IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 16, Issue 6 Ser. II (Nov. - Dec. 2019), PP 60-67
www.iosrjournals.org

Evaluation of the Level of Usage of BIM Tools for Project Delivery in Federal Universities in South-West, Nigeria

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Abstract: *Construction industry has been lagging behind other industries in terms of project delivery for the past decades. This was due to non-collaborative efforts of stakeholders and fragmented nature of building processes which was caused by lack of cooperation, poor information and integration. This had resulted to design errors, omissions, inefficiencies, coordination problems, cost overruns, delay and productivity losses due to conflicting interests, incompatible strategies among team members and limited access to timely information. Hence, Building Information Modeling integrates, and processes information throughout the entire life cycle of construction projects and ends fragmentation that exists within the building industry.This paper assess level of usage of BIM tools at Federal Universities in South-West, Nigeria. The study adopted mixed method. The population are the professionals within the physical planning units of the Federal Universities that were registered with their respective professional bodies. Data was analysed using both descriptive and inferential statistics, the descriptive statistics entails percentage, pie-chart, bar chart, and frequency while the inferential statistics includes mean scores, and relative importance index, Pearson correlation and Friedman test with the aid of SPSS version 22 and MS-Excel. Findings showed that Design and engineering, Project planning, Construction project control, finance and Accounting are the four BIM tools that are frequently used for construction projects in the physical planning units of the study area.As the project unfolds and the design is conceptualized, information in the form of drawings, specifications and new construction methods were communicated,The study concluded that the use of BIM tools is very important for reliable assessment. The study recommended that the government and regulatory bodies should include the use of BIM software into the training curriculum in order to enhance job production in south-west Nigeria*

Keywords: *Construction industry, Building Information Modeling,Construction Projects, Communication, Fragmentation.*

Date of Submission: 16-11-2019 Date of Acceptance: 02-12-2019

I. Introduction

Arayici, Khosrowshahi, Ponting and Mihindu (2009) described Building Information Modeling as lifecycle evaluation concept that seeks to integrate processes throughout the entire lifecycle of construction project. Hence, BIM is to create and re-use consistent digital information by the stakeholders throughout the project lifecycle. However, the traditional construction project delivery approach of Design-Bid-Build fragments the roles of participants during design and construction phases. This hinders the collaborative involvement of the general contractor or the construction manager during the design phase. Furthermore, the traditional practice of two dimensional drawings at the design phase does not promote a true collaborative approach. Architects and Engineers produce their own fragmented drawings to relay their design information to the owners and the contractors. These drawings are not integrated and usually pose conflicts of information which result in inefficiency in project delivery.

Traditionally, the inter-disciplinary collaboration in the Architecture, Engineering, and Construction (AEC) industries has revolved around the exchange of Two-Dimensional drawings and documents. Amor, Jiang and Chen (2007) noted that even though the separate design disciplines have been using Three-Dimensional models and applications for visualization and design development, the collaboration practices have remained more or less Two-Dimensional-based until recently. The widespread use and proliferation of object-oriented Computer-Aided Design (CAD) packages have increased constructability and level of automation in Tertiary Institution construction processes provides and encourages motives for the exchange of Three-Dimensional data in the collaboration process (Sacks, Treckmann, andRozenfeld 2009).

Most contractors have complained of poor design work, which lack better understandingand details. The consequence of this effect call for several meetings with the design teams and this slow down the workflow of all trades undertaken on the said project. Sometimes, the building owner's wishes are not well documented during the beginning of the project as a result of documentation of important information in the tender documents which affects series of construction phases and at the same time the profit margin of the construction company in question is also affected.

Researchers have shown that there is lack of adequate knowledge of Building Information Modelling (BIM) in the physical planning units of the universities as building generally record delay, abandonment and failure, substantial funds and high cost of operation, late delivery of project, poor quality work, rework , fragmentation and non-collaboration among team members (Langdon, 2007). Hussin*etal.*, (2013) observed that sustainability is the core of development projects in the developed countries .While addressing sustainability, Kasimu (2015), is of the opinion that lack of adequate knowledge management practices is the bane to high cost of construction projects in Nigeria.

Abolore (2012) noted that construction project delivery has not received the necessary attention it requires to positively impact on the way construction projects are executed just like other developing countries. Hence, the construction industry in Nigeria has been wasteful and inefficient in its activities of creating human habitat. The foregoing are pointers to the wide gap that exists in the level of knowledge required for effective implementation of Building Information Modelling (BIM) in South-West Universities in Nigeria. Succar (2009) has been the leading voice in the implementation of BIM thereby establishing the difference between conventional (method) of construction and Building Information Modelling (BIM).Hence the need for the study to assess the level of usage of BIM tools of Federal Universities in South-West, Nigeria

II. Literature Review

2.1 BIM for Project Delivery

Arayici*et al.*,(2009)noted the construction industry has been facing a paradigm shift so as to increase: productivity, efficiency, infrastructure value, quality and sustainability, reduce lifecycle costs, lead times and duplications. It is advocated that most of these can be obtained through Building Information Modeling (BIM). BIM can be defined as the use of the ICT technologies to streamline the building lifecycle processes of a building and its surroundings, so as to provide a safer and more productive environment for its occupants; and to assert the least possible environmental impact from its existence; and be more operationally efficient for its owners throughout the building lifecycle.Today in many organisations multi-disciplinary teams are clashing with traditional methodologies (e.g. business models, processes, legal and compensationschemes, etc.) that impede knowledge sharing which cause reinventing the matters and processes on a daily basis. Fragmentation and calcified processes inhibit widespread change in the building industry, which is also traditionally disconnected from lifecycle evaluation methods. However, modeling techniques replaces this fragmented process with an interdisciplinary approach that consolidates the team effort, (Bernstein and Pittman, 2005). It seems that the building industry is under pressure to provide value for money,sustainable infrastructure, etc. and hence adaptation of Building Information Modelling (BIM) technology has been inevitable (Mihindu and Arayici, 2008).

BIM as a lifecycle evaluation concept seeks to integrate processes throughout the entire lifecycle of a construction project. The focus is to create and reuse consistent digital information by the stakeholders throughout the lifecycle (Figure 3.2). BIM incorporate a methodology based around the notion of collaboration between stakeholders using ICT to exchange valuable information throughout the lifecycle. Such collaboration is seen as the answer to the fragmentation that exists within the building industry and that has caused various inefficiencies (Jordani, 2008).

To date, there are many projects that have utilised BIM systems within; environmental planning, design and development, optimisation, safety and code checking construction, and have realised its benefits. Such projects have recommended BIM systems as a remedy to address low productivity issues and proper delivery of project (Mihindu, and Arayici, 2008).

2.2 Levels of BIM

Currently there is a lack of a clear definition in regard to what BIM actually is (Howard and Björk 2008). There are many different levels to what professionals define as BIM and this makes discussions regarding BIM somewhat unclear. Many different organisations have tried to define BIM butthere is a lack of consensus, many aspects are similar in regards to the model but the level of how BIM affects the work processes differs (Isikdag, *et al.*, 2007).

BIM used by the NBIMS (National Building Information Modeling Standard) is used as a reference point, because it covers more than just the model.

Building information modeling is a new way of creating, sharing, exchanging and managing the information in the project throughout the buildings entire lifecycle. Isikdag, *et al*., (2007) categorized BIM into different parts such as:

Product –An intelligent representation of the building. It is intended asa repository for information to be used by the owner or operators and maintained throughout the buildings entire life-cycle.

i. Collaborative process –Covering business standards, automate the process capabilities and ;
ii. Interoperability for sustainable information usage.

The development of BIM tools have progressed in the pursuit of solutions for different professions. This process resulted in different programs that do not interface well with each other or with advanced project management tools. The two largest challenges for technology developers in regards to BIM have ended up being interoperability in existing BIM systems and creation of multi accurate models to fulfill different purposes (Thompson and Miner 2007).

The Industry Foundation Classes (IFC) defined by the "buildingSMART alliance", is the accepted standard for BIM models. IFC is an ambitious attempt to achieve model-based interoperability. It covers a wide range of modeling information, not limited by the geometry of the objects, but also Metadata related to other aspects of the building. (Steel *et al.,* 2012).

When analysing the level of interoperability in IFC, Steel *et al.,* (2012) consider it in four different levels.

(i) File level interoperability - This covers the ability for different tools to successfully exchange files.
(ii) Syntax level interoperability - This coves the ability for different tools tosuccessfully purrse files without errors. This also covers the ability for different tools to interoperate without errors.
(iii) Visualization level interoperability - This covers the ability for different tools to correctly visualise the exchanged model.
(iv) Sematic level interoperability - This covers the ability for different tools tocome to the same understanding of the meaning of a model being exchanged.

The advantage of BIM technology is greater than the sum of its parts. By looking at each individual benefit of BIM it can be seen that each element is a means to reduce cost, either directly through better designs and reduced material usage, or indirectly through efficiency gains. Consequently, BIM technology has the potential to go a long way in addressing the inefficiency issues that exist within the construction industry.

III. Methodology

The study adopted questionnairesurvey on the professionals in the physical planning units of the Federal Universities in South-West Nigeria.The study adopted both descriptive and inferential statistical tools. The descriptive statistics include the use of tables, percentages, frequency, pie chart and bar chart. Theinferential statistics entails mean scores, relative importance index and Pearson correlation.Results were obtained from the data generated through the structured questionnaires that were administered from the research work. One hundred questionnaires (100) were distributed out of which eighty-two (82) were retrieved. This represents 82% of the response rate which is above the usual rate of 20-30%for questionnaire survey in construction management studies (Kothari, 2004).

IV. Data Presentation And Analysis

Figure 4.1 shows the pie-chart of the background of the respondents. This indicated that$79^o$of the respondents were from ObafemiAwolowo University (OAU), Ile-Ife and University of Lagos (UNILAG) respectively while 58^o of the respondents are from University of Ibadan (UI). Also, 48^o of the respondents were from Federal University Oye (FUOYE), Federal University of Technology Akure (FUTA) and Federal University of Agriculture Abeokuta (FUNAAB) respectively.

Table 4.1 shows that all the Federal Universities surveyed in the study area has physical planning unit while Figure 4. 2 show the sections/units available in each of the schools. This Figure 4.2 indicated that all the physical planning units surveyed have sections/units of Architecture, Building, Engineering and Quantity Surveying in their School. The survey shows that all the sections of the physical planning units has the discipline of the built environment departments and the capacity of executing any tertiary building project undertaking by the physical planning units of each institution. However, it could be inferred from the analyzed results that the first generation universities are more encompassing and developed in terms of personnel/professionals in the physical planning unit and volume of projects handled by respective institutions.(See the figure for more detail)

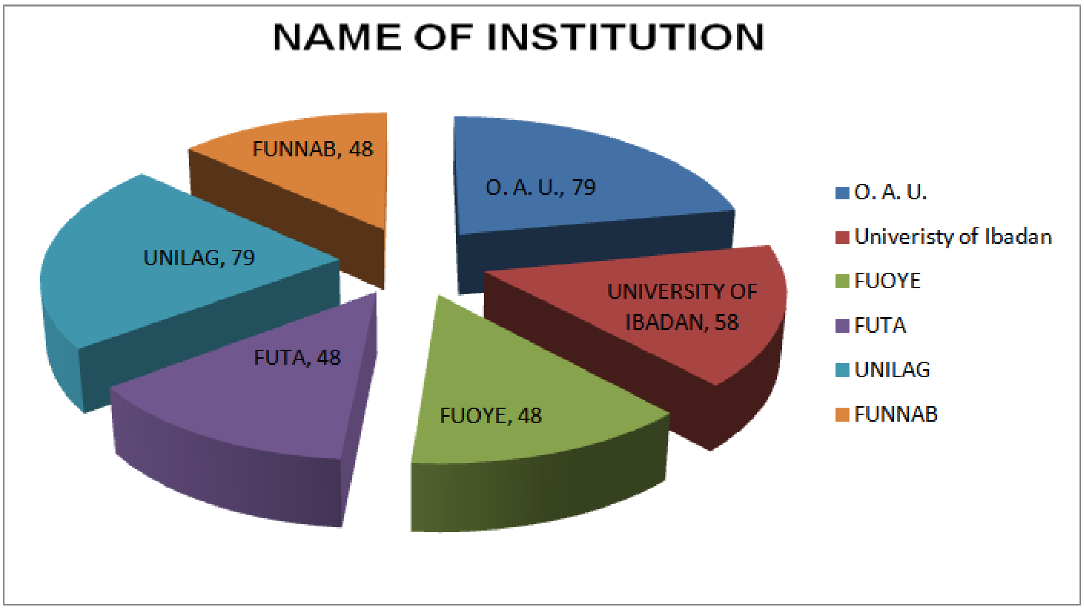

Figure 5.1: Name of Institutions

TABLE 4.1: Physical Planning Unit in your Institution

Physical Planning Units in Institution	Frequency	Percentage
Yes	82	100
No	-	-
Total	**82**	**100**

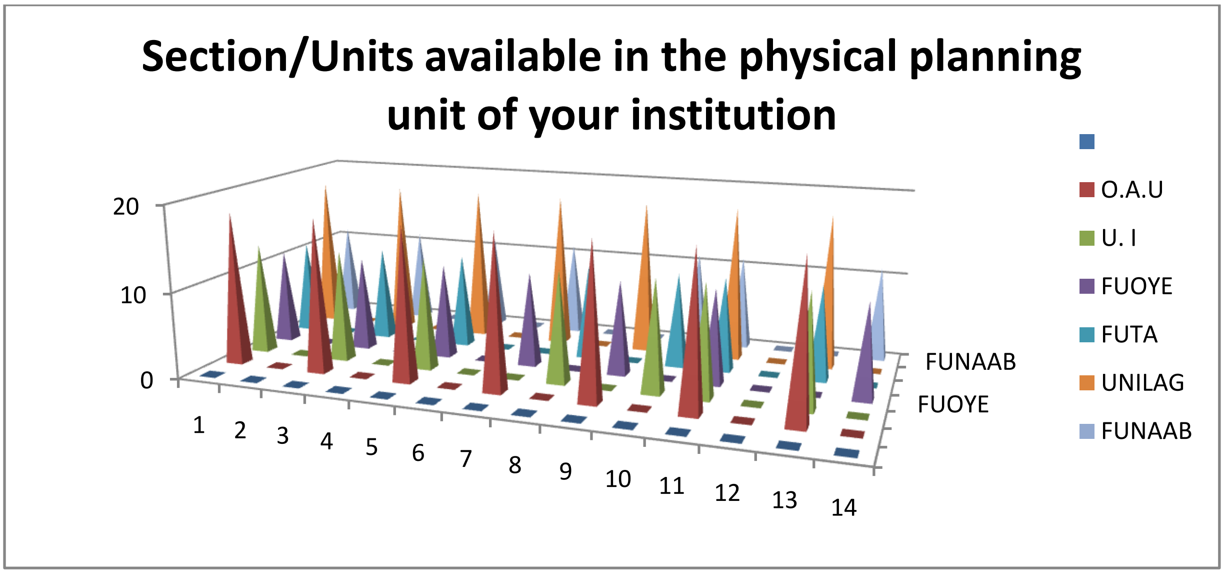

Figure 4.2 Section/Units available in the Physical Planning Units

Figure 4.3 shows the pie-chart of professional specialization of the respondents in the physical planning units of the Federal Universities in the South-West Nigeria. This indicated that 105^o in Engineering field while Architecture and Building accounted for 75^o, Quantity Surveying 65^o, Estate Management 22^o, Geo-Informatics/Land Surveying, Urban and Regional Planning 9^o respectively.

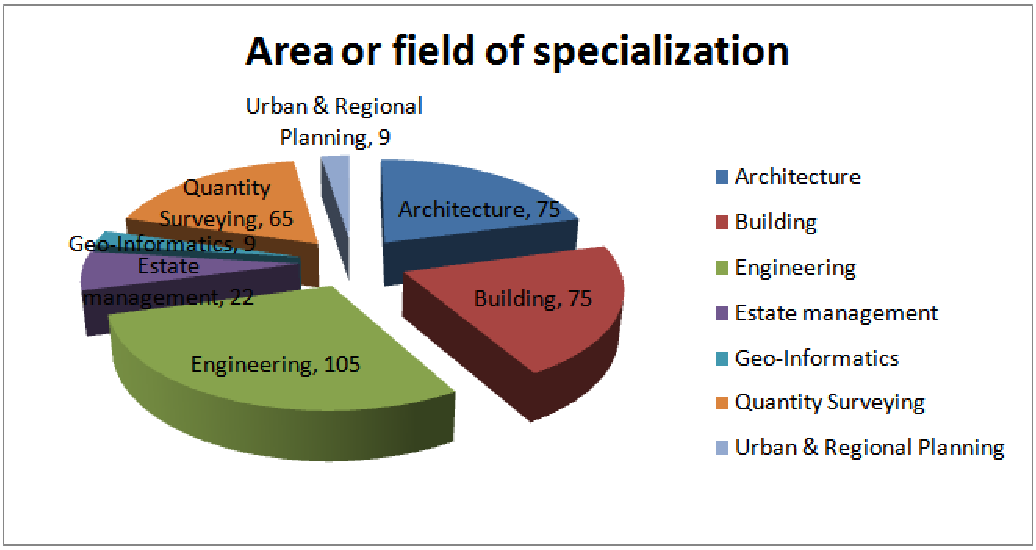

Figure 4.3: Area of Specialization

See Table 4.2for more details

Table 4.2: Professional Affiliation

Profession	Member	Percentage	Fellow	Percentage
Architecture	15	18.29	2	2.44
Building	16	19.51	1	1.22
Engineering	23	28.05	1	1.22
Estate Management	5	6.10	-	-
Geo-Informatics	2	2.44	-	-
Quantity Surveying	15	18.29	-	-
Urban & Regional Planning	2	2.44	-	-
Total	**78**	**95.12**	**4**	**4.88**

Also, Table 4.3 presents the academic qualification of the respondents. It shows that majority of the respondents had Master Degree (42.68%) while those with B.Sc degree were (31.71%), Higher National Diploma Degree (21.95%) and Post-Graduate Diploma Degree (14.63%) respectively. This Table 4.2 also indicated that the respondents have had more than 10 years of experience on the job.

Table 4.3: Academic Qualification of Respondents

Description/Range	**Mid-Value**	**Frequency**	**Percentage**
Academic Qualification (N=82)			
HND		14	17.1
PGD		7	8.5
B.Sc		26	31.7
M.Sc		35	42.6
Ph.D		2	2.4
Others		82	100.0-
Total			
Years of Experience (N=82)			
1 – 5	3.0	12	14.63
6 – 10	8.0	30	36.58
11 -15	13.0	24	29.27
16 – 20	18.0	11	13.42
Above 20	23.0	5	6.10
Mean	**10.99**		

Figure 4.4 and figure 4.5 shows the level of knowledge of respondents about BIM and level of usage of BIM softwares. figure 4.4 indicated that 35.59% of professionals in the physical planning units of the study area are moderately knowledgeable about the BIM while only 4.88% of the professionals are very highly knowledgeable.

Also, figure 4.5 revealed that 39.02% of the professionals make use of BIM while only 8.54% very highly use the BIM software.

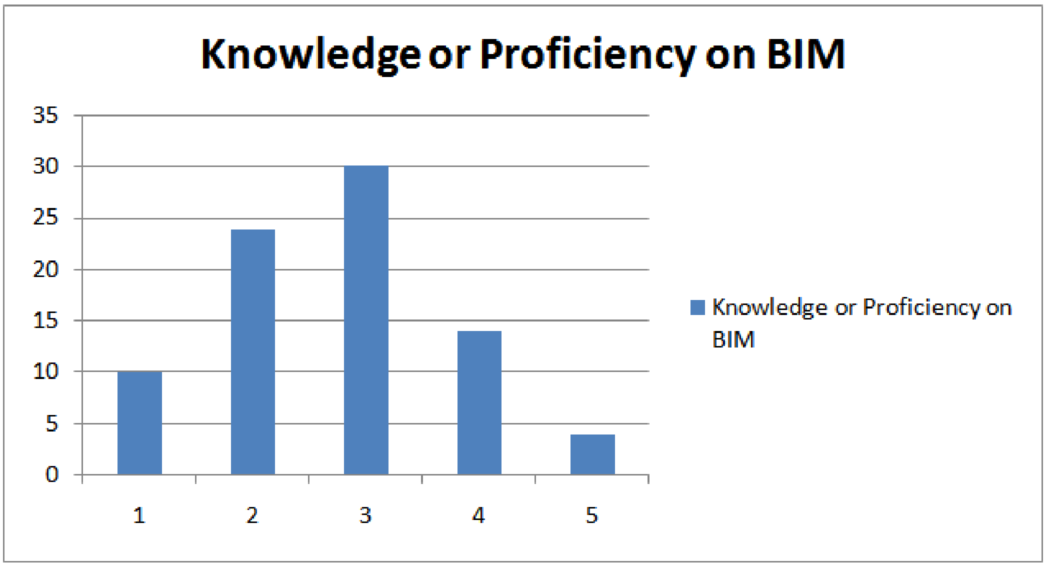

Figure 4.4: Knowledge or Proficiency on BIM

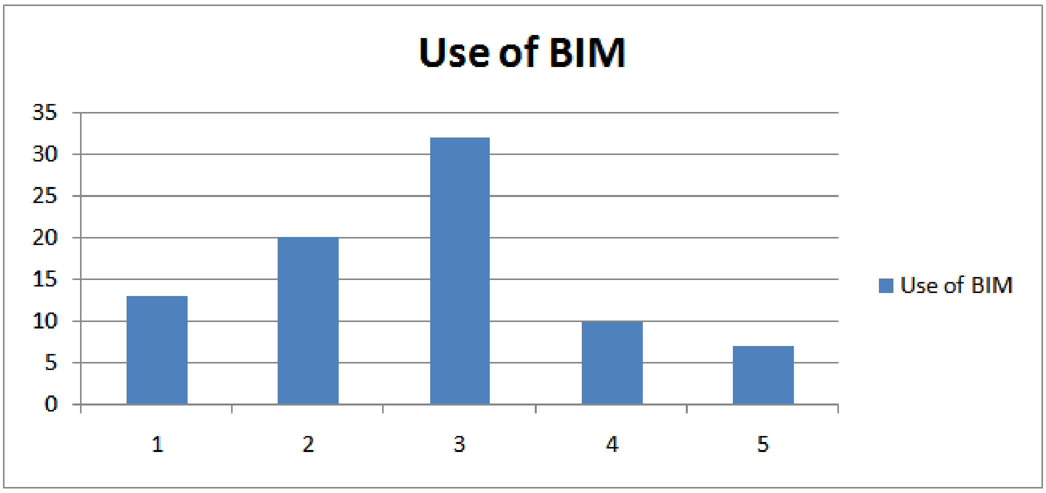

Figure 4.5: Use of BIM

Table 4.4.0 shows that there is statistical reason to reject the null hypothesis since the significant probability 0.004 and chi-square value of 17.440 with 5 degree of freedom less than the alpha level 0.05. We therefore conclude that there is significant difference on the Knowledge or Proficiency on BIM Softwares/tools in the physical planning unit of federal institutions in south west Nigeria. The table further revealed that University of Ibadan (UI) physical planning unit has the highest proficiency rate on BIM Softwares/tools with mean ranking of 51.90 closely followed by the ObafemiAwolowo University (OAU) with 51.5. While Federal University Oye (FUOYE) and Federal University Abeokuta (FUNAB) had the lowest proficiency with 28.05 and 27.53 respectively. However, the Post Hoc analysis in table 4.3.1 further shows the level of significance difference on the Proficiency on BIM Softwares/tools in various institutions.

Table 4.4.0: Kruskal Wallis Test on the Institutional Knowledge or Proficiency on BIM Softwares/tools in the physical planning unit

Institution (Grouping Variable)	Mean Rank	Ranking	Chi-Square	df	Asymp. Sig.
UI	51.90	1	17.440	5	0.004
OAU	51.50	2			
UNILAG	48.03	3			
FUTA	37.80	4			
FUOYE	28.05	5			
FUNAB	27.53	6			

Table 4.5 identifies design and engineering, construction projects control, project planning, procurement and finance and accounting software as the information management software that were well known in the physical planning unit of university in South-West Nigeria as over 50% of the respondents affirmed their awareness with Design and engineering softwares having the highest rate of awareness with 82.1%. While the rate of awareness on project bidding and marketing and workforce management tools were low as 29.8% and 34.5% of the respondents affirmed to their awareness. The table also reveals the rate of awareness of all the softwares on institutional basis with OAU having the awareness rate above 50% in all the tools except on workforce management of 42.1%. Similarly, design and engineering softwares were the only tool that has its rates above 50% in FUTA.

Table 4.5: Rate of Awareness of Softwares/Tools by Institutions

Tools/softwares	**Institutions**						
	FUOYE	**FUNAB**	**UI**	**FUTA**	**OAU**	**UNILAG**	**Total**
Project Bidding and marketing	2(18.2)	2(11.1)	4(40.0)	2(18.2))	11(57.9)	4(26.7)	25(29.8)
Project Planning	9(81.8)	13(72.2)	5(50.0)	3(27.3))	13(68.4)	8(53.3)	51(60.7)
Procurement	5(45.5)	7(38.9)	7(70.0)	3(27.3)	15(78.9)	6(40.0)	43(51.2)
Design and engineering	8(72.7)	16(88.9)	9(90.0)	6(54.5)	19(100)	11(73.3)	69(82.1)
Construction project control	9(81.8)	16(88.9)	7(70.0)	1(9.1)	14(73.7)	7(46.7)	54(64.3)
Workforce management	4(36.4)	9(50.0)	5(50.0)	0(0)	8(42.1)	3(20.0)	29(34.5)
Finance and accounting	5(45.5)	7(38.9)	5(50.0)	2(18.2)	13(68.4)	10(66.7)	42(50.0)
None of the above	1(9.1)	2(11.1)	0(0.0)	2(18.2)	0(0)	3(20.0)	8(9.5)

Table 4.6 categorised BIM tools on the level of usage and shows that Design and engineering, Project planning and Construction project control with mean value of 3.651, 3.370, and 3.272 respectively as the major BIM software that are highly frequently used for project delivery in the physical planning units. The table also shows that Workforce management and project Bidding tools with mean value of 2.532 and 2.342 were frequently used with Percentage rate below 50% level of usage.

Table 4.6: Level of Usage of Building Information Management Tools/softwares

Softwares	Response					Descriptive		
	1	**2**	**3**	**4**	**5**	Mean	Rank	Percentage (%)
Design and engineering	8	1	22	33	19	3.6506	1	71.08
Project Planning	10	6	22	30	13	3.3704	2	64.94
Construction project control	14	4	19	34	10	3.2716	3	61.98
Finance and accounting	15	12	18	24	10	3.0253	4	56.71
Procurement	14	12	28	19	3	2.8026	5	52.37
Workforce management	19	20	20	14	4	2.5325	6	45.71
Project Bidding and marketing	26	14	23	10	3	2.3421	7	40.00

V. Conclusion And Recommendation

Appraising the concept of building information and communication associated with construction project, seven BIM tools were considered.Design and engineering, Project planning, Construction project control, finance and Accounting with mean value of 3.651, 3.370, 3.272 and 3.03 respectively are the four major BIM software that are highly frequently used for project delivery in the physical planning units it was further revealed that Workforce management and project bidding tools with mean value of 2.532 and 2.342 were frequently used with Percentage rate below 50% level of usage.The study recommended that the government and regulatory bodies should include the use of BIM software into the training curriculum in order to enhance job production in south-west Nigeria.

References

[1]. Abolore.A. A. (2012). Comparative study of environmental sustainability in building construction in Nigeria and Malaysia. Journal of Emerging Trends in Economics and Management Sciences, 3(6), 951-961.

[2]. Amor, R., Jiang, Y. & Chen, X. (2007).BIM –are we there yet?,Proceedings of CIB W78 conference on Bringing ITC knowledge to work, Maribor, Slovenia, 26-29 June, 159-162.

[3]. Arayici, Y., Khosrowshahi, F., Ponting, A. M., &Mihindu, S. (2009).Towards implementation of building information modeling in the construction industry, .International Journal of Managing Projects in Business, **2**(3), 419-434.

[4]. Bernstein, P.G., & Pittman, J.H. (2005).Information modeling in the building industry Whitepaper, Autodesk SolutionsInc., CA.

[5]. Hussin, J. M., Rahman, I. A., &Memon, A. H. (2013). The way forward in sustainable construction: Issues and challenges. International Journal of Advances in Applied Sciences, 2(1), 15-24. https://doi.org/dx.doi.org/10.11591/ijaas.v2i1.1321.

[6]. Isikdag, U., Aouad, G., Underwood, J., & Wu, S. (2007,). "Building information models: a review on storage and exchange mechanisms".InBringingITC knowledge to work, 24th W78 Conference Maribor.**26**, 29 - 36.

[7]. Langdon, D. (2007a). cost of Green Revisited: Reexamining the Feasibility and Cost Impact of Sustainable Design in the Light of Increased Market Adoption. Carlifonia.

https://doi.org/10.1093/jhmas/jrr055

[8]. Hobbs, C. (2008). 'BIM by the back door', The Structural Engineer,**86**(13), 18.

[9]. Howard,R.&Bjork,B.(2008). Building information modelling: Experts' views on standardisation and industry deployment, Journal of Advanced Engineering Informatics **22,** 271–280.

[10]. Thompson, D.B.& Miner, R.G.(2007). BIM: Contractual Risks are Changing. Available a http://www.aepronet.org/ge/no35.htm .Accessedon August, 2017.

[11]. Sacks, R., Treckmann, M .&Rozenfeld, O.(2009). Visualization of work flow to support Lean Construction, Journal of Construction Engineering and Management, **135** (12), 1307-1315.

[12]. Mihindu, S., &Arayici, Y. (2008). "Digital construction through BIM systems will drive the re-engineering of construction business practices", 2008 International Conference on Visualisation, IEEE Computer Society, CA, ISBN 978-0-7695-3271-4, 29-34.

Akinola Victoria O. "Evaluation of the Level of Usage of BIM Tools for Project Delivery in Federal Universities in South-West, Nigeria." IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) , vol. 16, no.6, 2019, pp. 60-67