Assessment of Relationship between BIM and Traditional Method of Construction for Building Project in Federal Universities in South-West, Nigeria.

Akinola Victoria O.
Department of Building,
School of Environmental Technology,
Federal Universities of Technology,
P.M.B.507, Akure, Ondo State.
Nigeria.
olufunkhe_holla@yahoo.com

Okolie Kevin C.
Department of Building,
Faculty of Environmental Sciences,
Nnamdi Azikiwe University,
Awka, Anambra State.
kevinokolie@rocketmail.com

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 serves as a remedy to low productivity issues and facilitates proper delivery of projects in Federal Universities in South-West, Nigeria. The paper appraises the prevalence of BIM for effective implementation of building projects delivery in South-West, Nigeria. The study adopted mixed method; which is a combination of field survey (questionnaires and interviews), the sampling frame for the study includes 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, hypothesis were tested using Pearson correlation. Findings showed that out of 11 itemized construction operation only safety management were preferred using the traditional method by the building professionals in physical planning units of various institutions with RII of 51.11% and a mean value of 2.556 on a 5 point likert scale while BIM were highly preferred in all the itemized construction operations with mean values ranges from 3.817 to 4.281 and RII of above 75%.The study concluded that construction projects required good collaboration and proper information exchange among all involved stakeholders due to the nature of the industry. Adoption of BIM will ensures interface and effective information exchange among the professionals and phases in the project. The paper recommended that the use of BIM tools for construction projects will lead to effective project delivery to time, cost and quality which will lead to project success and reliable assessment.

***Keywords**: Construction industry, fragmentation, Building Information Modeling, Traditional Method, Professional.*

1.0 Introduction

Building has evolved through many centuries, from dwelling in caves to skyscrapers and recently to intelligent structures that can smartly respond to stimuli in its environment (Azhar, 2010). Kiviniemi, Fischer and Bazjanac (2005) observed that building practice has also undergone a great deal of metamorphosis in response to the dynamic nature of human needs and development. This submission was corroborated by Grillo (2010) that building design and construction are processes which traditionally involve several professionals collaborating for relatively short periods to develop a facility for use over a long period. However, most of the building designs have failed to meet user's requirements and functionality leading to inefficiencies in terms of performance of the construction industry.

However, construction industry has been noted for lagging behind other industries in terms of project delivery for the past decade (Eastman, Teicholtz, Sacks andListon, 2008). This could be adduced to non-collaborative efforts of stakeholders and the fragmented nature of the building processes. This view was in line with Sommerville, Craig and McCarney (2004) that the construction industry is highly inefficient and relies heavily on traditional means of delivering its products and services.

Furtherance to this assertion, the report of the study undertaken by the National Institute of Standards and Technology (NIST, 2004) in America assessed the cost of these inefficiencies. The study revealed that the price of new construction was increased by $6.12 per square meter due to inefficiencies within the industry. However, in 2004, a study was carried out by Construction Institute/Lean Construction Institute suggested that as much as 57% of time, efforts and material investment in construction projects does not add value to the final product delivery in comparison to a figure of only 26% in the manufacturing industry.

Moreover, project owners are becoming increasingly focused on deriving more value on their investment; they are aware of the consequences of late delivery, low productivity issues, technological advancement and the demand changes. Furtherance to this concern the Construction Users Round Table (CURT, 2007) generated two white papers urging significant changes throughout the construction processes and recommended the need for consideration of new methods of building project delivery. Many building owners as well as other institutions and corporate organizations shared the frustrations associated with the traditional methods of construction. This is evidence in the increase in the number of projects completed using alternative delivery methods. This demonstrated building owner's dissatisfaction with the traditional Design-Bid-Build process. This view was corroborated by CURT (2007) on the difficulties experienced on typical projects as "artifacts of a construction process fraught by lack of cooperation and poor information integration."

The submission highlighted typical problems as design errors, omissions, inefficiencies, coordination problems, cost overruns, delay and productivity loses. The study attributed historical reasons for this dysfunctionality to be multiplicity of participants with conflicting interests, incompatible cultures among team members and limited access to timely information. Tam, Tam, Zeng and Ng (2007) submitted that building process can be grouped into three major phases as: the conception/design phase, construction phase and operation or user phase. The conception/design phase could be described as the period when most of the decisions that influence the performance of the building are conceptualized; the construction phase represents the actualization stage when the capital cost of construction is incurred; and the operation or user phase account for the greatest proportion of time period of the building life span relative

to earlier two phases. These phases resulted into the fragmentation of the construction industry. This fragmentation process inhibits widespread change in the building industry. Hence the need for this study is to appraise the prevalence of BIM for effective implementation to enhance public building projects delivery in South-West, Nigeria.

2.0 Literature Review

2.1 An Overview of 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 organizations multi-disciplinary teams are clashing with traditional methodologies (e.g. business models, processes, legal and compensation schemes, 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).

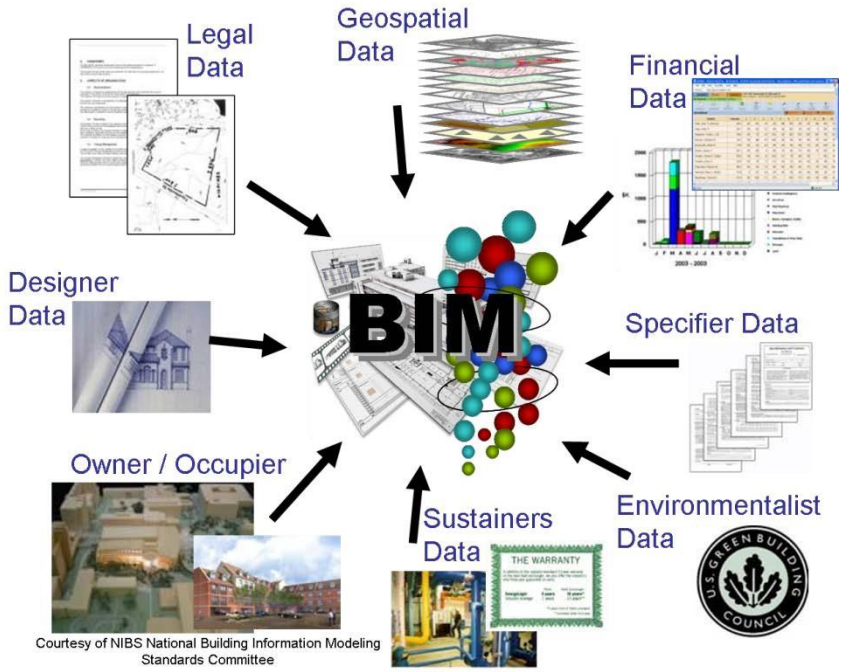

Figure 3.2: Communication, Collaboration and Visualisation with BIM model
Source: (NIBS, 2008),

Demchak *et al.,* (2008) defined Building Information Modeling (BIM) as process and practice of virtual design and construction throughout its lifecycle. It is a platform to share knowledge and communicate between project participants. In other words, Building Information Modeling is the process of developing the Building Information Model.

3.0 Methodology

The study adopted questionnaire survey 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. The inferential 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.

4.0 Data Presentation and Analysis

4.1. Demographic Information

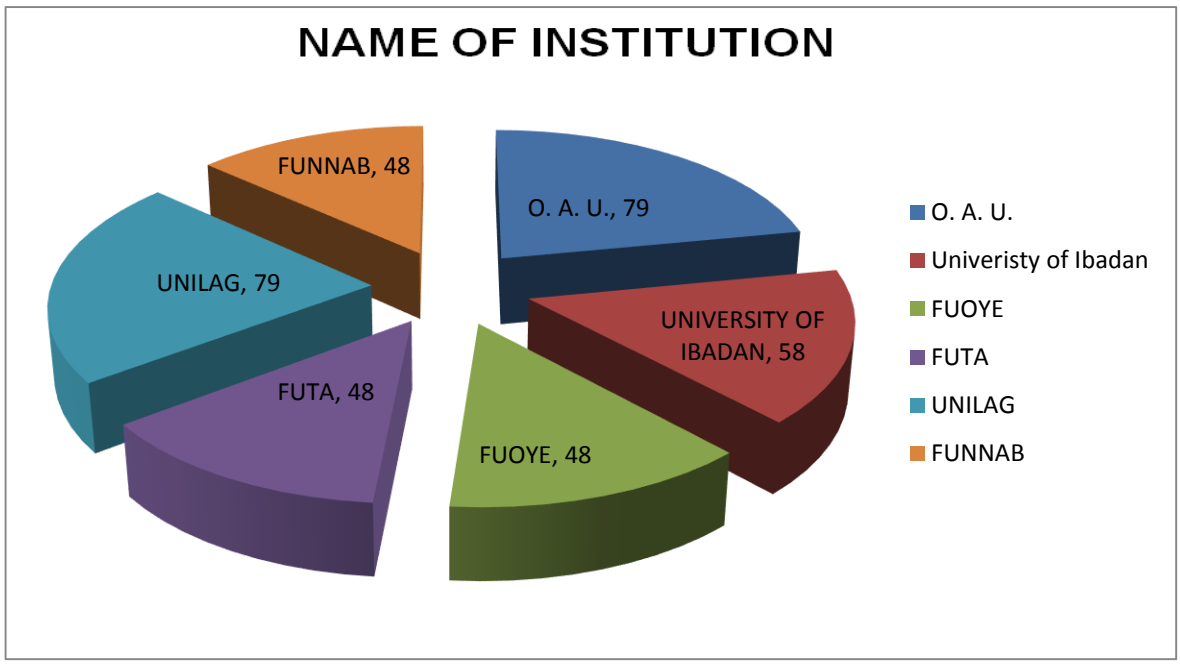

Figure 4.1: Name of Institutions

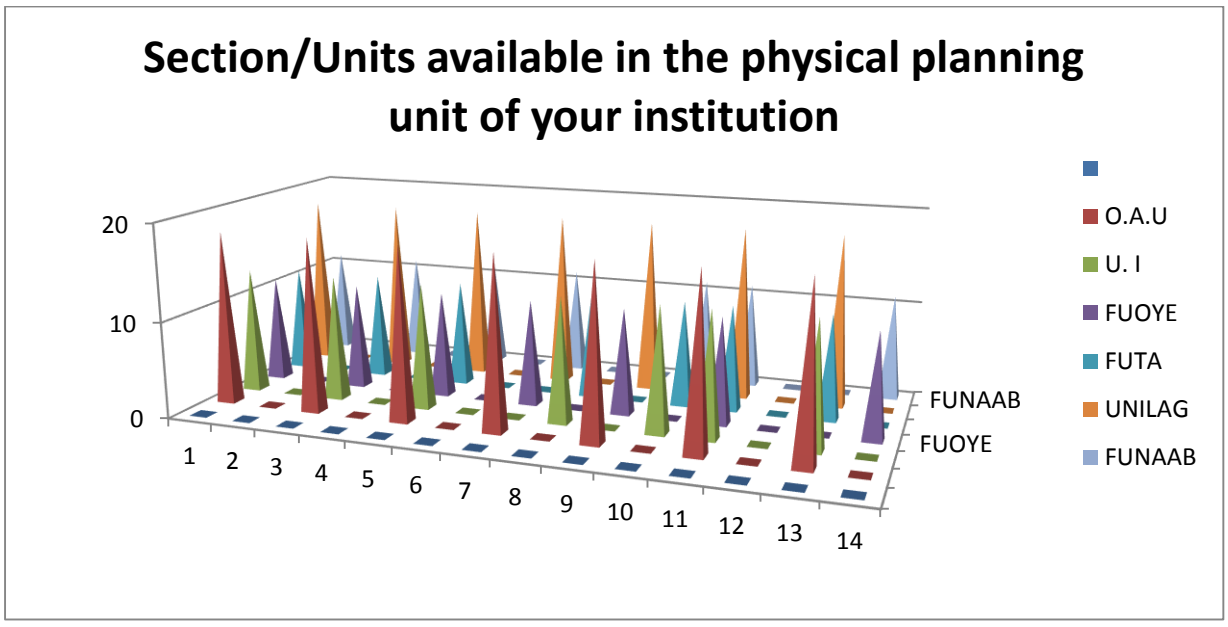

Figure 4.2 Section/Units available in the Physical Planning Units

Figure 4.1 shows the pie-chart of the background of the respondents. This indicated that79^{o}of the respondents were from Obafemi Awolowo 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 4.2 indicated that all the physical planning units surveyed have sections/units of Architecture, Building, Engineering and Quantity Surveying.70.73% indicated that Estate

Management are available in the physical planning unit of OAU, FUOYE, UNILAG and FUNAAB while 29.27% noted that the same is not available in UI and FUTA. Moreover 57.32% noted that GIS is available in the physical planning units of OAU, FUOYE and UNILAG while 42.68% noted that the same is not available in UI, FUTA and FUNAAB. Finally 73.17% indicated that Urban and Regional Planning is available in the physical planning unit of OAU, UI, FUTA and UNILAG while 26.83% noted that same is not available in FUOYE and FUNAAB. 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.

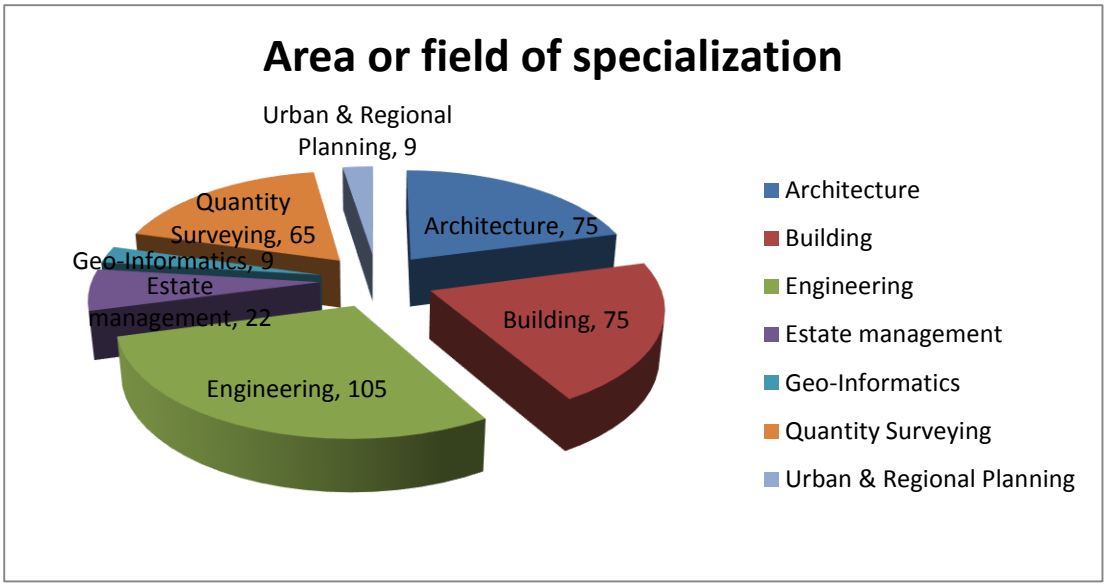

Figure 4.3: Area of Specialization

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.

Table 4.1: 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**		

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 4.1 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 5.2 also indicated that the respondents have had more than 10 years of experience on the job.

Furthermore Table 4.2 reveals the professional affiliation of respondents. This indicated that 18.29% of the respondents were professional members of the Nigerian Institute of Architect while 2.44% were fellows of the Institute. 19.51% were professional members of the Nigerian Institute of Building while 1.22% is fellows of the Institute. 28.05% are professional member of the Nigerian Society of Engineers while 1.22% is fellows of the professional Institute. 6.10% are professional members of the Nigerian Institute of Estate Surveyors are Valuers, 2.44% were professional members of the Nigerian Institute of Surveyors and Nigerian Institute of Town Planners, 18.29% were professional members of the Nigerian Institute of Quantity Surveyors.

Summarily, 95.12% of the respondents were affiliated to their various professional bodies while 4.88% were fellows of the various Institutes.

Inference from the analyzed data of Figure 4.3 and Tables 4.1 to 4.2 shows the quality of professional personnel in the physical planning unit in terms of area of specialization, academic qualification, years of experience and competence. This implied that tertiary institutional building projects executed by the physical planning units in the study area have been monitored by qualified and experienced professionals from time to time.

Table 4.3: Relationship between Traditional (Conventional) Method and BIM on Site Construction Operation.

Traditional Method									BIM Method							
Construction Operation	**Response**					**Descriptive**			**Response**					**Descriptive**		
	1	**2**	**3**	**4**	**5**	**Mean**	**Rank**	**RII(%)**	**1**	**2**	**3**	**4**	**5**	**Mean**	**Rank**	**RII(%)**
Safety management	26	14	21	10	10	2.556	1	51.11	3	7	21	22	29	3.817	11	76.34
Construction methodology	29	20	16	9	7	2.321	2	46.42	2	6	18	19	38	4.024	6	80.48
Planning and Scheduling	27	23	17	11	3	2.259	3	45.19	0	10	15	25	33	3.976	9	79.52
Construction progress tracking and control	27	23	17	11	3	2.259	4	45.19	2	5	12	26	38	4.121	4	82.41
Layout planning and site management	32	19	19	3	9	2.244	5	44.88	3	7	12	24	37	4.024	6	80.48
Project meeting and discussions	32	19	17	8	6	2.232	6	44.63	2	5	21	22	32	3.939	10	78.78
Targeted output vs Actual output	27	26	22	3	4	2.159	7	43.17	2	1	18	32	30	4.048	5	80.96
Project management	33	23	9	9	5	2.114	8	42.28	0	3	14	22	43	4.281	1	85.61
Claim analysis and dispute resolution	35	23	10	5	8	2.111	9	42.22	3	6	15	22	37	4.012	8	80.24
Project documentation	33	26	11	7	4	2.049	10	40.99	0	7	12	22	41	4.183	2	83.66
Overview of project plan	33	27	13	5	4	2.024	11	40.49	2	4	12	28	36	4.122	3	82.44
						2.212		44.23						4.050		80.99

Table 4.3 shows the relationship between traditional approach and BIM approach and was explained as follows:

Table 4.3.1 Safety management

Traditional approach using compliance with statutory laws, work ethics with a mean score of 2.556 was preferred while BIM approach incorporated into with a mean score of 3.017 was highly preferred for construction projects more than traditional method

Table 4.3.2 Construction methodology

Traditional approach based on sequence of site activities and paper documentation with a mean score of 2.321 while BIM approach using digital visualization of site activities with a mean score of 4.024 was very highly preferred for construction operation for effective delivery of building projects.

Table 4.3.3 Planning and scheduling

Traditional approach using schedule and bar chart with a mean score of 2.259 is preferred while BIM approach using link schedule to 3D model with a mean score of 3.976 is highly preferred. The BIM approach using planning and scheduling for construction operation processes in the physical planning unit will deliver building projects to time, cost and quality.

Table 4.3.4 Construction progress tracking and control

Traditional approach using bar chart colouration and progressive representation with a mean score of 2.259 was preferred for construction operation while BIM approach using automation of models to reflect update and progress with a mean score of 4.121 are very highly preferred for effective delivery of building projects in PPU of their institutions.

Table 4.3.5. Layout Planning and Site Management

Traditional approach based on compliance with statutory law work ethics with a mean score of 2.244 was preferred while BIM approach incorporated into the project models with a mean score of 4.024 was very highly preferred for construction operation in effective delivery by projects of projects to time more than Traditional method approach.

Table 4.3.6 Project meeting and discussions

Traditional approach with a mean score of 2.232 will be preferred using paper documentation and chain information sharing with a mean score of 3.939 was highly preferred for construction project as proper dissemination of information will be done very fast and also it will be received to time and this will lead to effective delivery of building projects in their physical planning unit.

Table 4.3.7 Targeted output Vs Actual output

Traditional approach with a mean score of 2.159 is not preferred using bar chart comparison while BIM approach using visual comparison of models with a mean score of 4.048 are very highly preferred for construction operation and in effective delivery of building projects in their physical planning units.

Table 4.3.8 Project Management

Traditional approach leads to fragmentation among team members with a mean score of 2.114 was preferred for construction operation while BIM approach allows integration among project team members with a mean score of 4.281 was very highly preferred for effective delivery of building projects to time, cost and quality.

Table 4.3.9 Claim analysis and dispute resolution
Traditional approach based on condition of contract with a mean score of 2.111 was preferred for construction operation while BIM approach based on collective responsibility with a mean score of 4.012 was very highly preferred for effective delivery of building projects.

Table 4.3.10 Project Documentation
Traditional approach using analog with a mean score value of 2.049 was not preferred for construction projects while BIM approach using digital with a mean score of 4.183 was very highly preferred for construction projects than Traditional method in project delivery.

Table 4.3.11 Overviews of project plan
Traditional approach using project network analysis with a mean score of 2.024 was preferred for project execution while BIM approach using digital representation of project network analysis with a mean score of 4.122 was very highly preferred for construction operation.
The findings revealed that the most preferred construction operation using BIM for project execution that affects the performance and delivery of projects are all the itemized construction operations while traditional approach least preferred construction operations are dispute resolution, project documentation and overview of project plan with mean score of 2.11, 2.049 and 2.024

The table showed that out of 11 itemized construction operation only safety management were preferred using the traditional method by the building professionals in physical planning units of various institutions with RII of 51.11% and a mean value of 2.556 on a 5 point likert scale of measurements while BIM were very highly preferred in all the itemized construction operations with their mean values ranges from 3.817 to 4.281 and RII of above 75%. The table further revealed in general that BIM were very highly preferred to Traditional Method with an RII of 80.99% to 44.23% as indicated by the respondents. Conclusively, using BIM approach will improve the rate of delivery of projects to time, quality and cost.

Test of Hypothesis
Hypothesis was formulated to test if there is any relationship between Traditional 2D (conventional method) and cost of implementing BIM .The hypothesis was tested using Pearson correlation method of 0.05 level of significance.

Hypothesis Set Up
H_O: There is no significant relationship between traditional 2D (conventional method) and cost of implementation BIM
H_I : There is significant relationship between traditional 2D (conventional method) and cost of implementation BIM

Table 4.4: Pearson Correlation of Traditional 2D (Conventional Method) and Cost of Implementation BIM

Variable	N	Mean	SD	*R*cal	*R*tab
Traditional 2D conventional method	82	13.805	15.610	0.447*	0.217
Cost of implementation BIM	82	15.634	6.153		

*significant $p<0.05$

Table 4.4 shows the mean value of traditional 2D (Conventional method) as 13.81 ,with standard deviation of 15.61 while cost of implementation of BIM with mean value of 15.63 with standard deviation of 6.15, that *r* calculated (0.447) is greater than r tabulated (0.217) at 0.05 level of significant thus it reveals the level of significant. Thus, the null hypothesis was rejected. Therefore, there is significant relationship between traditional 2D conventional method and cost of implementation BIM.

4.2 Discussions of Findings

Findings revealed that out of 11 itemized construction operation, only safety management were the most preferred using traditional method by the building professionals in physical planning units of various institutions with Relative Important Index of 51.11% with mean value of 2.556 on a 5 point likert scale of measurements while BIM were highly preferred in all the itemized construction operations with their mean values ranges from 3.817 to 4.281 and RII of above 75%. However, BIM were highly preferred to Traditional Method with Relative Important Index of 80.99% to 44.23% as indicated by the respondents. Conclusively, using BIM approach will improve the rate of delivery of projects to time, quality and cost in the physical planning units of the universities.

Conclusion and Recommendation

Conclusively, construction projects required good collaboration and proper information exchange among all involved actors due to the collaborative nature of the industry. Traditionally this exchange was made in the form of drawings and documents while the adoption of BIM will ensures interface and effective information exchange between different actors and phases in the project. The paper recommended that the use of BIM tools for construction projects will lead to effective project delivery to time, cost and quality which will lead to project success and reliable assessment.

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