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Building Information Modelling (BIM) Education in Nigerian Universities

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ABSTRACT

Building Information Modelling (BIM) has become a popular subject amongst professionals in the architecture, engineering, and construction (AEC) industry. One way to bridge the BIM skillset knowledge gap is by training the recent crops of undergraduate and postgraduate students for BIM competency. This study examines the current realities of BIM education in Nigerian tertiary institutions from the student's perspectives. Quantitative data through a structured survey questionnaire was gathered from architecture students across seven Nigerian universities involving three public and four private universities. A total of 197 duly completed survey responses were analyzed for the purpose of the study using descriptive statistics and the Relative Importance Index (RII). The study revealed that despite the improvement in the introduction of BIM courses, most students with dedicated BIM courses in their universities registered a low knowledge impact from the BIM course content. Lack of adequate information technology (IT) infrastructure emerged as the highest-ranked barrier to effective BIM education in Nigerian Universities. The study ultimately revealed a lack of standardization in the level at which BIM is taught across Nigerian tertiary institutions. The study recommends the need for adequate funding to establish functional BIM labs for architecture faculties in Nigerian Universities.

Keywords: Architecture Schools, BIM, Nigeria, Skills, University Education

1. INTRODUCTION

The level of awareness of building information modeling (BIM) is becoming increasingly massive globally both in advanced countries and developing nations of the world (Isanovic & Colakoglu, 2020). Architecture, Engineering, and Construction (AEC) professionals are beginning to key into this new paradigm shift (Lim *et al*., 2021) which is becoming more versatile with steady technology improvements. The benefits are endless and new frontiers of the tool are being discovered. Autodesk (2020) defined BIM as the holistic process of creating and managing information for a built asset through an intelligent model and enabled cloud platform that helps integrate structured multi-disciplinary data to produce a digital representation of an asset across its lifecycle. BIM is also defined as a sustainable and integrated collaborative process that unites all project stakeholders through its digital information storage and editing systems to facilitate seamless design documentation, construction, and building operations for shared benefits of improved accuracy, productivity, communication, decision-making, waste reduction and efficiency of time, energy and water resources (Oyesode *et al*., 2022). The sustainable and collaborative edge of BIM is the key anchor upon which all its other benefits hinge. BIM's benefits cut across the project planning, design, construction, maintenance, and operations stages of any building. Many research studies have established BIM's ability to reduce project costs, improve quality, facilitate information sharing, and enhance productivity across the project lifecycle phases. (Chan *et al*., 2019; Parn *et al*., 2017; Abubakar *et al*., 2014; Chen & Luo, 2014). BIM benefits have also been seen in effective design optimization, project management, waste minimization, and safety management (Wang *et al*., 2022; Tang *et al*., 2021). Prior studies have revealed low technical and operational BIM skillsets by professionals as one of the barriers to the rapid adoption and deployment of BIM especially in developing countries (Tanko & Mbugua, 2022; Farooq *et al*., 2020; Saka et al., 2019; Ahmed & Hoque, 2018; Ogunmakinde & Umeh, 2018; Liu *et al*., 2015). Aside from the place of self-development from paid BIM training, workshops, and seminars normally embarked on by professionals long after they have graduated, the quickest way to bridge the gap of inadequate BIM skills is to expose students to the concept and working principles of BIM early in the course of their architecture training (Tanko & Mbugua, 2022; Enhassi *et al*., 2018). This will increase their value-addition possibilities to architecture and construction firms upon graduation and also facilitate an optimized deployment of the BIM tool for such organizations. It also eases their adaption to the industry and reduces the training efforts by firms in bringing their staff up to a required level of BIM competency and efficiency. Pillay *et al*. (2019) affirmed that graduates with excellent BIM skill sets stand a chance of getting hired more quickly than their counterparts only with CAD design skills. Arroteia *et al*. (2019) noted that the demand for BIM-competent professionals has increased significantly in the light of ongoing revolution within the built sector. Studies on the significance of tertiary education in advancing a BIM-oriented AEC sector have continued to receive attention from researchers globally with numerous research conducted already on the transition of CAD teaching to BIM (Kelly *et al*., 2015; Sacks & Pikas, 2013; Weber & Hedges, 2008). In recent years, studies are beginning to focus on the current realities of BIM implementation and usage in tertiary institutions. There is however still a wide gap in the literature on this subject (Tanko & Mbugua, 2022; Pillay *et al*., 2019). Similarly, despite the steady BIM popularity, there are little or no research efforts aimed at establishing the current state of BIM education amongst Nigerian Institutions of higher learning. This study intends to bridge the literature gap in the context of BIM education studies in Nigerian Architecture Schools. The study will primarily discover the level of BIM implementation in Nigerian Architecture Schools by investigating BIM education and deployment from the perspectives of the students. Section 2 of the paper reviews extant literature on BIM adoption while section 3 discusses the methodology adopted for the study. The analysis and discussion of findings from the data gathered are presented in Section 4. Section 5 and Section 6 present the conclusion and recommendations respectively.

2. GLOBAL REVIEW OF BIM EDUCATION

The incorporation of BIM in the architecture school curriculum has been and is still gathering significant pace in recent years (Isanovic & Colakoglu, 2020; Barison & Santos, 2018). Despite the noticeable increase in the drive for BIM learning in schools of architecture, there still remains a lack of consensus on how BIM teachings can be safely incorporated into academic curricula (Isanovic & Colakoglu, 2020) due to different attitudes and perceptions of the BIM impact on students (Pillay et al., 2019). While some are of the school of thought that BIM is a significant ingredient in improving architecture education in the 21st century (Aksamija, 2017; Ambrose & Fry, 2012; Clayton *et al*., 2010), others consider BIM as a potential threat to the creative development of students if introduced to them in schools (Denzer & Hedges, 2008). BIM has however been regarded by most educators and professionals as an inevitable part of 21st-century architectural education due to the rapid changes in architectural and engineering practice globally which the education sector has to adequately measure up to.

Rooney (2017) explained that awareness, interest, and implementation in practice and academia vary significantly between different countries. In Turkey, for example, BIM recognition and implementation in professional practice recently gained serious momentum under the pressure of international project requirements to use BIM. Some of the leading

Universities in Turkey have already started the introduction of BIM into undergraduate and postgraduate courses (Isanovic & Colakoglu, 2020). The study by Pillay *et al*., 2019) on BIM implementation in South African Schools revealed that students are already being taught BIM in the 4th year and 5th year of their study (MSc degree). It revealed that the emphasis on BIM teaching is at the MSc level in South African Universities. The majority of the MSc students did affirm that BIM helped them understand designs better. The postgraduate students' respondents however preferred that BIM teachings be introduced early from the first year. BIM Integration into tertiary education curriculum is still at a low level in Malaysia with no standardization yet. The study by Tanko & Mbugua (2022) revealed that public and private university students in Malaysia mainly design 3D models at BIM stage 1. The study however revealed that no student is on BIM Level 0 which is a positive improvement on gradual BIM integration in Malaysian schools. The study revealed that Revit Architecture is deployed by most Malaysian University students followed by Cost X. The study by Song & Alzarrad (2022) on BIM education in US higher education revealed that BIM is taught in all US Construction programs. The study revealed that most of the dedicated BIM courses are taught at 100L and 200L while other BIM-related courses are taught at 300L and 400L. Revit and Navisworks were the most popular BIM tools used by students in various construction programs in the US. In the UAE, the study by Kausar *et al*. (2020) revealed that CAD is extensively used among students while BIM usage amongst students is low. The study however revealed a high necessity for BIM learning integration in tertiary education. In Australia, the 2020 report on BIM education at Australian Universities by Shuchi *et al*. (2020) revealed that most Australian Universities have included BIM education in their curriculum. Figure 1 below shows an Australian Map with the distribution of Higher Education Institutions (HEI) providing BIM-incorporated higher education architecture curriculum.

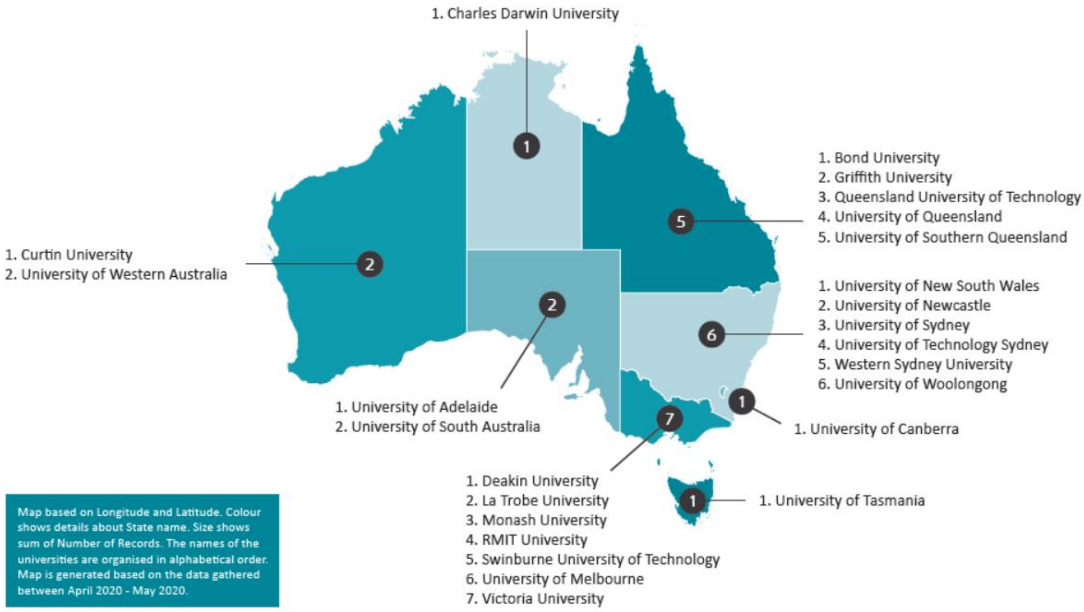

Figure 1: Distribution of Australian HEIs providing BIM education
Source: Adapted from (Shuchi *et al.,* 2020)

2.1. BIM in Nigerian Universities Architecture Curriculum (NUC)

The teaching of BIM in architecture schools has become very important because of BIM's ability to capture rich information such as size, information, geometry, materials, etc. all of which AutoCAD is not able to perform because of the simple line data information it provides (Ibrahim, 2006). As revealed in section 2.1 above, most universities globally have already begun the dissemination of BIM knowledge and the introduction of dedicated BIM courses into their education curriculum. Pillay *et al*. (2019) noted that some universities globally have implemented dedicated BIM labs and BIM-competent staff are being hired to teach BIM courses as part of their infrastructural needs. According to Clevenger *et al*. (2010), the three widely adopted strategies for BIM incorporation in tertiary education curricula are: (1) Developing dedicated BIM courses to cover basic BIM concepts and BIM uses, (2) Updating existing courses with a focus on specific BIM uses for the core topic(s) in each course (e.g. introducing 4D modeling in a scheduling course) and (3) a combination of both strategies along with a BIM-enabled capstone. Abdirad & Dossick (2016) and Clevenger *et al*. (2010) recommended the third strategy which is the combination of the introduction of dedicated BIM courses and an update of the existing courses with a focus on specific BIM application areas for the core topics. Table 1 below shows a list of all Architecture courses according to the 2022 Architecture Core Curriculum Course Contents as published by the Nigerian Universities Commission (NUC, 2022).

Table 1: List of Architecture Courses in Nigerian Universities (BSc Yr. 1 – 3)

OVERVIEW OF 100-LEVEL ARCHITECTURE COURSES ACCORDING TO NUC 2022			
	Code	**Title**	**Elements of BIM in Course Content**
1	GST 111	Communication in English	None
	GST 112	Nigerian Peoples and Culture	None
	MTH 101	Elementary Mathematics I	None
	MTH 103	Elementary Mathematics III	None
	PHY 101	General Physics (Mechanics)	None
	FAA103	Graphics Communication I	None
	FAA 104	Graphics Communication II	None
	FAA 121	Introduction to Basic Computer Applications	None (More of Computer History and MS-Packages software usage)
	FAA 126	Introduction to Sustainable Built Environment	None
	ARC 101	Introduction to Architecture	None
Freehand Sketching is not on this list but is taught in most Institutions in 100L 1st & 2nd Sem.			
*Basic Elements of Planning is not on this list but is taught in some Institutions in 100L as elective			
ARC 102 Introduction to Architecture II is taught in most Institutions in 100L as Design Studio			
OVERVIEW OF 200-LEVEL ARCHITECTURE COURSES ACCORDING TO NUC 2022			
	Code	**Title**	**Elements of BIM in Course Content**
	GST 212	Philosophy, Logic, and Human Existence	None
	ENT 211	Entrepreneurship and Innovation	None
	FAA 221	Introduction to Computer-Aided Design	None (Basically AutoCAD)
	ARC 201	Architectural Design Studio I	None
	ARC 202	Architectural Design Studio II	None

	ARC 203	Building Components and Methods I	None
	ARC 204	Building Components and Methods II	None
	ARC 205	History of World and Traditional Architecture	None
	ARC 206	Building Materials Workshop Practice and Safety	None
	ARC 207	Building Structures, I	None
	ARC 208	Building Structures II	None
Building Material Course is not on this list but taught in most Institutions in 200L 2nd Sem			
*Basic Land Surveying is not on this list but taught in some Institutions in 200L as elective			
OVERVIEW OF 300-LEVEL ARCHITECTURE COURSES ACCORDING TO NUC 2022			
	Code	**Title**	**Elements of BIM in Course Content**
	GST 312	Peace and Conflict Resolutions	None
	ENT 312	Venture Creation	None
	FAA 313	Research Methods	None
	ARC 301	Architectural Design Studio III	None
	ARC 302	Students Industrial Work Experience Scheme (SIWES)	None
	ARC 303	Building Components and Methods III	None
	ARC 304	Entrepreneurship for Architects	None
	ARC 305	Building Structures III	None
	ARC 307	Building Services, I	None
	ARC 309	Building Information Modelling	Yes (BIM Theoretical Introduction)
* Working Drawing & Detailing is not on this list but taught in most Institutions in 300L 1st Sem*			

Source: NUC 2022 Architecture Curriculum

Table 2: List of Architecture Courses in Nigerian Universities (BSc Yr. 4, MSc Yr. 1&2)

OVERVIEW OF 400-LEVEL ARCHITECTURE COURSES ACCORDING TO NUC 2022			
	Code	**Title**	**Elements of BIM in Course Content**
	FAA 484	Professional Practice	None
	Arc 401	Architectural Design Studio IV	None
	Arc 402	Architectural Design Studio V	None
	ARC 403	Building Components and Methods IV	None
	ARC 405	Building Services II	None
	ARC 406	Research Project/Dissertation	None
	ARC 407	Theory and Methods of Contemporary Architecture	None
	ARC 409	Building Economics, Quantities and Estimating	None
Advanced Building Material is not on this list but taught in some Institutions in 400L 1st Sem			

Building Maintenance is not on this list but taught in some Institutions in 400L 2nd Sem			
*Urban Planning is not on this list but taught in some Institutions in 400L *			
OVERVIEW OF MSc 1 ARCHITECTURE COURSE ACCORDING TO NUC 2022			
	Code	**Title**	**Elements of BIM in Course Content**
	ARC 811	Advanced Design Studio I	None
	ARC 812	Advanced Design Studio II	None
	ARC 841	Advanced Working Drawing & Specification I	None
	ARC 842	Advanced Working Drawing & Specification II	None
	ARC 843	Advanced Building Materials & Construction	None
	ARC 852	Research Methods & Seminar	None
	ARC 857	Advanced Structures I	None
	ARC 858	Advanced Structures II	None
	ARC 815	Advanced Landscape Design	None
	ARC 885	Project Management I	None
	ARC 886	Project Management II	None
OVERVIEW OF MSc 2 ARCHITECTURE COURSE ACCORDING TO NUC 2022			
	Code	**Title**	**Elements of BIM in Course Content**
	ARC 813	Advanced Design Studio III	None
	ARC 814	Advanced Design Studio IV	None
	ARC 881	Professional Practice and Procedure I	None
	ARC 882	Professional Practice and Procedure II	None
	ARC 837	Architectural Criticism	None
	ARC 883	Environmental Impact Assessment (EIA)	None
	ARC 887	Entrepreneurial Study	None
	ARC 889	Contemporary Issues in Architecture	None

Source: NUC 2022 Architecture Curriculum

ARC 309: Building Information Modelling (2 Units C: LH 15; PH 45)

Learning Outcomes

At the end of this course, the students should be able to:

1. define and discuss what BIM is;
2. evaluate the historical issues within the construction industry which is driving BIM adoption;
3. demonstrate skills in the use of simple BIM software components;
4. explore the global drivers which have led to BIM adoption;
5. develop a global perspective of what BIM is; and
6. discuss the future of BIM.

Course Contents

What and the nature of BIM. The role of BIM in the construction industry. BIM in the design and construction to maintenance and operation. Sustainability from industry and research experts using state-of-the-art BIM software. The historical issues of BIM in the construction industry. Drivers of BIM adoption. A global perspective of BIM. How BIM helps the AEC industry to succeed. The limitations of BIM. The key case studies on BIM adoption, and the future of BIM.

Figure 2: BIM Course Content

Source: NUC 2022 Architecture Curriculum

3. METHODOLOGY

The following sub-sections explained the methodology employed for this study which aimed to investigate the current realities of BIM education in Nigerian Architecture Schools: (a) an overview of the quantitative data gathering process, (b) the analysis technique adopted for the data, and (c) Data reliability test.

3.1. Quantitative Data Gathering

Using a structured, closed-ended survey questionnaire, quantitative data were collected in order to investigate the current realities of BIM education from the perspectives of architecture students in Nigerian Universities. Students from seven Architecture Schools participated in the filling of the questionnaire. Responses from three public Universities and four Private Universities were collated and analyzed to understand BIM education in Nigerian Institutions. The Public Schools that participated in this study include the University of Lagos, the Federal University of Technology Akure, and the University of Nigeria Nsukka while the private Universities that participated in this study include Covenant University Ota Ogun State, Caleb University Imota Lagos, Bells University of Technology Ota, Ogun State, and Afe Babalola University Ado Ekiti. These schools offer a comprehensive architecture program thereby making them suitable for this research. The close-ended questionnaire was hosted on the Google form platform from where students are made to respond to the questions via a generated link mailed online to all potential participants in various Universities. The questionnaire was divided into four sections. The first section gathered the basic demographic information about the respondents such as the name of the school, gender, and their current level of university education. The second section gathered information on the level of CAD and BIM courses taught in respondents' various institutions and also rated the effectiveness and impact of the BIM course curriculum on their current theoretical and working knowledge of BIM. In the third section, questions were asked to assess the perception of respondents on the impact of BIM courses in schools and their preferred academic level or year for architecture schools to start teaching BIM. The maturity level of respondents was also gathered. In the fourth section, respondents were asked to evaluate on a 5-point Likert scale, the barriers to the early introduction of BIM courses in Architecture schools. The assessment was made on the degree of agreement: 1 – Strongly Disagree; 2 – Disagree; 3 – Partially Agree; 4 – Agree; 5 – Strongly Agree.

3.2. Analysis Technique

The result of the data was analyzed using descriptive statistics with results presented in the form of tables and textual reporting. Relative Importance Index (RII) was also used to rank the degree of importance of the various barriers to BIM early introduction in schools using the value of the index which determines the ranking. RII is especially used for questionnaires that use a Likert scale (Tholibon *et al*., 2021). The relative importance index (RII) formula is given below (Tholibon *et al.*, 2021):

$$\text{Relative Importance Index}=\frac{\sum w}{AN}=\frac{5n_5+4n_{4+}3n_3+2n_2+1n_1}{5N}$$

Where *w* represents the respondent's weighting of each factor which ranges from 1 to 5; n1 represents the number of respondents for strongly disagree; n2 for the number of respondents for disagree; n3 for the number of respondents for partially agree; n4 for the number of respondents for agree; and finally n5 for the number of respondents for strongly agree. *A* however represents the highest weight which is 5 while the total number of respondents is labelled as *N*. The Relative Importance Index (RII) value normally ranges from 0 to 1.

3.3. Reliability of Data

A total of 197 survey responses from across the seven Universities were correctly filled and used for the purpose of data analysis. In order to ensure the internal consistency of the questions, the results of the data were tested for reliability using the Statistical Package for Social Sciences (SPSS) v24 to measure Cronbach's Alpha coefficient. Table 3 below provides a summary of the reliability test result. The Cronbach Alpha value of 0.825 shows that there is high internal consistency for the data set. According to Zhang *et al*. (2020), there is high internal consistency for a data set when the alpha value is equal to or greater than 0.7

Table 3: Reliability Statistics

Cronbach's Alpha	N of items
.875	27

4. ANALYSIS AND DISCUSSION OF FINDINGS

The following subsections describe the survey results: Section 4.1 gives an overview of the demographic profile of the respondents and discusses the status of CAD teaching and the proficiency of respondents. Section 4.2 discusses respondents' feedback on the study level where BIM courses are introduced and also the effectiveness and knowledge impact of the BIM courses. Section 4.3 discussed the feedback of respondents on their BIM maturity level and the level at which they are officially allowed to use BIM for the design and presentation of their works. The last section 4.4 discussed the feedback of respondents on the list of barriers to the early introduction of BIM courses in their Institutions.

4.1. Demographic Profile of Respondents

For the data analysis, a total of 197 responses were used. Table 4 shows the frequency of respondent demographic factors such as university name, gender, and level. The questionnaire was completed by all students of the seven universities. Students from the University of Nigeria Nsukka (UNN) had the highest feedback responses at 40.4 % followed by students from Caleb University, Lagos at 20.2%. Students from the University of Lagos came in third with 13.6%, and students from the Federal University of Technology Akure (FUTA) were fourth with 9.6%. Covenant University students finished with 8.1%, while the Bells University of Technology and Afe Babalola University Students came in sixth and seventh with 5.6% and 2.5% feedback percentages respectively. The questionnaire was targeted mainly at post-graduate students and undergraduate students in their final year of study. The majority of the respondents are males at 68.4% while females made up 31.6%. The majority of respondents are Masters Year 2 (MSc II) and Masters Year 1 (MSc I) students at 35.5% and 30.5% respectively. Final-year BSc or B-Tech students stood at 18.8% while year 3 students' feedback stood at 15.2%. The results as shown in Table 4 below further reveal that the vast majority (97.5%) of the respondents are proficient with AutoCAD while 2.5% are not proficient with AutoCAD. According to the survey, the majority of the respondents (76.1%) took specialized CAD courses in their 100 and 200 Levels, respectively while 17.8% were taught CAD in year 3 before going for the mandatory Students Industrial Work Experience Scheme (SIWES). The high percentage of students taking CAD courses in 100 and 200 Level confirms the reviewed 2022 release of the NUC architecture curriculum which indicated that CAD courses be taken within the first two years of the undergraduate degree program.

Table 4: Respondents Background Demographic Distribution

Characteristics		Frequency (N=197)	Percentage (%)	Cum %age
University	Caleb University	40	20.2	20.2
	Convenant University	16	8.1	28.3
	University of Lagos	27	13.6	41.9
	Federal University of Tech Akure (FUTA)	19	9.6	51.5
	University of Nigeria Nsukka (UNN)	80	40.4	91.9
	Bells Univ of Technology	11	5.6	97.5
	Afe Babalola University Ado	5	2.5	100
Gender	Male	134	68.4	68.4
	Female	62	31.6	100
Level	300L	30	15.2	15.2
	400L/500L	37	18.8	34
	MSc 1	60	30.5	64.5
	MSc 2	70	35.5	100
	PGD	0	0	100
CAD Course and Proficiency	Yes	192	97.5	97.5
	No	5	2.5	100
Level of CAD Course	100L-200L	150	76.1	76.1
	300L	35	17.8	93.9
	400L/500L	5	2.6	96.5
	MSc 1	2	1	97.5
	MSc 2	0	0	97.5
	Not Applicable	5	2.5	100

4.2. Level of BIM Course Introduction and effectiveness of BIM course content

The data on students with BIM course exposure, as shown in Table 5, revealed that 54.8% confirmed having undergone BIM course lessons, while 46.2% stated that they had never received any specific BIM lesson throughout their university study. The level at which BIM course was taught varied between undergraduate and masters levels. About 17.1% took the BIM course in their 100L/200L while 26.5% took the BIM course in 300L, and 13.7% in their undergraduate final year (400L/500L). This wide disparity in the level at which BIM courses were taken shows that the level at which the BIM course is taken across Nigerian Universities is not consistent. There appears to be a lack of standardization in the level at which BIM courses should be taken as well as the contents of BIM courses. Despite the fact that a reasonable number of respondents confirmed to have completed the BIM course, only 10.7% affirmed the effectiveness of the BIM course contents, while 12.2% confirmed a significant knowledge gain from the course. A total of 21.8% confirmed that the BIM course content was ineffective while 39.1% were not taught any BIM course. In summary, 60.9% of respondents reported inefficient or no BIM course content during their architectural training, while 67.1% of the respondents reported little or no technical or practical depth in the BIM contents they were taught. The overall result of the data collected on the BIM course and its effectiveness appears to reveal a lack of technical depth and a lack of standardization in the level at which students took the BIM course and the curriculum of the BIM course. The review of the 2022 NUC curriculum for architecture degree training also indicated that the only level at which any BIM course is introduced in the University Architecture degree is at 300L of the undergraduate study. The course content also showed that only historical issues relating to BIM and definitions formed the bulk of the course content. This confirmed the empirical data findings gathered from the respondents regarding the technical depth and effectiveness of the course content. This study's findings on the introduction of BIM courses at 100L/200L/300L in Nigerian Universities is in sharp contrast to the study on BIM training in South African schools, which found that the emphasis on BIM course contents is put at the MSc degree levels (Pillay *et al.*, 2019). There is however a similarity in the research findings on the preferred level for the introduction of BIM courses in schools. According to the findings of this survey, 72.6% of respondents preferred that BIM-related courses begin in 100L and 200L, while 20.3% preferred that BIM courses begin in 300L of undergraduate programs. This confirms the findings of research conducted on South African students, who preferred that BIM courses be introduced early in their undergraduate programs (Pillay *et al*., 2019).

Table 5: Level of BIM Course and Effectiveness of BIM Course Content Distribution

Characteristics		Frequency (N=197)	Percentage (%)	Cum %age
BIM Course	Yes	107	54.3	54.3
	No	90	45.7	100
Level of BIM Course	100L-200L	29	14.7	14.7
	300L	50	25.3	40
	400L/500L	20	10.2	50.2
	MSc 1	9	4.6	54.8
	MSc 2	0	0	54.8
	Not Applicable	89	45.2	100
Rating of the depth of BIM process knowledge and technical skills gained from the BIM course	No Knowledge (No BIM course)	75	38.1	38.1
	Little Knowledge	34	17.3	55.4
	Neutral	23	11.6	67
	Medium Knowledge	41	20.8	87.8
	Great Knowledge	24	12.2	100
Effectiveness of the BIM course content	Highly Ineffective	24	12.2	12.2
	Ineffective	19	9.6	21.8
	Neutral (No BIM course content)	77	39.1	60.9
	Effective	56	28.4	89.3
	Highly Effective	21	10.7	100
Preferred level for the introduction of BIM courses	100L-200L	143	72.6	72.6
	300L	40	20.3	92.9
	400L/500L	11	5.6	98.5
	MSc1	3	1.5	100
	MSc2	0	0	100

4.3. BIM Tool Usage and BIM Maturity Level of Respondents

The data gathered as shown in Table 6, shows that the majority of the schools (69.1%) only allow students in MSc 1 first semester to use the BIM tools for design development and presentation. This implies that the majority of students are not formally permitted to use the BIM tool for design and presentation throughout their BSc undergraduate program. The study also revealed that the majority of student respondents are at BIM Maturity level 1. BIM Level 1 is a maturity level that offers no collaboration benefit of any sort. It deals mainly with 2D data and 3D modeling using any BIM tool (Shimonti, 2018). This research finding probably explains the reason why most architectural firms in Lagos State are on BIM Maturity Level 1 according to a study conducted by Oyesode *et al*. (2022). As shown in Table 7, the personal BIM training efforts of respondents with the highest mean value of 4.32 contributed significantly to students' current technical knowledge of BIM. Attendance of BIM-based enlightenment programs and symposiums came second in the ranking with a mean value of 3.55, while knowledge from university-based BIM courses was the lowest rank with a mean score of 2.36.

Table 6: Distribution of Respondents BIM Background and Maturity Level

Characteristics		Frequency (N=197)	Percentage (%)	Cum %age
School Approved level of BIM for design generation and presentation for respondents	From 200L and above	15	7.6	7.6
	From 300L and above	14	7.1	14.7
	From 400L/500L and above	18	9.1	23.8
	From MSc 1 and above	136	69.1	92.9
	Not Applicable	14	7.1	100
BIM Maturity Level of Respondents	BIM Level 0 (2D Design with AutoCAD and manual drafting)	24	12.2	12.2
	BIM Level 1 (3D Modelling using 3D Modelling Tools. No Collaboration)	173	87.8	100
	BIM Level 2 (3D 4D Modelling and Manual Information Sharing using other discipline 3D models)	0	0	100
	BIM Level 3 (3D to 7D modelling on a Cloud-based server for seamless information sharing)	0	0	100
Impact of BIM-based University degree courses on BIM knowledge of respondents	No Impact	76	38.5	38.5
	Little Impact	46	23.4	61.9
	No BIM Knowledge	22	11.2	73.1
	Medium Impact	34	17.3	90.4
	Great Impact	19	9.6	100
Impact of Personal BIM training efforts on BIM knowledge of respondents	No Impact	1	0.5	0.5
	Little Impact	16	8.1	8.6
	No BIM Knowledge	23	11.7	20.3
	Medium Impact	36	18.3	38.6
	Great Impact	121	61.4	100
Impact of BIM enlightenment programs and symposium on BIM knowledge of respondents	No Impact	7	3.6	3.6
	Little Impact	28	14.2	17.8
	No BIM Knowledge	42	21.3	39.1
	Medium Impact	89	45.2	84.3
	Great Impact	31	15.7	100

Table 7: Mean Distribution of Training Medium Impact on Respondent's BIM Knowledge

Impact of Training Mediums on Respondent's BIM Knowledge	N	Mean	Std. Dev
Impact of Personal BIM Training efforst	197	4.32	1.002
Impact of BIM enlightenment programs and symposiums	197	3.55	1.032
Impact of University BIM-based courses	197	2.36	1.391

4.4. Barriers to the Early Introduction of BIM Courses in Universities

The respondents were asked about their perception on the barriers to the early introduction of BIM courses in Nigerian Universities. The results shown in Table 8 below reveal that the dominant barrier to the early introduction of BIM courses in Nigerian universities is perceived to be a lack of adequate IT Infrastructure in Architecture schools, followed by educators' lack of operational knowledge of BIM tools and educators' lack of awareness of BIM. Other perceived significant barriers are the absence of BIM in the NUC

Curriculum, an overloaded architecture curriculum, and a lack of BIM interest among educators, which are ranked 5th, 6th, and 7th respectively.

Table 8: Ranking of the barriers to BIM early introduction in architecture schools

S/N	BARRIERS TO BIM EARLY INTRODUCTION IN ARCHITECTURE SCHOOLS	Level of Agreement using the Likert Scale					Total (Ef)	Efx	Mean (Efx/Ef)	Relative Index (RI)	Rank
		1	2	3	4	5					
1	BAR 1: Perception that BIM suppresses design creativity in students	117	43	12	10	15	197	354	1.796954	0.359391	**9**
2	BAR 2: Lack of Adequate IT Infrastructure	14	24	32	50	77	197	743	3.771574	0.754315	**1**
3	BAR 3: Overloaded Architecture Curriculum	26	41	16	72	42	197	654	3.319797	0.663959	**6**
4	BAR 4: Lack of BIM Theoretical Knowledge Processes by educators	14	21	37	110	15	197	682	3.461929	0.692386	**4**
5	BAR 5: Lack of BIM tool technical operating skills by educators	15	24	21	88	49	197	723	3.670051	0.73401	**2**
6	BAR 6: Lack of requisite project experience by educators to teach BIM	91	20	36	32	18	197	457	2.319797	0.463959	**8**
7	BAR 7: Lack of BIM Interest by educators	16	59	46	54	22	197	598	3.035533	0.607107	**7**
8	BAR 8: Lack of awareness of BIM benefits by educators	17	28	29	92	31	197	683	3.467005	0.693401	**3**
9	BAR 9: BIM Absence in NUC Curricullum	23	18	55	66	35	197	663	3.365482	0.673096	**5**

5. CONCLUSION AND FURTHER RESEARCH

This study's findings revealed the current state of BIM education in Nigerian universities as well as some theoretical knowledge contributions and implications. According to the findings, the majority of Nigerian students are proficient in CAD but are only at level 1 of BIM Maturity. The literature review revealed that the only BIM-dedicated course according to the NUC 2022 curriculum for Architecture training taken at BSc year 3 is more introductory and does not give the students sufficient knowledge of the basic theoretical and practical rudiments of BIM. This is supported by empirical findings that show that the majority of the respondents who acknowledged having taken a BIM course were dissatisfied with the course content which provided little or no substantive knowledge of BIM. Most students obtained an operational understanding of BIM technologies through deliberate self-training initiatives. The study revealed that the respondents preferred that BIM courses be introduced earlier in their architecture training. The study on barriers to the early introduction of BIM training in Nigerian universities revealed that the lack of adequate IT Infrastructure was ranked the most significant barrier to BIM training in Nigerian universities. IT Infrastructure is defined in this research as the system of hardware, software, network resources, and servers required for the delivery of BIM project lifecycle processes. Adequate IT Infrastructure makes up the technology which is one of the three components of BIM Maturity as established by Succar (2009). Other barriers to BIM training in Nigerian universities include a lack of BIM-competent educators who are unaware of the benefits of BIM. Other reported barriers include a lack of BIM-related course content in the current curriculum and a perceived overloaded curriculum with too many other courses at the detriment of BIM-related or BIM-dedicated courses. This study has offered insights into the current reality of BIM education in Nigerian universities from the perspective of architecture students. These are the categories of people who will be released into the Nigerian labor markets for value addition to the architecture and construction industry which is currently in dire need of BIM-competent professionals. Since there is no representation of northern universities among the respondent universities used for the study data gathering process, the results discussed in this study may not be generalizable to northern Nigerian universities offering architecture with the questionnaire administered predominantly to selected private and public universities from the western and eastern part of Nigeria. However, the study is significant as it draws the attention of architectural educators, departments of architecture in Nigerian universities, and university owners in Nigeria to the need to proffer substantive solutions to the identified barriers of BIM Education for Architecture Students in Nigerian universities.

6. RECOMMENDATIONS

Based on the findings of this study, it is imperative that BIM labs with adequate IT Infrastructure be provided in the Architecture Department of all Nigerian Universities to facilitate early BIM Education for Architecture Students. It is also imperative that BIM-competent architectural educators be hired in Architecture faculties of Nigerian universities to promote the offering of substantive BIM training to Architecture Students. The study findings also suggest the need to re-access the current architecture curriculum with a view to adapting relevant BIM components to some of the existing architecture courses while teaching students. There is also a need to introduce more BIM-based courses into the architecture curriculum to give architecture students enough fundamental basics and adequate working knowledge of BIM before they are released into the Architecture, Engineering, and Construction (AEC) practical world. Further research is recommended on the educator's perspective of BIM education in Nigerian universities. Framework for integrating BIM into architectural education and simplified BIM training techniques are other areas for future research work.

REFERENCES

Abdirad, H., & Dossick, C. (2016). BIM Curriculum Design in Architecture, Engineering and Construction Education: A Systematic Review. *Journal of Information Technology in Construction (ITcon), 21*, 250-271. Retrieved from http://www.itcon.org/2016/17

Abubakar , M., Ibrahim, Y. M., Kado, D., & Bala, K. (2014). Contractor's Perception of the Factors Affecting Building Information Modelling (BIM) Adoption in the Nigerian Construction Industry. *Conference on Computing in Civil and Building Engineering* (pp. 167-178). Orlando, FL, USA.

Ahmed, S., & Hoque, M. (2018). Barriers to Implement Building Information Modelling (BIM) to Construction Industry: A Review. *Journal of System and Management Science, 8*(1), 45-60.

Aksamija, A. (2017). BIM in Architectural Education: Teaching Advanced Digital Technologies to Beginner Designers. *The International Journal of Architectonic, Spatial and Environmental Design, 11*(2), 13-25.

Ambrose, M. A., & Fry, K. M. (2012). Re: Thinking BIM in the Design Studio-Beyond Tools… Approaching Ways of Thinking. *CAAD, INNOVATION, PRACTICE: 6th International Conference Proceedings of the Arab Society for Computer Aided Architectural Design.* Manama, Kingdom of Bahrain: The Kingdom University.

Arroteia, V. A., Amarul, G. G., Kikuti, S. Z., & Melhado, S. B. (2019). BIM Knowledge Assessment: An Overview among Professionals. In *Architecture in the Age of the 4th Industrial Revolution, 2*, 315-324.

Autodesk., B. (2020). *What is BIM?* Autodesk. Retrieved from https://www.autodesk.com/solutions/aec/bim

Barison, M., & Santos, E. (2018). Advances in BIM Education. In a. C. R. F. Ivan Mutis, *Transforming Engineering Education: Innovative Computer-Mediated Learning Technologies* (pp. 45-122). Reston ASCE American Society of Civil Engineers.

Chan, D. W., Olawumi, T. O., & Ho, A. M. (2019). Perceived benefits of and barriers to Building Information Modelling (BIM) Implementation in Construction: The case of Hong Kong. *Journal of Building Engineering, 25*(100764).

Chen, L., & Luo, H. (2014). A BIM-based construction quality management model and its applications. *Automation in Construction, 46*(0), 64-73.

Clayton, M., Ozener, O., Haliburton, J., & Farias, F. (2010). Towards Studio 21: Experiments in Design Education Using BIM. *Disruption, modeling, and construction: changing dialogues: Proceedings of the XIV Congress of the Iberoamerican Society of Digital Graphics.* Bogota, Colombia: Universidad de los Andes.

Clevenger, C. M., Ozbek, M., Glick, S., & Porter, D. (2010). Integrating BIM into construction management education. *EcoBuild 2010 BIM Academic Forum.* Washington DC.

Denzer, A., & Hedges, K. (2008). From CAD to BIM: Educational strategies for the coming paradigm shift. *AEI 2008 Conference: Building Integration Solutions.*

Enhassi, A., AbuHamra, L. A., & Alkilani, S. (2018). Studying the benefits of Building Information Modelling (BIM) in Architecture, Engineering and Construction (AEC) Industry in the Gaza Strip, Jordan. *Journal of Civil Engineering, 12*(1), 87-98.

Farooq, U., Rehman, S. K., Javed , M. F., Jameel, M., Aslam, F., & Alyousef, R. (2020). Investigating BIM Implementation Barriers and Issues in Pakistan Using ISM Approach. *Journal of Applied Sciences*, 1-18. https://doi.org/10.3390/app10207250

Hosseini, R. M., Ehsan, A., Linda , T., & Chileshe, N. (2015). Barriers to Adoption of Building Information Modelling (BIM) in Iran: Preliminary Results. In *The 6th International Conference on Engineering, Project, and Production Management (EPPM2015),* Gold Coast, Australia. https://doi.org/10.32738/CEPPM.201509.0038

Ibrahim, M. (2006). *To BIM or not to BIM, This is NOT the Question: How to Implement BIM Solutions in Large Design Firm Environments.* University of Thessaly. Volos, Greece: eCAADe.

Isanovic, H., & Colakoglu, B. (2020). Students' perceptions of BIM learning scenario in architectural education. *Journal of Faculty of Architecture, 17*(3), 195-209. https://doi.org/10.5505/itujfa.2020.87528

Kausar, M., Mahanta, N. R., & Samuel , A. (2020). Fundamentals of implementing Building Information Modeling (BIM) in architectural education at the graduate school level. *Advances in Science and Engineering Technology International Conference (ASET) IEEE 2020.* https://doi.org/10.1109/ASET48392.2020.9118360

Kelly, M., Connor, J. O., Costello, M., & Nicholson, G. (2015). A Collaborative Academia-Industry Approach to Programme-Wide Implementation of Building Information Modelling Processes using a Reciprocal Learning Framework. *CITA BIM Gathering.*

Lim, Y. W., Chong, H. Y., Ling, P. C., & Tan, C. S. (2021). *Greening Existing Buildings through Building Information Modelling: A Review of the recent development.* https://doi.org/10.1016/j.buildenv.2021.107924

Liu, S., Xie, B., Tivendale, L., & Liu, C. (2015). Critical Barriers to BIM Implementation in the AEC Industry. *International Journal of Marketing Studies, 7*(6), 162-171. https://doi.org/10.5539/ijms.v7n6p162

NUC. (2022). *National Universities Commission Core Curriculum and Minimum Academi Standards for the Nigerian University System (CCMAS).* National University Commission (NUC).

Ogunmakinde, O. E., & Umeh, S. (2018). Adoption of BIM in the Nigerian Architecture, Engineering and Construction (AEC) Industry. *42nd Australasian Universities Building Education Association (AUBEA).* Curtin University, Singapore.

Oyesode, S. A., Dare-Abel, O. A., & Daramola, S. A. (2022). BIM Maturity Level of Architectural firm BIM Operators in Lagos State, Nigeria. *International Journal of Scientific & Engineering Research, 13*(12), 282-293.

Parn, E. A., Edwards, D. J., & Sing, M. (2017). The building Information Modelling Trajectory in Facilities Management: A review. *Automation in Construction, 75*, 45-55.

Pillay, N., Gumbo, T., & Musonda, I. (2019). Discovering the level of BIM Implementation at South African Architecture Schools: A qualitative study. *Creative Construction Conference 2019.* Budapest, Hungary. https://doi.org/10.3311/CCC2019-115

Rooney, K. (2017). *International BIM Education Report.* NATSPEC BIM, ICIS. Retrieved from https://bim.natspec.org/images/NATSPEC_Documents/BIM_Education_Global_2017_Update_Report_V4.0.pdf.

Sacks, R., & Pikas, E. (2013). Building Information Modelling Education for Construction Engineering and Management 1: Industry Requirements, State of the Art and Gap Analysis. *Journal of Construction Engineering Management, 139*(11).

Saka, A., Chan, D. W., & Olawumi, T. O. (2019). A Systematic Literature Review of Building Information Modelling in the Architecture, Engineering and Construction Industry- The Case of Nigeria. *Environmental Design and Management International Conference.* Hong Kong.

Shimonti, P. (2018). *What is BIM.* Geospatial world. Retrieved from https://www.geospatialworld.net/blogs/what-is-bim/

Shuchi, S., Chowdhury, M., Martek, I., Hosseini, R. M., Piennaar, J., Rahnamayiezekavat, P., & Jupp, J. R. (2020). *BIM Education at Australian Universities: 2020 insights.* Australian BIM Academic Forum (ABAF).

Song, S., & Alzarrad, A. (2022). Improvig BIM Integration and Implementation in Construction Education. *Construction Research Congress.* https://doi.org/10.1061/9780784483985.014

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

Tang, Y., Xia, N., Lu, Y., Varga, L., Li, Q., Chen, G., & Luo, J. (2021). BIM-based safety design for emergency evacuation of metro stations. *Automation in Construction, 123*(103511).

Tanko, B. L., & Mbugua, L. (2022). BIM Education in Higher Learning Institutions: A Scientometric Review and the Malaysia Perspective. *International Journal of Built Environment and Sustainability, 9*(1), 23-37. https://doi.org/10.11113/ijbes. v9.n1.864

Tholibon, D. A., Nujid, M. M., Mokhtar, H., Rahim, J. A., AbdulAziz, N. F., & Tarmizi, A. A. (2021). Relative Importance Index (RII) in ranking the Factors of Employer Satisfaction towards Industrial Training Students. *International Journal of Asian Education (IJAE), 2*(4), 493-503. https://orcid.org/0000-0002-2729-2694

Wang, K., Guo, F., Zhang, C., Hao, J., & Schaefer, D. (2022). Digital technology in architecture, engineering and construction (AEC) industry: Research trend and practical status towards construction 4.0. *Construction Research Congress. ASCE* (pp. 983-992). Reston, VT, USA: Jazizdeh, F, Shealy T, Garvin M.J Eds ASCE.

Weber, D., & Hedges, K. (2008). From CAD to BIM: The Engineering Student Perspective. *Proceedings from the American Society of Civil Engineers, 1-8.*

Zhang, R., Tang, Y., Wang, L., & Wang, Z. (2020). Factors Influencing BIM Adoption for Construction Enterprises in China. *Advances in Civil Engineering, 20*. https://doi.org/10.1155/2020/8848965