIM with a view of establishing strategies that will improve these competencies. This research will be needful in providing built environment educators as well as construction stakeholders with essential knowledge of the core BIM competencies required as they develop and implement BIM contents in their domain.

2. RESEARCH METHODOLOGY

The research methods upon which this study is premised is presented in this section. The section also discusses the research approach, the research instrument, as well as the sampled population, responses and method of analysis. A quantitative research approach was employed using a questionnaire survey method to obtain information from built environment professionals (Architects, Quantity Surveyors, Builders, and Civil Engineers) based on the findings from the extensive review of literature. The questionnaire survey was carried out on a sample of built professionals drawn from the list of registered professional practising in Abuja from their respective professional bodies such as Nigerian Institute of Architects (NIA), Nigerian Institute of Quantity Surveyors (NIQS); Nigerian Institute of Builders (NIOB), and Nigerian Institute of Civil Engineers (NICE). The instrument used for data collection consist of a well-structured questionnaire developed to achieve the objectives of this study. The questionnaire was further sub-divided into three sections. Section "A" which contain background information about the respondent was designed to collect data on the general characteristic of the respondents in order to check for the quality of the data for further analysis. Section "B" focused on examining the level of awareness and experience of profession in the use of BIM. While Section "C" contain information about the competencies of the professional in the use of BIM. The questions were asked on a 5-point likert – type scale with the 5 being the highest, 5 denotes Very good/Strongly possessed/Strongly required as it applies to the different questions asked while 1 denotes None/Strongly disagree. A total of 317 questionnaires were mailed out to target respondents for completion. A total of 152 were filled and returned of which only 140 sets are usable for data analysis representing an overall response rate of 44% of the total responses expected. This response rate is considered to be in order as it underscores the assertion of by Moser and Kalton

(1999), who posited that a study can only be considered biased if the response rate is below 30%.

In order to analyse the data obtained through the survey, the study employed percentage and frequency to analyse the background information of the respondents while charts were used to analyse the level of awareness and the experience of professionals in the use of BIM. Descriptive statistics (Mean Item Score [MIS], Standard deviation [SD]) was used in analysing and ranking of the responses on the competencies to determine the competencies exhibited, while Gap analysis approach used by Mullin, Thurairajah, and Williams (2010) to derive a formula for estimating the gap percentage in BIM competencies.

3. COMPETENCIES OF BUILT ENVIRONMENT PROFESSIONALS IN THE USE OF BIM

3.1. An overview of BIM

The Royal Institute of British Architects (RIBA), Construction Project Information Committee (CPIC) and Building Smart have jointly defined Building Information Modelling (BIM) as the digital representation of physical and functional characteristics of a facility creating a shared knowledge resource for information about it forming a reliable basis for decisions during its life cycle, from earliest conception to demolition (The BIM Hub, 2014). The most significant highlights of the BIM methods are; single file concept; use of real Architectural elements for modelling, parametric capabilities where changes to the model affect all related drawings (and vice versa) and the automatic generation and updating of documentation among several others (Aouad, Wu, Lee, and Onyewobi, 2014; Aranda-Mena, Crawford, Chavez, and Froese, 2008). According to a research conducted by Center for Integrated Facility Engineering (CIFE) in 2007, financial benefits in BIM-based projects during design and construction phase yields 7% reduction in project completion time, 10% of cost saving, 40% elimination of unbudgeted changes, 80%-time reduction to generate cost estimate and 3% cost estimation accuracy within 3%.

3.2. BIM Competency Classification

The BIM competency of an individual or group of individuals represents the ability of users to fulfil all the important areas of an effective BIM implementation to deliver value and achieve the expected BIM product/service. These competencies differ in their nature and can be acquired through equally varied means. According to Succar (2013), there are basically two classification of BIM competencies, which are Tiers classification and Auxiliary classifications. These classifications are important to organize BIM competencies into meaningful, exhaustive, and mutually-exclusive clusters (Gregor, 2006). The auxiliary classification labels BIM competencies as either generic or specialised. Generic BIM competencies are equally valid across all disciplines, specialties and roles; Example include Data exchange and communication competencies that are required of all professionals in a BIM domain irrespective of your discipline while Specialized BIM competencies are valid only within a subset of disciplines, specialties and roles. Example include an architect (Discipline A) developing a 3D spatial model for a hospital building would require a different set of competencies from those required by an engineer (Discipline B) performing thermal analysis of the hospital's zones. (Succar *et al.*, 2013). The tier classification group competencies into sets, element of the same set have

certain things in common. A BIM Competency Set is a hierarchical collection of individual competencies identified for the purposes of BIM implementation and assessment.

3.2.1. Tier classification

Succar (2013) in his work "An integrated approach to BIM competency assessment, acquisition and application" divided the Tier classification of the BIM competency into three main Subdivisions.

3.2.1.1. Tier 1: Core competencies

"The core competencies tiers encompass the personal abilities of individuals enabling them to conduct a measurable activity or deliver a measurable outcome. These core competencies tier refers to personal abilities as opposed to 'organisational core competences" ([Succar *et al.*,2013] – Page 7).

3.2.1.2. Tier 2: Domain competencies

"The domain competencies tier: They refers to the professional abilities of individuals, the means they use to perform multi-task activities and the methods they employ to deliver outcomes with complex requirements. There are eight competency sets within this tier as ; four primary sets (managerial, functional, technical and supportive) representing the main types of professional ability; and four secondary sets (administration, operation, implementation and research & development) identifying those abilities which are formed by the overlap of Primary Sets. *Primary competency sets* represent an individual's main professional abilities while the *Secondary competency sets* represents an individual's ancillary professional abilities". ([Succar *et al.*,2013] – Page 8).

- Managerial Competencies; These are abilities that help construction professionals to create, plan, organize, lead, regulate, guide and control the entire BIM implementation processes from inception to completion.

- Functional Competencies: These consist of an internetwork of skills that helps the smooth working of a BIM process within an organization. They include skill sets such as collaboration, facilitation, and project management among many others.

- Technical Competencies: These are discipline specific abilities that helps individuals achieve their core and central BIM project deliverables. They include such competencies as an ability of an Architect to generate good Models using BIM software tools.

- Supportive Competencies: These are the abilities required to maintain the smooth working of an organization's information and communication technology (ICT) systems. They include network management, hardware maintenance, software installation and troubleshooting, internet connections among others.

- Administration Competencies: These abilities are quite synonymous to that managerial competencies. They are competencies required to manage the human resources (roles, responsibility, welfare, performance, hierarchy etc.), financial resource and policies of an organization in order to achieve their BIM goals and Objective.

- Operational Competencies: These are abilities required to run and deliver a project design, analyses, simulation and estimation in order to ensure effective BIM project delivery.

- Implementational Competencies: They are the skill sets required to introduce transformative concepts and tools into an organisation. These abilities are necessary in finding the tools, processes, and innovative training methodology that best fit their organization existing workflows. They include component development, library management and standardisation.

- Research and Development: These are abilities that are geared towards keeping an organization's BIM status up to date. They are specifically focused on finding new technological solutions to existing problems, with an aim of improving an organizational workflows and deliverables.

3.2.1.3. Tier 3: Execution competencies

"The execution competencies tier represents and individual's ability to use specific tools and techniques to conduct an activity or deliver a measurable outcome. The ability to use a software tool (e.g. a 3D model authoring tool), drive a vehicle (e.g. a 30 tonne tipper truck) or operate specialized field equipment (e.g. a laser scanner) are examples of execution tier competencies. Also, the ability to employ specialized techniques (e.g. programming, drawing and plastering) is also classified under the Execution Competency Tier.
This notwithstanding, Succar (2013) stated that competencies organized by tiers, sets and topics complement each other. That is, for an individual to deliver an activity, a mixture of competencies from across all three tiers is typically required. For example, for a structural engineer to efficiently generate and exchange a data-rich 3D model with an architect, she/he will require core engineering qualifications, BIM domain expertise (knowledge of collaboration requirements and data exchange protocols) and execution abilities (ability to use modelling and data exchange tools)" ([Succar *et al.*,2013] – Page 9).

3.3. State of BIM Education in Nigeria

The construction industry of developing countries like Nigeria are still using the old 2D method of drafting and designing. One of the main reasons is that most of the teachers are experts in 2D drafting and some of them are in 3D modelling but there are relatively few professionals who can teach BIM. Even though some experts are available, they are not enough for providing the knowledge of BIM to all the professionals (Yakami, 2016). Sabongi (2009) argues that the existing curricula are often very crowded, which makes it difficult to find any room to accommodate additional courses and that staff are unwilling to change the existing curriculum

in order to incorporate BIM. Another practical challenge is the lack of educational resources (Becerik Gerber *et al*., 2011; Sabongi, 2009).

3.4. Strategies for Improving The Competencies Of Built Environment Professionals

To solve the issue of BIM implementation in Nigeria, and to as well increase the BIM competency level of built environment professionals. Isa (2015) developed strategies for overcoming the various process and technological barriers hindering this improvement. This strategies include improving BIM awareness and understanding, outsourcing BIM experts, provision of training by employers, provision of education in higher institutions, government support among other. Mordue *et al*., (2016) outline some best BIM resources that can help improve the competencies of built environment professionals in the use of BIM. According to Mordue *et al*., (2016), these resources include but are not limited to the use of Social media; Attending trade shows and events organised by professional institutions, software vendors and like-minded people who want to share best practises; Perusing publications and Journals; Joining associations and forums either physically or virtually to share ideas, opinions and views on particular BIM issues; Visiting virtual BIM libraries; Heading to summer schools; among others.

4. RESULTS

The section presents the findings from the analysis of data obtained from the electronic Survey, desktop review, and extant literature as mentioned in the previous sections. Inference were made, relationships were drawn between observed information through the analysis of past studies similar to the research work in order to determine the agreement or otherwise.

4.1. Demographic Information of Respondents

Table 1 shows the general characteristics of the respondents to the questionnaires, the characteristics include designation of the respondent, highest qualification of the respondent, years of experience in the profession, membership of professional body and type of membership. It is important to state that a large proportion of the respondent got their higher education from the North central, where the study area is located. This statistics justifies the assumption that most of the professionals practising in Abuja are likely to observe their higher education from the same geopolitical zone or region where the study area is located. Hence providing an empirical evidence for the nexus between their current BIM competency gap and the level of BIM education received in such region.

Table 1: Summary of respondents Characteristics

Variables	Classification	Frequency	Percent
Designation of Respondent	Quantity Surveyor	48	34.3
	Civil Engineers	28	20.0
	Builders	21	15.0
	Architects	30	21.4
	Others	13	9.3
	Total	**140**	**100.0**
Years of working Experience	Less than 5 years	79	56.4
	5-10 years	31	22.1
	10-15 years	12	8.6
	16 years and above	18	12.9
	Total	**140**	**100.0**
Membership of professional body	NIA	30	21.4
	NIQS	47	33.6
	NIOB	20	14.3
	NSE	29	20.7
	Others	14	10.0
	Total	**140**	**100.0**
Professional Membership	Graduate	68	48.6
	Probationer	14	10.0
	Corporate	52	37.1
	Fellow	6	4.3
	Total	**140**	**100.0**
Highest formal qualification	ND	3	2.1
	HND	15	10.7
	BSc./B.Tech/B.Engine	91	65.0
	PGD	0	0.0
	MSc./MTech	26	18.6
	PHD	5	3.6
	Total	**140**	**100.0**

4.2. BIM Awareness and Experience Level of Built Environment Professionals in Nigeria

The study reveals that BIM is becoming more popular in the field of the Nigerian construction industry with about 84% of the respondent been aware of BIM and only just 16% maintained a neutral position or are said to be unaware, this is in agreement with the findings of Yakami (2016) whose result reads that majority (82%) of the participant had an experience in using BIM and hence, indicating that BIM is gaining more popularity in the field of construction industry. However, the study also shows that only 50% of the respondent have been involved in at least one BIM based project while the remaining 50% haven't been involved in any BIM based project despite their level of awareness. The statistical breakdown is presented in Figure 1 and Figure 2 respectively. Respondent were also asked about the means through which they acquire their BIM competencies, the result indicate that vocational training remains one of the most adopted means by respondent to cover up for their competency gaps in the use of BIM.

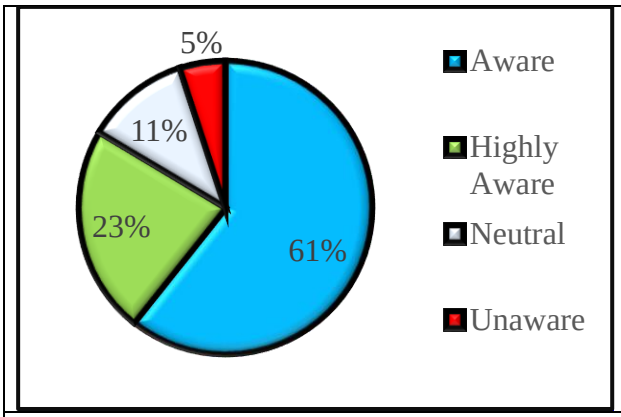

Figure 1: BIM Awareness level of Respondents

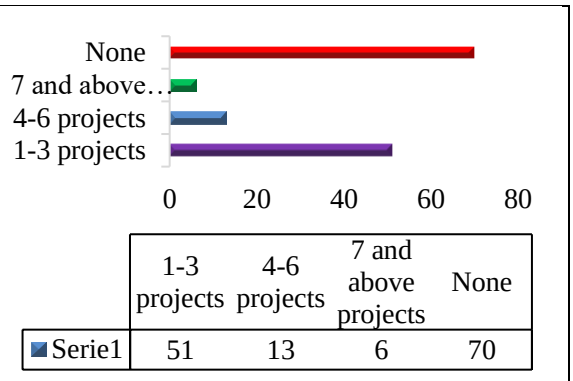

Figure 2: BIM experience of Respondent

4.3. Level of importance of BIM Competencies Required by Nigerian Built Environment Professionals

In order to identify the level of importance of BIM competencies required by built environment professionals to use BIM in the study area, the professionals were asked to rank the identified BIM competency areas as collated from extant literature review. Technical competencies (with a mean value of 4.44), Operational competencies (with a mean value of 4.38) and Implementation (with a mean value of 4.27), were the top three highest-ranking variables assessed by the professionals while managerial and administrative competencies were embedded at the bottom of the chart with a mean value of 3.93 and 3.78 respectively. See Table 2 below for details. The result is partly in agreement with research of Succar (2013) which also identified Technical and functional competencies as one of the most required competencies of built environment professionals.

Table 2: Competencies required by Built Environment Professionals in the Use of BIM

S/N	Competency Set	mean	Std. Deviation	Ranking	Decision
1.	Managerial	3.93	0.934	7th	Required
2.	Administrative	3.78	1.176	8th	Required
3.	Functional	4.21	0.869	4th	Required
4.	Operation	4.38	0.826	2nd	Required
5.	Technical	4.44	0.815	1st	Required
6.	Implementation	4.27	0.936	3rd	Required
7.	Supportive	3.94	1.044	6th	Required
8.	Research and development	3.97	1.059	5th	Required

4.4. Gap Analysis of the Required and the Attained BIM Competencies

In order to determine the variation in the gap between the competency required of built environment professionals and that attained by these professionals, a gap analysis test was conducted based on the response of the professionals. Table 3 present the mean gap between the competencies required and exhibited by built environment professionals in the study area. Operational, technical, functional, implementational, supportive, and research & development competencies recorded the highest mean gap of 1.6, 1.5, 1.4, 1.4, 1.2, and 1.1 respectively, while managerial and administrative competencies with mean gaps of 0.3 and 0.0 showed the least variation.

Table 3: Gap Analysis of Required and Possessed Competencies

S/N	Competency Set	Required Mean	Exhibited mean	Mean Gap	Rank
1	Managerial	3.929	3.633	0.296	7
2	Administrative	3.779	3.74	0.039	8
3	Functional	4.207	2.805	1.402	3
4	Operation	4.379	2.764	1.615	1
5	Technical	4.436	2.955	1.481	2
6	Implementation	4.271	2.893	1.378	4
7	Supportive	3.943	2.717	1.226	5
8	Research and development	3.971	2.912	1.059	6

Source: Researcher Data Analysis (2019)

4.5. Overall Percentage Competency Gap in the Use of BIM

This study adapted a Gap analysis approach used by Mullin, Thurairajah, and Williams (2010) to derive a formula for estimating the overall percentage gap in BIM competencies. This is calculated by evaluating what is expected from and what is attained/possessed/exhibited by those professionals in the industry. Initially, this research assesses the attainment in the identified area of BIM competence and the importance of these competency set. Both of these measures were combined to build an overall BIM competency gap.

$$Overall\ attainment\ of\ BIM\ Competency = \frac{\sum_{i=1}^{n} I_i A_i}{\sum_{i=1}^{n} I_i}$$

$$i = 1 - 8; BIM\ competency\ set$$

$$A_i = Attainment\ of\ i^{th}\ BIM\ competency\ set$$

$$I_i = Importance\ of\ i^{th}\ BIM\ competency\ set$$

Since 1-5 Likert scale was used for scoring BIM competencies, $A_i Max = 5$

Therefore,

$$Percentage\ of\ Gap\ in\ BIM\ Competency = \frac{5 - \frac{\sum_{i=1}^{n} I_i A_i}{\sum_{i=1}^{n} I_i}}{5} \times 100\%$$

Table 4 presents the required mean (I), attained mean (A), as well as their product (AI). The Table also reveal the summation of product (AI) and (I) for the eight competency sets. The values were used in the computation of the weighted mean shown in Table 5 below.

Table 4: Gap Analysis of Required and Possessed Competencies

S/N	Competency Set	Required Mean (I)	Exhibited mean (A)	(AI)
1	Managerial	3.929	3.633	14.274
2	Administrative	3.779	3.74	14.133
3	Functional	4.207	2.805	11.801
4	Operation	4.379	2.764	12.104
5	Technical	4.436	2.955	13.108
6	Implementation	4.271	2.893	12.356
7	Supportive	3.943	2.717	10.713
8	Research and development	3.971	2.912	11.564
	Sum	**32.915**		**100.053**

Source: Researcher Data Analysis (2019)

Table 5 presents the percentage competency gap of built environment professionals in the use of BIM in Abuja. It reveals that professionals in this study area are 39% away from attaining the apex of BIM competency acquirable. When these statistics is read alongside the mean gaps presented in Table 3, it is observed that operational, technical, functional and implementational competencies are the major contributors to this significant percentage value.

Table 5: Percentage Gap in BIM Competency

	Parameters	Numerical value
1	Maximum BIM competency acquirable (A)	5
2	Weighted Mean (AI/I)	3.04
3	Gap computation	$= \frac{5 - 3.040}{5} \times 100\%$
4	Percentage Gap in BIM Competency	**39.2%**

Source: Researcher Data Analysis (2019)

4.6. Strategies to Improve the Competency Level of Built Environment Professionals

The result reveal that Attending BIM seminars, workshops, Trade shows, and Event; enrolling for BIM software training and Incorporation of BIM into the Academic curriculum of higher institutions are the most important strategies for improving the competencies of built environment professionals with RII of 0.911, 0.903 and 0.900 respectively while Reduction in the cost of implementing BIM, Change in procurement method (From traditional to Integrated Project Delivery), and Outsourcing BIM experts by various professional bodies with RIIs of 0.821, 0.814, and 0.806 were ranked as the least effective strategies for improving the BIM competencies of built environment professionals in the study area.

Table 6: Strategies to improve the competencies of built environment professionals

Strategies	**RII**	**Rank**	**Decision**
Attending BIM seminars, workshops, Trade shows, and Event	0.911	1	Very Effective
Enrolling for BIM software training	0.903	2	Very Effective
Incorporation into the Academic curriculum of higher institutions	0.900	3	Very Effective
Carrying out collaborative BIM studio projects while still a student.	0.877	4	Very Effective
Increased awareness for the use of BIM	0.877	5	Very Effective
Engaging in BIM based projects	0.864	6	Very Effective
Government legislation supporting the use of BIM	0.859	7	Very Effective
Research and Development	0.849	8	Very Effective
Making BIM compulsory for certain categories of Project	0.823	9	Very Effective
Joining interactive BIM platforms on social media	0.821	10	Very Effective
Reduction in the cost of implementing BIM	0.821	11	Very Effective
Change in procurement method (From traditional to Integrated Project Delivery)	0.814	12	Very Effective
Outsourcing BIM experts by various professional bodies	0.806	13	Very Effective

Source: Researcher Data Analysis (2019)

5. DISCUSSION

In order identify and examine the BIM competencies possessed by built environment professionals in the study area. These competencies were identified and ranked using mean item score (MIS). The result indicated that built environment professionals possess both Administrative competencies (Organize initiatives to encourage staff to adopt BIM software tools and workflows within the organization; Identify the responsibilities of a BIM manager, a model manager and similar BIM roles; and Establish the necessary metrics to measure the financial performance of BIM projects) and Managerial competencies (i.e. Generate an overall mission statement covering BIM Implementation within an organisation; Define the strategic objectives to be achieved from implementing BIM software tools and model-based workflows; and Identify changes to organisational processes as necessary to benefit from model-based workflows). Meanwhile, they remain undecided about the status of their Technical, Research and development, Implementational, functional, operational and Supportive BIM competencies. In comparison with the findings of Succar (2013), built environment professionals in Abuja only possess one (i.e. Managerial) of the four primary BIM competency set required to deliver outcomes with complex requirement, the other three primary sets lacking are functional, technical, and supportive competencies.

The competencies required of built environment professionals in the use of BIM was also ranked using Mean item score. Although the research considers it as an ancillary objective, it was very instrumental in helping to achieve the second objective which is establishing a competency gap. The result of the analysis shows that Technical, Operational, Implementational and Functional competencies are the most required (Primary) competencies by built environment professionals. meanwhile, Research & development, Supportive, managerial and administrative competencies were embedded at the bottom of the chart respectively. the result is partly in agreement with that of Succar (2013) which also identified Technical and functional competencies as one of the most required competencies of built environment professionals.

To establish the competencies gaps of built environment professionals in the use of BIM. This was achieve using Gap analysis to examine the mean gaps between the required competencies and the exhibited competences, which was further analysed by adapting a Gap analysis approach used by Mullin, Thurairajah, and Williams (2010) to give the overall percentage BIM competency deviation of these professionals from the maximum attainable. The result shows that the gap is much more pronounced for operational, technical, functional, implementational, supportive and Research & development competencies with a mean gap value of 1.615, 1.481, 1.402, 1.378, 1.226 and 1.059 respectively than for managerial and administrative competencies which recorded a relatively low mean gaps of value 0.296 and 0.039 respectively. However, the overall percentage competency gap was computed as the ratio of the difference between the maximum attainable competency mean (i.e. 5 on a Likert scale of 1-5) and the weighted exhibited competency mean to the maximum attainable mean of 5, expressed in percentage. This gap was established to be 39% reflecting the percentage deviation in the competencies of built environment professionals in the use of BIM.

6 CONCLUSION AND RECOMMENDATION

BIM is central to effective construction project delivery; therefore, its usage should not be underestimated. This study explored the competencies of built environment professionals in the use of building information modelling in Abuja, Nigeria. Based on the findings from the reviewed literature and empirical results from a quantitative research approach to the study, the following conclusions were drawn: There is an increased awareness of BIM in the Nigerian construction industry. However, the built environment professionals in Abuja still have a competency gap of 39% with an average possession of Administrative and Managerial BIM competencies and a high deficiency in Technical, Operational and Implementational competencies which are most required. Vocational training is currently most adopted for bridging these gaps. More so, the most effective strategies to improve the competency level of built environment professionals in the use of BIM are established to be: Attending BIM seminars, workshops, Trade shows, and Event; Enrolling for BIM software training and Incorporation of BIM into the Academic curriculum of higher institutions. The research therefore recommends that academic institutions offering built environment courses should seek for an immediate update and continuous improvement in the areas of BIM competencies not available in their curriculums and importance should be attached to BIM related contents in the curricular such as Integrated Studio works and the use of BIM software packages. There is also an urgent need for personal development by built environment professionals especially in the areas of Technical, operational, functional and supportive BIM competencies which were rated low in terms of attainment. This can be achieved by attending BIM seminars, workshops, etc.; and Enrolling for BIM software training.

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BIOGRAPHICAL NOTES

Emmanuel Temidayo Olorunfemi is a highly intelligent, trail blazing and extremely motivated millennial with an undying passion for excellence. He has demonstrated capacity in various aspect of life with construction being one of his strongest niches. Emma Femi as fondly called graduated from the Federal University of Technology Minna in 2019, with a First-class honor in Quantity surveying, coming out as one of the top 1% best students in the university. He has proven himself overtime as a first-class construction analyst who pays keen attention to details and highly adept at construction project management. One of his distinguishing factors is his unbridled enthusiasm to share information and knowledge on his expertise with others, this singular character trait has helped him in the training of a number of Quantity surveyors on the use of many 21st century Quantity surveying softwares. He presently works with Cost Generals Consult as a freelance Quantity surveyor and Ifeanyi Anago & Partners as a Project manager (National Youth Service Corps). He is also the present *Secretary for professional development* of the Nigerian Young Quantity Surveyors Forum (YQSF) FCT chapter, where he is volunteering in capacity building of Young Quantity Surveyors. His Research interest includes but are not limited to Construction Psychology, Construction blockchain financing, Building Information Modelling, Environmental Sustainability, and Affordable housing development.

Dr. Luqman Oyekunle Oyewobi is a Senior Lecturer of Quantity Surveying in the School of Environmental Technology at the Federal University of Technology, Minna, Nigeria. Luqman is a Registered Quantity Surveyor with Quantity Surveying Registration Board of Nigeria. Before going to University of Cape Town for his PhD, he received B.Tech Honours Degree in Quantity Surveying with a First Class (Summa Cum Laude) from Federal University of Technology, Minna (2006) and Master Degree from Federal University of Technology, Akure (2010). He has been working as a lecturer in the Department of Quantity Surveying, Federal University of Technology, Minna since 2007. Prior to that, he has had stint as a Practicing Quantity Surveyor with Oyo State Local Government Service Commission. While working as a practitioner in the construction industry, he became worried why some organisations fail while others succeed. This experience informed his decision to examine the causes of performance differentials among large construction organizations in South Africa. Dr. Oyewobi has received numerous awards including Vice-chancellor's award for the best graduating student in School of Environmental Technology, Federal University of Technology, Minna, Niger State 2005/2006 session.

Oludolapo Ibrahim Olanrewaju is a young multitalented Quantity surveyor, researcher and programmer. He attended Federal University of Technology, Minna where he studied Bachelor of Technology in Quantity surveying and graduated in 2017. He graduated with a First Class and emerged the best graduating student in department of Quantity surveying for 2017 set. Oludolapo is currently a PhD student at Victoria University of Wellington, New Zealand. He has a strong passion for ICT and he has been involved in series of software projects like DOLLAQUESS (Quantity surveying software he designed), decision support systems,

inventory manager and others. He is the founder and CEO of Dollasoft Technologies. His research interests are on environmental health, building information modelling, construction informatics, construction health and safety (H&S), construction management, construction emissions, green construction, etc.

Roseline Olorunfemi is a first-class female student of Quantity Surveying in the School of Environmental Technology at the Federal University of Technology, Minna, Nigeria. Roseline is a strong member of the Nigerian young Quantity Surveyors forum, where she advocates for the inclusiveness more women in Surveying. Her favorite quotes read that "*Women are not baby factories or house hold accessories, there is more to womanhood than reproduction and housekeeping. Hence women are unique and can solved our greatest construction problems if provided the right environment to practice".* She also works with Cost Generals Consult as a freelance construction analyst and a quantity surveyor intern. Her research interest focuses on environmental Impact assessment, Women in surveying, Construction management among others.

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