Evaluation of the Factors Influencing the Intention-To-Use Bim Among Construction Professionals in Abuja, Nigeria

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ABSTRACT. Purpose: This paper evaluated the factors influencing the intention to use BIM among construction professionals in Abuja with the view to understanding the variables that influence BIM adoption in Nigeria.

Design/Methodology/Approach: A questionnaire was used as part of the study's quantitative research strategy. The population of the study included construction professionals registered with Federal Inland Revenue Service (FIRS) which is 4,195. To determine the sample size for the investigation, the Kothari sample size calculation was used (352 professionals). Cronbach's Alpha reliability testing was done prior to analysis, and the resultant coefficient (0.784) shows that the data gathering tool was reliable. The mean item score was used to examine the obtained data. Using the UTAUT constructs and the one-sample t-test, the mean score was used to rank the factors impacting the intention to utilise BIM.

Findings: The study assessed the factors influencing the intention of using BIM among construction professionals in Nigeria using the UTAUT constructs as a yardstick. Mean item score was used to rank the identified variables from the literature review that influence the intention-to-use BIM. The highly ranked variables in each of the constructs include; Facilitating Conditions ("My clients have an interest in the use of BIM"), Performance Expectancy ("Using BIM is of benefit to me"), Effort Expectancy ("I do not have difficulty in explaining why using BIM may be beneficial"), Social Influence ("People who are important to me (e.g. family, friends) think that I should use BIM"). Additionally, using the one-sample t-test value of 3.5, the results showed that respondents believed all of the proposed solutions to be statistically significant ($p < 0.05$).This shows that the constructs in the research model have a huge impact on BIM adoption which is the main dependent construct.

Research Limitation/ Implications: Inability to reach all the thirty-six (36) states in Nigeria would affect the generalization of the study and it is also anticipated that some knowledgeable construction professionals would be reluctant to fill the questionnaire due to to work engagement and other personal reasons.

Practical Implication: Complete adoption of BIM by few number of professionals may practically increase the number of unemployment in the built environment/construction sector.

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Originality/Value: This study is the first in Nigeria to explore the behavioural intention of construction professionals using the UTAUT model and include critical variables that influence BIM adoption.This study would serve as a theoretical foundation for future studies and as well assist construction industry stakeholders to develop appropriate policies to improve BIM adoption in Nigeria.

Keywords: BIM · Construction professionals · Evaluation · Usage · UTAUT

1 Introduction

Construction is one of the sectors that significantly contributes to economic growth in Nigeria. (Olanrewaju et al. 2018). It is evident from previous studies that developing countries like Nigeria are hotspots for infrastructural investors. Nonetheless, some critical issues such as time and cost overrun (Bin Seddeeq et al. 2019; Idrees and Shafiq 2021), poor productivity (Loosemore et al. 2021), labour shortage (Pradhananga et al. 2021), material wastage (Fayisa and Wayessa 2021) and slow adoption of emerging technologies (Okpala et al. 2021; McNamara and Sepasgozar 2021) is attributable to the construction sector. Hence, the application of emerging technologies in a meaningful way solves some of the issues in the construction industry (Akdag and Maqsood 2019).

The construction industry has witnessed significant changes in the previous several decades, including a rise in interest in information technology with a view to enhancing construction productivity and cost control. The information technology applied in the construction industry includes 3D printing (Pessoa et al. 2021), big data analytics (Aghimien et al. 2021), building information modelling (BIM) (Olanrewaju et al. 2021), digital twin (Opoku et al. 2021), blockchain (Scott et al. 2021) among others. BIM is one of the most researched emerging technologies in the construction industry with diverse applications.

The construction industry started using BIM in mid-2000 (Zhao 2017) and it has gained momentum among researchers in many developed and developing countries of the world including New Zealand (Doan et al. 2021), China (Cui et al. 2021), United States (Mutis and Mehraj 2022), United Kingdom (Dalu et al. 2021), and Seychelles (Adam et al. 2021).

Some researches have also evaluated the BIM capabilities of built environment experts and the condition of BIM in Nigeria (Olorunfemi et al. 2021). This shows that BIM is a crucial technology that may improve Nigeria's construction sector by lowering costs, speeding up the completion of projects, and enhancing project quality and productivity. Due to the numerous advantages it offers in construction projects, including increased productivity, decreased rework, decreased conflict among building experts, and cost savings, it is necessary to examine the behavioural intention to utilise BIM by construction professionals in Nigeria.

Studies have recently begun examining BIM adoption from the standpoint of construction professionals' behavioural intentions in both developed and developing nations. For instance, Cui et al. 2021) studied the use intention of architectural designers towards BIM in China. Similar to this, Wu et al. (2021) examined the theory of planned behaviour

to examine the adoption of BIM in China (TPB). By using the Unified Theory of Acceptance and Use of Technology, Abubakar and Oyewobi (2019) investigated the BIM preparedness of construction professionals (UTAUT).

However, few or no studies have studied the behavioural intention of construction professionals in Nigeria towards the use of BIM. Brown et al. (2002) and Howard et al. (2017) emphasized that the attitude of people towards innovation can affect its implementation negatively. This is because the acceptance of an innovation is hinged on individual acts based on their perception of the innovation. This current study contends that the use intention of construction professionals influences the adoption of BIM.

2 Theories Underpinning the Study

The purposes and capacities of BIM have been attempted to be contextualised by a number of studies. According to Lee et al. (2006), BIM is a modelling tool, communication platform, and a digital virtual model.

According to RICS (2014), no specific definition of BIM has been widely accepted since it is always expanding as new frontiers and sectors encroach into previously established bounds. Nevertheless, each definition of BIM is an attempt to capture the characteristics, functions and abilities inherent in the BIM system which is based on individual use. The definition of BIM exist in many forms as described below:

- According to the US National Building Information Standard [NIBS] (2012), BIM is a digital representation of a facility's structural and functional details. It described BIM in more depth as a shared knowledge resource for information about a facility that provides a trustworthy basis for choices throughout its life cycle, which is defined as beginning with initial conceptualization and ending with destruction.
- BIM is a methodology used to integrate digital descriptions of connections between building digital objects. This enables stakeholders to query, simulate, and estimate actions and their effects on the building process as a lifecycle entity.

Theoretical Framework (UTAUT Theory)

Primarily, there exist eight theories upon which the study of human behaviour towards the adoption or execution of required behaviour is hinged, these theories have undergone progressive development from the 1960s as more factors influencing the behavioural attitude of humans emerges. The innovation diffusion theory (IDT), the theory of reasoned action (TRA), the theory of planned behaviour (TPB), the social cognitive theory, the motivational model, the model of perceived credibility (PC) utilisation, the technology acceptance model (TAM), and a combination of the TAM and TPB are among the eight theories mentioned above. For this study, three of these models (theory of reasoned action, Theory of Planned behaviour and Technology Acceptance Model, as well as a hybrid model Unified Theory of Acceptance and Use of Technology), would be considered.

Vankatesh *et al*. (2003), established the Unified Theory of Acceptance and Use of Technology (UTAUT) model in 2003, this was to eliminate the several disadvantages observed from the utilization of the previously existing eight models especially the technology Adoption Model (TAM), whilst incorporating social factors and human behaviours in the operation of the model. This model refines, integrates and corroborates the existing theories. The UTAUT model sprung up from the painstaking evaluation and comparative analysis carried out on the existing eight models in the longitudinal field of behavioural studies.

UTAUT (Theory) FACTORS
According to the Unified Theory of Acceptance and Use of Technology (UTAUT), the adoption of any new technology by a professional is dependent on four factors: the degree to which the professional believes the new technology will improve his or her performance (performance expectancy), how easy the professional feels the technology will be to use (effort expectancy), other experts' opinions about the importance of using the technology (social influence), and the degree to which the professional believes that the necessary infrastructure exists to support the use of the new technology(facilitating conditions). There are thus five factors that need to be in place before a professional will adopt a new technology: Awareness; Performance expectancy; Effort expectancy; Social influence, and Facilitating Conditions.

Assessing the Level of Readiness to Adopt BIM Amongst Built Environment Professionals in Selected Northern Nigerian States
This study assesses the level of readiness of building professionals in using BIM by exploring the factors guiding the acceptance of new technologies; awareness, performance expectancy, effort expectancy, social influence and facilitating conditions with the view to encourage BIM adoption. The study discovered that the Nigerian building professionals are nowhere near ready to adopting Building Information Modelling (BIM) and there is a dire need for Nigerian buildings professionals to restore their good name and regain their sense of professional pride in providing the highest quality buildings and structures.

3 Research Methodology

In this study, a quantitative research methodology was applied. The goal of quantitative research is to gain a better understanding of society. Olarewaju *et al.* (2020) and Babatunde et al. (2020) are two examples of past BIM-related research that successfully used quantitative approaches. Thus, this supports the use of quantitative techniques in this research. All Abuja-based construction industry experts are included in the study's sample. The Federal Inland Revenue Service's (FIRS) database's names and addresses of Abuja-based construction companies served as the study's population. This database was considered credible because it captures professionals that regularly pay their taxes, suggesting that they are active in the field. A total of 4,195 professionals in Abuja were registered on the database as of November 2019. The sample size of 352 was arrived at

using Kothari's formula (2004) is given in Eq. (1):

$$n = \frac{Z^2 pqN}{e^2(N-1) + Z^2 pq} \tag{1}$$

The building industry experts in Abuja, Nigeria, were chosen using a straightforward random sample approach. The problem is that there is not an official publication that lists how many professionals have used BIM for a while. In order to allow everyone in the public the chance to participate in the research if they are informed about BIM, simple random sampling was chosen, as also recommended by Ibrahim *et al.* (2006). As a research tool for this study, a questionnaire was used since it ensures the viewpoint of the intended responder and is appropriate for evaluating unobservable phenomena (Tharenou *et al.* 2007).

The entire survey was divided into three sections: questions about respondents' backgrounds and experiences; questions regarding construction professionals' intentions to utilise BIM in Abuja, Nigeria; and questions seeking recommendations and opinions on how to ensure the adoption of BIM projects. On a Likert scale with 1 being "strongly disagree," to 5 being "strongly agree," the respondents were asked to score the identified elements (variables). A total of 156 questionnaires, or a 44% response rate, were collected after a total of 352 questionnaires were distributed and served at random to the public. Idrus and Newman (2002) believed that any query with a response rate of 20% to 30% was sufficient for research in the construction sector. Li *et al.* (2005) conducted a similar questionnaire study in the UK and achieved an 11% response rate. A mean item score and a t-test were used to analyse the data that was gathered.

4 Results and Discussion

Table 1. Demographics characteristics of respondents

Variables		Frequency	Percentage (%)
Highest academic	Higher National Diploma	14	8.97
Qualification	Bachelor Degree	72	46.15
	Post Graduate Diploma	11	7.05
	Master Degree	58	37.18
	Doctorate Degree	1	0.64
	Total	**156**	**100.00**
Profession	Architect	65	41.67
	Builder	7	4.49
	Engineer	25	16.03
	Estate surveyor	9	5.77

(*continued*)

Table 1. (*continued*)

Variables		Frequency	Percentage (%)
	Quantity surveyor	50	32.05
	Total	**156**	**100.00**
Age group	21-30	70	44.87
	31-40	50	32.05
	41-50	17	10.90
	50 above	19	12.18
	Total	**156**	**100.00**
Years of experience	10–15 years	4	2.56
	15–20 years	33	21.15
	20 years above	31	19.87
	5–10 years	85	54.49
	Less than 5 years	3	1.92
	Total	**156**	**100.00**
Main class	Government		19
	Private	137	87.82
	Total	**156**	**100.00**
	Large	19	12.18
	Medium	96	61.54
	Small	41	26.28
	Total	**156**	**100.00**

Result and Discussion on Variables Influencing the Intention-To-Use BIM (UTAUT Construct)

The descriptive data for the UTAUT concept are shown in Table 1. It displays the components' relative importance to the mean scores in descending order. The table also demonstrates that, according to the respondents, all of the proposed solutions are statistically significant ($p < 0.05$) using the one-sample t-test value of 3.5 (the same cutoff was used in a prior BIM research by Olanrewju *et al.* (2020). The "Facilitating circumstances" factors' mean scores vary from 3.40 to 3.96. The highest-ranking of these factors was "My clients have an interest in the usage of BIM" (mean = 3.96; SD = 0.074; t (155) = 7.75; $p = 0.00 > 0.05$), while the lowest-ranking was "BIM is compatible with other systems that I use" (mean = 3.40; SD = 1.22; t (155) = −1.05; $p = 0.29 > 0.05$). With reference to the p-value, which should be less than 0.05 for each of the relevant factors, a threshold of 3.5 was chosen in order to get the most significant experiences based on the mean score. Therefore, only three (3) of these facilitating condition variables were considered significant because they were above the set 3.5 thresholds.

Table 2. Variables influencing the Intention-to-use BIM (UTAUT construct)

S/N	UTAUT constructs	MS	*SD*	t-value ($\mu = 3.5$)	*df*	Sig. (2-tailed)	R
Facilitating conditions							
FC5	My clients have an interest in the use of BIM	3.96	0.74	7.75	155	0.00	1
FC4	I have the required subscription for BIM packages	3.57	1.04	0.85	155	0.40	2
FC1	I have the resources necessary to use BIM	3.54	1.15	0.49	155	0.63	3
FC3	A specific person or group is available for assistance with difficulties concerning the use of BIM	3.47	1.08	-0.37	155	0.71	4
FC2	BIM is compatible with other systems that I use	3.40	1.22	-1.05	155	0.29	5
Performance expectancy							
PE1	Using BIM is of benefit to me	4.13	0.93	8.52	155	0.00	1
PE4	Using BIM improves my performance in my job	4.03	0.73	9.09	155	0.00	2
PE3	Using BIM will increase my productivity	3.90	1.25	3.99	155	0.00	3
PE5	Using BIM will increase clients satisfaction	3.17	1.10	-3.78	155	0.00	4
PE2	Using BIM will enable me to accomplish my design more quickly	3.11	0.86	-5.67	155	0.00	5
Effort expectancy							
EE4	I do not have difficulty in explaining why using BIM may be beneficial	4.15	0.68	11.90	155	0.00	1
EE3	I clearly understand how to use BIM	4.04	0.79	8.62	155	0.00	2

(*continued*)

Table 2. (*continued*)

S/N	UTAUT constructs	MS	*SD*	t-value ($\mu = 3.5$)	*df*	Sig. (2-tailed)	R
EE2	Learning to use BIM will be easy for me	4.00	0.87	7.16	155	0.00	3
EE1	It will be easy for me to become skillful at using BIM	3.99	0.88	6.98	155	0.00	4
EE5	My clients would love a BIM-enabled project	3.35	1.30	-1.42	155	0.16	5
Social influence							
SI2	People who are important to me (e.g. family, friends) think that I should use BIM	4.19	1.06	8.16	155	0.00	1
SI4	My clients think I should use BIM for them	4.18	0.74	11.46	155	0.00	2
SI1	People who influence my behaviour think that I should use BIM	4.13	1.08	7.25	155	0.00	3
SI5	My clients feel BIM would increase their project social status	3.82	1.27	3.16	155	0.00	4
SI3	People who are important to me (e.g. colleagues) think that I should use BIM	3.64	1.07	1.64	155	0.10	5

The mean score of the variables under "***Performance Expectancy***" ranges between 3.11 and 4.13. These variables ranged from "Using BIM is of benefit to me*"* (mean = 4.13.; $SD = 0.93$; $t\,(155) = 8.52$; $p = 0.00 < 0.05$) which is the highest-ranked to "Using BIM will enable me to accomplish my design more quickly" (mean = 3.11; $SD = 0.86$; $t\,(155) = -5.67$; $p = 0.00 < 0.05$) which is the least ranked. To get the most significant experiences based on the mean score, a threshold of 3.5 was set with a reference to the *p*-value which should be less than 0.05 for each of the significant variables. Therefore, only three (3) of these performance expectancy variables were considered significant because they were above the set 3.5 thresholds.

The mean score of the variables under "***Effort Expectancy***" ranges between 3.35 and 4.15. These variables ranged from "I do not have difficulty in explaining why using BIM may be beneficial*"* (mean = 4.15.; $SD = 0.68$; $t\,(155) = 11.90$; $p = 0.00 < 0.05$) which is the highest-ranked to "My client would love a BIM-enabled project" (mean = 3.35; $SD = 1.30$; $t\,(155) = -1.42$; $p = 0.16 > 0.05$) which is the least ranked. To get the most significant experiences based on the mean score, a threshold of 3.5 was set

with a reference to the *p*-value which should be less than 0.05 for each of the significant variables. Therefore, only four (4) of these effort expectancy variables were considered significant because they were above the set 3.5 thresholds.

The mean score of the variables under "***Social Influence***" ranges between 3.64 and 4.19. These variables ranged from "People who are important to me think that I should use BIM" (mean = 4.19.; $SD = 1.06$; $t\ (155) = 8.16$; $p = 0.00 < 0.05$) which is the highest-ranked to "People who are important to me (e.g. colleague" (mean = 3.64; $SD = 1.07$; $t\,(155) = 1.64$; $p = 0.10 > 0.05$) which is the least ranked. To get the most significant experiences based on the mean score, a threshold of 3.5 was set with a reference to the *p*-value which should be less than 0.05 for each of the significant variables. Therefore, all the five (5) variables of social influence were considered significant because they were above the set 3.5 thresholds. The mean values for constructs in the conceptual model based on the UTAUT model including facilitating conditions, effort expectancy, performance expectancy, behaviour intention, actual use, adoption of BIM and social influence indicators are between 3.11 and 4.19 which is above average (around 62–84%). The descriptive statistics also suggest that most of the respondents agree with the statements in the questionnaire as observed in the table.

5 Discussion of Findings

This study's objective was to assess the factors influencing construction professionals' intentions to employ BIM in Nigeria using the UTAUT constructs as a benchmark. The discovered factors from the literature review that impact the intention to utilise BIM were ranked using the mean item score. Facilitating conditions ("My clients have an interest in the use of BIM"), Performance expectancy ("Using BIM is of benefit to me"), Effort expectancy ("I do not have difficulty in explaining why using BIM may be beneficial"), and social influence ("People who are important to me (e.g. family, friends) think that I should use BIM") are the variables that receive the highest rankings in each of the constructs. The constructs are represented by variables that are comparable to those used by (Mahamadu *et al*. 2014).

6 Conclusion and Recommendation

Effective construction project management in terms of cost, time, and quality depends on the usage of BIM. This report offers information to those involved in the building business on how to increase the use of BIM in the Nigerian construction sector. To change the environment for BIM deployment, a full understanding of the factors affecting BIM acceptance is essential. In light of this, the study evaluated, using the UTAUT model, the behavioural intentions of Nigerian construction professionals about the use of BIM. A questionnaire was used to obtain primary information from 156 Abuja-based construction industry experts. In order to draw logical conclusions from the data obtained, descriptive statistics (charts and tables) and inferential statistics (t-test) were used to examine the data. According to the report, enabling conditions, intention to use BIM, actual use of BIM, and crucial success aspects of the intention-to-use BIM are the four key factors impacting BIM adoption in the Nigerian construction sector. The report

makes the following suggestions in an effort to accelerate BIM adoption in the Nigerian construction sector. Collaboration between the government and construction industry stakeholders: In order to make BIM implementation for building projects a reality, the government must work with industry stakeholders including professionals, clients, and professional bodies, among others.

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