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CAD AND BIM IN ARCHITECTURE EDUCATION: AWARENESS, PROFICIENCY AND ADVANTAGES FROM THE STUDENT PERSPECTIVE

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Abstract

This study assesses the level of awareness and proficiency of Computer Aided Design (CAD) and Building Information Modeling (BIM) as well as their advantages from 64 MSc students at Ahmadu Bello University, Zaria-Nigeria. Results reveal extensive use of AutoCAD (92%) and Revit (87%). Significant differences were recorded in awareness and proficiency for BIM 4D-7D. Overall, these were rated lower than CAD 2D and BIM 3D. High ratings for advantages of CAD and BIM relate to design and visualization of pre-construction documents. The study concludes that industry trends, practice requirements and employment potentials motivate learning of CAD/BIM from the student perspective.

1. INTRODUCTION

Computer Aided Design (CAD) and Building Information Modeling (BIM) have become indispensible to designers in the Architectural, Engineering and Construction (AEC) industry worldwide. It is almost inconceivable to embark on a project without the use of either one of these tools. It is common to employ both in design because of the many benefits CAD and especially BIM offer to contemporary world of professional practice. These include speed and accuracy when using CAD software such as AutoCAD over traditional hand drafting and drawing, production of breathtaking and realistic visualizations (Badrinath, Chang & Hsieh, 2016), enhanced speed in information sharing and production of construction documents (Halttula, Haapasalo & Herva, 2015), fosters teamwork and collaboration among construction professionals, thus reducing overhead costs. This in turn relates to an improved return on investment for businesses, better marketing options to attract clients as well as reduced rework, errors and omissions in construction documents (Almutiri, 2016). BIM also aids better operational management efficiency for both client and construction professionals across the lifetime of the project (Doumbouya, Gao, & Guan, 2016). Despite these documented benefits, challenges exist to the successful adoption of these technologies in the AEC industry. These include software interoperability and incompatibility problems (Abubakar, Ibrahim & Bala, 2013; Abubakar, Muhammed & Abdulrazaq, 2017), inadequate supply of trained staff to meet specialist requirements as well as high costs for software and training in light of rapid technological advancements (Czmoch & Pękala, 2014) (Gimenez, Robert, Suard & Zreik, 2016). Almutiri (2016) also notes the issue of uncertainties regarding legal issues and incorporation of the tools in different educational contexts. Consequently, a large number of studies have focused on identifying and proffering modalities on overcoming the aforementioned issues in practice and within the curriculum of Higher Education Institutions (HEIs) (ibid; Becerik-Gerber, Gerber & Ku, 2011; Rosli, Razak, Younus, Keumala & Ismail, 2014; Aly, 2014; Kiviniemi, 2015; Badrinath et al. 2016; Abdiran & Dossick, 2016). The focus of studies involving academia is premised on the fact that HEIs produce future professionals who are expected to be proficient to meet changing demands of the industry (Kocaturk & Kiviniemi, 2013; Kiviniemi, 2015; Almutiri, 2016; Badrinath et al., 2016).

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Although a lot has been achieved in the area of proffering solutions to how best to overcome challenges to successfully incorporating BIM and CAD related tools in construction related curricula (Mandhar & Mandhar, 2013; Kocaturk & Kiviniemi, 2013; Abdirad & Dossick, 2016), it is necessary to periodically evaluate the impact these interventions have had on students within HEIs especially in developing countries where basic infrastructure is often inadequate. Few studies examine the awareness and proficiency levels of students in Nigeria. Although some studies explore the use of CAD and BIM in professional practice (Abubakar, Ibrahim, Kado & Bala, 2014; Ryal-Net & Kaduma, 2015; Akinrele & Moses, 2016; Olaleye, Garba & Lawal, 2017), few studies attempt to identify advantages from the student perspective towards improving learning and pedagogy. Specifically, studies rarely employ established dimensions of CAD/BIM as employed in practice. Additionally, studies evaluating CAD and BIM tools in HEIs usually target instructors and undergraduate students. Consequently, a gap exists for evaluating these tools within the AEC curriculum using graduate students (Abdirad & Dossick, 2016). Evaluating CAD and BIM tools in AEC curricula is important for at least two reasons. First, establishing the degree of awareness and proficiency levels of students reveals what has been achieved within the curriculum and what still needs to be done. Secondly, such evaluations highlight areas for improvement based on standards employed in practice. The current paper therefore evaluates the awareness and proficiency levels of CAD and BIM tools in the oldest school of architecture in Nigeria using responses from postgraduate students who are approaching the end of their course and have undergone the various facets of training available in school. The study poses three research questions:

i) What is the degree of awareness and proficiency of CAD/BIM tools for postgraduate students?

ii) Are there any differences between awareness and proficiency levels from the sample?

iii) What are the advantages of CAD/BIM use from the student perspective?

2. REVIEW OF RELATED LITERATURE

2.1. Dimensions of CAD and BIM in practice

CAD encompasses non-parametric tools for drafting, visualization and documentation (Ramilo & Embi, 2014). It is generally conceived as the automated version of manual drafting (Grabowski, 2010). CAD programs such as AutoCAD, SketchUp and 3D studio Max were developed on traditions of manual drafting to represent building components (Botchway, Abanye & Afram, 2015). BIM software such as Revit simulates intelligent 3D models using parametric building components to mimic real life (Ramilo & Embi, 2014). Czmoch & Pękala, (2014, p. 211) note that BIM "is based on a virtual 3D model of the proposed facility as the sole source of all information about the project". The essence of BIM is collaboration and management where all information and documentation of a project are contained in a single 3D model in a synchronized database (Guidera & Mutai, 2008; Ibrahim & Muhammed, 2016). Consequently, BIM is translated as either Building Information Modeling (Becerik-Gerber et al., 2011; Rodriguez, 2014; Aly, 2014) or Building Information Management (Sacks & Pikas, 2013; Czmoch & Pękala, 2014). The difference between these two definitions lies within the extent the model is viewed- whether as a product of construction documents or as a process for construction management and maintenance. At its full potential, BIM targets implementation in several progressive dimensions (Figure 1). These range from BIM 3D to nD depending on its use as a facilitator of a construction product or management process (Czmoch & Pękala, 2014; Ibrahim & Muhammed, 2016; Almutiri, 2016).

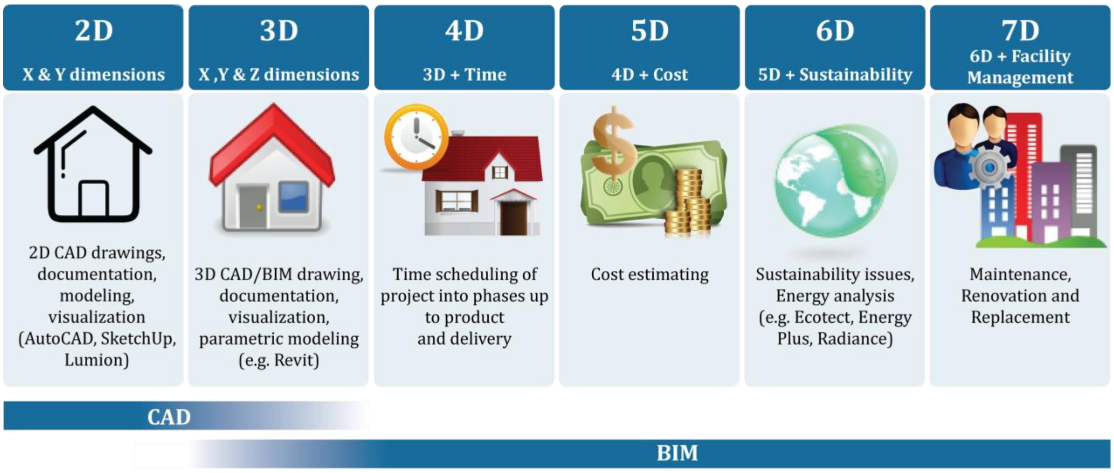

Figure 1: Schematic of CAD and BIM levels employed in the study

3D BIM involves parametric modeling of the entire project. In Nigeria, Autodesk's Revit is widely employed for parametric modeling (Ryal-Net & Kaduma, 2015). This is an advanced extension of 2D design, considered an automated version of the traditional way designers conceive and represent projects. 2D drawings produced using CAD software especially AutoCAD remain the industry standard in Nigeria (ibid). Consequently, many students are proficient in the use of AutoCAD (Fagbemi, Ojo & Ayeni, 2016). This is true of other 2D CAD software such as Sketchup, 3Ds Max, Lumion etcetera employed for visualization purposes. 4D BIM involves the scheduling of building elements alongside the 3D model, thus introducing a platform for managing the construction process as it can schedule the project into phases from product to delivery (Almutiri, 2016). 5D BIM involves cost estimation while 6D BIM relates to the sustainability aspects of the project in terms of parameters such as energy projections. 7D BIM, sometimes denoted nD (Ibrahim & Muhammed, 2016) handles facility management involving detailed specifications of project components to aid maintenance and replacement information over the entire life time of the project (Czmoch & Pękala, 2014). BIM nD was first developed by Aouad et al. in 2006 at the University of Salford (Ibrahim & Muhammed, 2016).

BIM adoption and regulation policies have been implemented at different levels globally, with the European Union (EU) especially Scandinavian countries, the UK, US and Canada occupying top positions. BIM rate of adoption and visibility is higher in developed countries where an upsurge in research interests have also been recorded (Ibrahim & Muhammed, 2016). Kolaric, Vukomanovic, Stober and Dolacek-Alduk (2017) note that public sector projects in the UK are expected to have achieved BIM level II compliance by 2016. This level refers to the collaboration of all stakeholders in a project on 3D models not necessarily shared in a way that ensures information is communicated through a common standard such as the Industry Foundation Classes (IFC). France, Germany and the UK are the pioneers of BIM implementation in Europe (ibid). BIM usage is however increasing globally. It is expected that its usage by design professionals will rise to 80% in the next three years (Malleson, Kato, Popsilova, Watson & Friborg, 2016). In Nigeria, few studies are available regarding the implementation and adoption levels of BIM (Ibrahim & Muhammed, 2016). Although the public sector has demonstrated readiness in the management, process and technology sector, it is not fully ready to adopt BIM, specifically in the people sector (ibid).

2.2. Awareness and proficiency of CAD and BIM from the student perspective

Industry standards and employment prospects drive the need to learn and adopt CAD and BIM for the majority of studies reviewed on awareness and proficiency. In Nigeria, students are more aware of and more proficient in CAD related software notably Autodesk's AutoCAD as well as Google's SketchUp compared to BIM software such as Autodesk's Revit largely because AutoCAD is still widely employed in the Nigerian Construction Industry (NCI). These two points are discussed in greater detail in the successive paragraphs.

Rosli et al.'s 2014 study of student preferences using BIM software in the design studio at the University of Malaysia revealed the preferred use of AutoCAD and SketchUp for 100% and 88% of surveyed respondents respectively. The authors note that a primary reason why AutoCAD is preferred in architectural practice is largely due to its flexibility and sufficiency in 2D graphics and representation. Revit was revealed to be the common BIM software with 27.8% of students employing it for their designs (ibid). The relatively low percentage recorded is ascribed to the existing confusion regarding BIM implementation in the Malaysian construction industry. The authors note that the unavailability of a national BIM implementation guideline is a principal reason for the low adoption of BIM within architectural companies.

This trend of CAD software notably AutoCAD and SketchUp still in extensive use within schools of architecture is consistent in several other studies in developing countries, Nigeria inclusive. In fact, some studies make little distinction between CAD and BIM software as the terms are sometimes employed interchangeably. Al-Matarneh and Fethi (2017) found out that the most employed CAD software by students in Jordan were AutoCAD and Adobe Photoshop (54% each), Autodesk's 3Ds Max (53%), Revit (18%), SketchUp (15%), Graphisoft's ArchiCAD and Thermal Analysis (13% each). Proficiency followed the same curve with higher levels-AutoCAD (90%), Photoshop (85%), 3D Max (70%), Revit (40%) and SketchUp (35%). Students who self-taught themselves account for the largest percentage (30%) of learning methods from the sample. Nwakonye, Owoseni, Oluwatayo & Emokpae's study of the extent of BIM usage at Covenant University in Nigeria revealed a 98% awareness level for BIM across both undergraduate and postgraduate respondents. The study also reports that intermediate users, largely those in 400L, account for 74% proficiency with BIM software. This is because the software is formally taught at this level. This trend was also recorded for energy and sustainability analysis, as 64.7% of students from 400L were aware of this facet of BIM. Although the study presents data in the Nigerian BIM scenario, the rationale for several critical measurement indices and variables employed in the study such as categories of users, BIM levels and choice of singling out BIM 6D for assessment remain unclear. This makes replication and comparison of results from other schools difficult. Fagbemi et al., (2016) present a clearer picture when assessing CAD proficiency levels of architecture graduates working in selected architectural firms in Akure, Nigeria. The authors observed that more attention is paid 2D presentations, thus the focus is on CAD and not necessarily BIM. "Most of the firms are currently solely into 2D drafting . . . further requests by the client for 3D presentations attracts extra fees as it will be contracted out to experts that are not members of staff" (p. 1207). Consequently, almost all staff in the selected firms are proficient in AutoCAD as it is the major software employed in the firms. Self-learning (47.4%) was the common learning method as "none of the staff had CAD as part of their school curriculum" (p. 1208). The paper rightly concludes that acquiring skills in 2D presentations notably proficiency in AutoCAD was a major employment strategy in the NCI.

Studies reviewed from the US and Scandinavia make the distinction between CAD and BIM software in terms of awareness and usage. Joannides, Olbina and Issa (2012) note that many schools in the AEC industry are introducing BIM into their curricula and employing new staff based on their expertise in BIM. The study, which aimed at evaluating the current implementation into curricula and identify trends in teaching the same in accredited AEC schools in the US, found a high BIM implementation level (78%) in the schools. Revit was the most common software taught in the schools by a wide margin. ArchiCAD and Bentley followed this. BIM 3D for creating models and project coordination was the most common implementation level in architecture courses (59% and 53%) for undergraduate and postgraduate students respectively. 4D recorded lower scores at both categories of students (3% and 9%) but were higher for 5D (9% and 19%). BIM 6D was the lowest implemented category across the sample (5% and 3%) for undergraduate and postgraduate students respectively. The study concluded that hiring BIM knowledgeable staff as well as teaching BIM courses was an indication of the influence of industry standards and expectations.

A different trend was recorded among civil engineering faculties in Croatia where results showed high BIM awareness but low proficiency levels for undergraduate programs (Kolaric et al., 2017). Revit was likewise the most common BIM software, employed for visualization, communication and data analysis but not for advanced levels such as sustainability. These, the authors recommend, would be best understood at masters or postgraduate levels. Almutiri's (2016) study of AEC academics, professionals and students in KSA recorded a higher awareness of BIM (62%) over those who had none (38%). Awareness levels were higher for students studying abroad than for those studying within KSA (ibid). AutoCAD, Revit, SketchUp, 3Ds Max and ArchiCAD are the most widely taught software (in order of use). AutoCAD is the most widely employed in practice. The study also reports that BIM is largely employed in the pre-construction phase to produce architectural drawings, rendering/visualization, modeling and design implementation. This is the general trend from literature reviewed.

3. METHODOLOGY

In order to address the research questions, a questionnaire survey was designed to gather information on awareness and proficiency levels of respondents as well as obtain incentives of learning CAD and BIM in the form of advantages to students. This was the approach commonly employed in previous studies. Postgraduate students in the MSc class at ABU were employed for the study for two reasons. First, Masters students are at the end of the architecture program and would have undergone all training and variances of learning CAD and BIM in school and practice over time via internship in architectural firms. CAD (in the form of AutoCAD and SketchUp) is introduced during the first year. This is expanded upon in the third year in preparation for the mandatory Students' Industrial Work Experience Scheme (SIWES). This internship program aims at exposing undergraduate students especially in professional disciplines to the real work of practice for a period of about six months. BIM in the form of Revit is then taught in the final year prior to graduation. Secondly, despite this advantage, postgraduate students are rarely employed to assess awareness and proficiency levels of CAD and BIM in AEC schools (Abdirad & Dossick, 2016).

In response to the first research question addressing the degree of awareness and proficiency attained by students, respondents were required to select the different CAD and BIM implementation levels obtained from literature on a scale of 1 to 5; 1 being low awareness/proficiency and 5 denoting full awareness and proficiency of all facets of the implementation levels. Results were analyzed for descriptive statistics in SPSS v.21 and presented as means (M), standard deviations (SD) and Relative Importance Index (RII). SD values reveal how clustered individual ratings are around the mean. SD values less than 1 illustrate that ratings from most respondents did not vary much from the mean value. RII is a ratio of the total actual scores (AS) for each implementation level divided by a product of the number of responses and the maximum possible score (maxPAS). Mathematically, this is expressed as $RII= \Sigma AS/(\Sigma \text{ maxPAS})$. The maximum value for RII is 1.

To establish whether differences exist between awareness and proficiency levels, data was analyzed for normality using the Kolmogorov-Smirnov (KS) and Shapiro-Wilk (SW) tests in SPSS v.21. Overall, these were found to be significantly different from non-normal distributions (Awareness-KS = 0.196, $p = 0.000$; SW = 0.915, $p = 0.000$ while Proficiency-KS = 0.18, $p = 0.000$; SW = 0.93, $p = 0.002$). Thus the Wilcoxon signed rank tests for related samples were employed to establish differences (or not) of the medians of awareness and proficiency for implementation levels of CAD and BIM. According to Field (2013), the Wilcoxon signed-rank test is the non-parametric equivalent of the paired-samples t-test employed where two sets of scores from the same participants are to be compared. Median values are more suited than mean values for the analysis (ibid). Results are presented as Median values (Mdn), Wilcoxon test statistics (W), standardized test statistic (z) and the significant value (p). P values less than 0.05 for comparisons between awareness and proficiency median values are considered significantly different from each other.

1 The maximum score for any factor per respondent is 5 (on a 5 point likert scale). For 64 respondents, maximum possible score (maxPAS) = 320

To address the third research question, twelve main advantages of employing CAD and BIM in literature from the student perspective were presented for respondents to select using the same likert rating employed for research question one. RIIs were employed to rank the most important advantages from the student perspective. RIIs above 0.75 were considered most important. Additionally, information on software use was obtained from the sample, in line with similar studies. Results from these analyses are presented in the succeeding section.

4. RESULTS AND DISCUSSION

The survey targeted the entire MSc I class (N 88) at the department of Architecture at ABU. 64 questionnaires (73%) were retrieved and employed for analysis. Results reveal the extensive use of AutoCAD (92%) and Revit (87%), followed by SketchUp (57%) within the sample (Figure 2). These statistics support findings in literature regarding influence of practice over the software students learn. This also underscores the influence of formal learning in school over which software students are likely to be more proficient in.

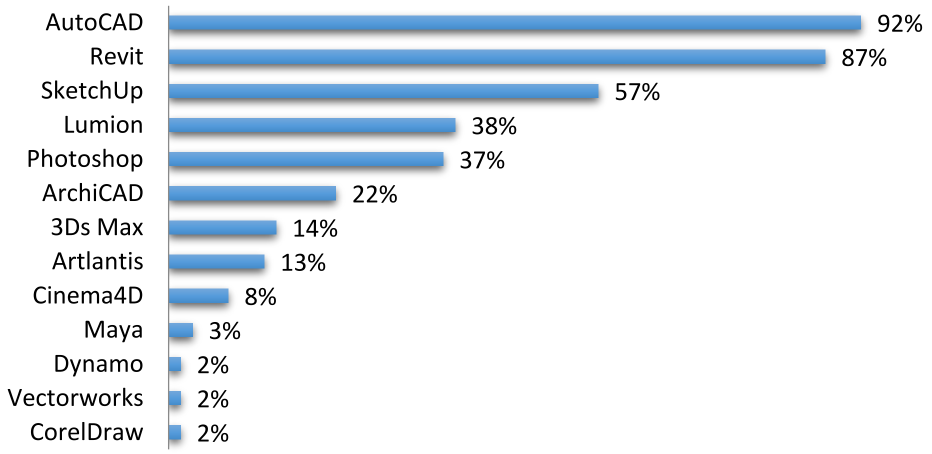

Figure 2: Software usage by students

In response to research question one, respondents are more aware of CAD 2D and BIM 3D (Figure 3). BIM 4D-7D are comparatively less known and employed within the sample. Within this range, BIM 4D and 6D were ranked slightly higher. A possible reason for this is that Scheduling and Sustainability are formally taught as part of the MSc curriculum at MSc I in the Project Management as well as Sustainability and Architecture courses respectively. Students may have simply assumed knowledge in these courses translates to BIM implementation levels in practice. BIM 5D relating to Cost estimating is seen as the job of Quantity Surveyors, thus of lower importance to architecture students. However, Cost estimation and aspects of Building Economics are formally taught in the undergraduate program. Facility management (BIM 7D) may have been perceived as the responsibility of Facility managers, and not architects. This may account for its low rating from this sample.

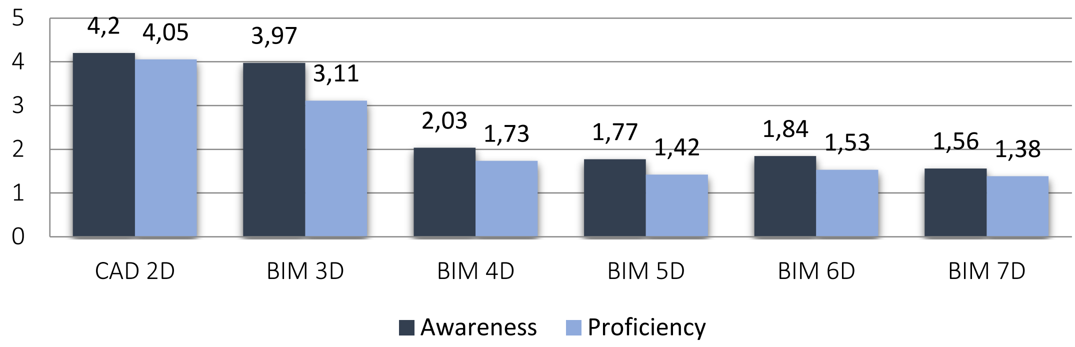

Figure 3: Mean values for Awareness and Proficiency levels in CAD and BIM software capabilities

Results from the comparison of median values of awareness and proficiency revealed significant differences (Table 1). This means that apart from CAD 2D, awareness and proficiency were significantly different for all levels of BIM implementation from the sample. Students were on average, more aware of BIM implementation levels than being proficient at them.

Table 1: Differences in Awareness and Proficiency levels

	Awareness				**Proficiency**				**Wilcoxon signed-rank tests**		
	Mdn	*SD*	*Sum*	*RII*	*Mdn*	*SD*	*Sum*	*RII*	*W*	*z*	*p*
CAD 2D	4	0.839	269	0.84	4	0.898	259	0.81	130.5	-1.506	*0.132*
BIM 3D	4	0.854	254	0.79	3	1.236	199	0.62	42.00	-4.773	*0.000**
BIM 4D	2	1.154	130	0.41	1	1.073	111	0.35	70.00	-2.373	*0.018**
BIM 5D	1	1.109	113	0.35	1	0.773	91	0.28	11	-3.035	*0.002**
BIM 6D	1	1.263	118	0.37	1	0.975	98	0.31	20	-2.537	*0.011**
BIM 7D	1	1.006	100	0.31	1	0.882	88	0.28	10	-2.389	*0.017**

*Significant at 0.05

In response to the third research question, results reveal that students rated 11 out of the 12 advantages highly. RIIs for these items were well above the 0.75 benchmark set for the study. The notable exception was reduction in production costs, ranked 12th with RII of 0.67 in Table 2. In essence, production costs are perceived to be the most disadvantageous facet of employing CAD and BIM from the student perspective. Items related to the pre-construction stage of design such as enhancing design output, marketing, saving time/speed, photo-realistic rendering, aiding design options and employability potentials were ranked 1-7 with RIIs equal to and above 0.9. These items also record SD values less than 1 (Table 2). Collaborative aspects of BIM such as error reduction, fostering competence and teamwork were comparatively ranked lower on the table.

Table 2: Ranking of advantages of CAD/BIM from the student perspective

Advantage of CAD/BIM	**SD (1)**	**D (2)**	**N (3)**	**A (4)**	**SA (5)**	**Missing**	**M**	**SD**	**Sum**	**RII**	**Rank**
Enhances design output	0 (0%)	0 (0%)	1 (2%)	11 (17%)	51 (80%)	1 (2%)	4.79	0.446	302	0.96	1
Good for marketing and business	0 (0%)	0 (0%)	1 (2%)	13 (20%)	49 (77%)	1 (2%)	4.76	0.465	300	0.95	2
Saves time, speed	0 (0%)	0 (0%)	1 (2%)	16 (25%)	47 (73%)	0 (0%)	4.72	0.487	302	0.94	3
Photo realistic renders	0 (0%)	0 (0%)	3 (5%)	13 (20%)	48 (75%)	0 (0%)	4.7	0.554	301	0.94	3
Aids alternative	0 (0%)	0 (0%)	4 (6%)	18 (28%)	41 (64%)	1 (2%)	4.59	0.613	289	0.92	5

design options											
Increases design consistency, accuracy	1 (2%)	0 (0%)	5 (8%)	13 (20%)	44 (69%)	1 (2%)	4.57	0.777	288	0.91	6
Increases employability potential	0 (0%)	2 (3%)	5 (8%)	14 (22%)	41 (64%)	2 (3%)	4.52	0.784	280	0.90	7
Reduces errors	2 (3%)	0 (0%)	4 (6%)	22 (34%)	36 (56%)	0 (0%)	4.41	0.868	282	0.88	8
Fosters competence	0 (0%)	3 (5%)	2 (3%)	29 (45%)	30 (47%)	0 (0%)	4.34	0.761	278	0.87	9
Good source of income	0 (0%)	1 (2%)	9 (14%)	23 (36%)	30 (47%)	1 (2%)	4.3	0.775	271	0.86	10
Fosters teamwork	1 (2%)	5 (8%)	8 (13%)	20 (31%)	29 (45%)	1 (2%)	4.13	1.024	260	0.83	11
Reduces production cost	5 (8%)	12 (20%)	15 (23%)	15 (23%)	15 (23%)	2 (3%)	3.37	1.271	209	0.67	12

Students are more aware and proficient at design and visualization aspects of CAD and BIM

Findings from the study reveal the overwhelming dominance of AutoCAD and Revit for design related purposes. These software are formally taught at undergraduate levels in the school. SketchUp closely followed these, being another 2D CAD software that is taught. Together, these results support findings in literature that AutoCAD and Revit are the most common software packages employed in school by students (Almutiri, 2016; Al-Matarneh & Fethi, 2017). Differences observed between awareness and proficiency for all levels of BIM except 2D CAD support the finding that students focus on being proficient at the pre-construction stage of design where presentation drawings and visualizations are optimized to secure commissions from clients. This assertion is further lent credence by the ranking of advantages of CAD and BIM presented in Table 2 where the top ranked items related to pre-construction stage activities.

AEC Industry and Practice influence CAD and BIM learning trends

Consequently, industry demands and practice trends motivate students to learn CAD and BIM. In fact, the curriculum is designed around the demand in practice, as the current focus in the NCI is proficiency in AutoCAD and 2D representation (Ryal-Net & Kaduma, 2015; Fagbemi et al., 2016). Proficiency and speed in 2D representation was found to be a strong employment factor in architecture firms (ibid). Joannides, Olbina and Issa (2012) also report the advantage of BIM knowledge for employment of faculty staff in the US. In Nigeria, 3D rendering and modeling are usually contracted out to specialists for a fee (Fagbemi et al., 2016). Students in architecture school who have been introduced to the advanced capabilities of BIM software such as Revit and 3Ds Max have benefitted from this venture in recent years. This occurs largely because architects in practice are often overwhelmed with design and drafting of projects, with little time for learning new visualization capabilities of BIM software. The lack of time for older employees to adjust and learn new aspects of BIM software in the face of rapid technological development has been proffered as a challenge to the full adoption of BIM (Ramilo & Embi, 2014). It is often easier for younger people to learn and adapt to computer applications than older professionals working in practice environments with busy and time consuming schedules as commonly obtains in architecture.

CONCLUSION AND RECOMMENDATION

This study set out to explore awareness and proficiency levels of CAD and BIM from the student perspective in response to the dearth of comparative information available for the implementation of BIM in AEC education in Nigeria. Results revealed the extensive awareness and proficiency of CAD 2D and BIM 3D largely for pre-construction stage design and visualization purposes. BIM 4D-7D were relatively less employed from the sample. Additionally, ratings for advantages of CAD and BIM from the sample underscore the tendency for students to be motivated by industry trends in practice and for employment purposes. The collaborative aspect of BIM, espoused for its great benefit (Guidera & Mutai, 2008; Abubakar, Ibrahim & Bala, 2013; Ibrahim & Muhammed, 2016), is yet to be fully explored by students and academia in Nigeria.

The study recommends the future integration of these more advanced BIM implementation levels into the curricula at master's level in Nigerian schools of architecture in line with recommendations from Abdirad and Dossick (2016). It is also important that HEIs liaises with professional bodies, notably the Nigerian Institute of Architects (NIA) and other allied professions in the built environment to guide government policies regarding the adoption of a national framework for BIM implementation as policies at this level directly bear upon industry and practice trends (Abubakar, Ibrahim & Bala, 2013). Industry and practice trends, as revealed by this study, impact academic trends and student learning of BIM. Consequently, more studies need to be conducted in other schools of architecture to aid generalization of these results as they accrue from a single school and class. This was a limitation in the present study.

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