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Critical Barriers of Building Information Modeling (BIM) adoption and BIM Maturity Level in Nigeria:Experts Perception

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ABSTRACT

This paper presents an expert perception of empirical investigation into the barriers of building information modeling (BIM) adoption and maturity level in Nigeria. Nigeria is the largest African country with potentials for construction and building investment. However, since the proliferation of BIM in most countries, it appears that the rate of adoption is poor and where there is an adoption, the maturity level seems to lag. This paper therefore used cross-sectional survey research method and thus random sampling technique; however, principal component analysis were employed for dimensionality reduction of variables at eigenvalue of 1, after which a set of multiple linear regression of the factors were being considered and analysed using SPSS version 23 for ease of computation. The result of the research shows that BIM adoption in the country still remains at an unacceptable level and top among the critical barriers to adoption of BIM in Nigeria is not the presumed challenge of electricity and internet connectivity, but rather lack of highly skilled cross trained staff with both construction and IT skills. Finally, the construction industry in Nigeria may not keep to track to global best practices and technological advancement as regards BIM, if they still battle with issue of adoption and do not improve in experts and firms BIM maturity level.

Keywords: Building Information Modeling, Construction, Adoption, Maturity Level**.**

1. INTRODUCTION

The construction industry is a labour-ladened sector and has remained significantly unchanged for many years. A lot of technical developments have been made in the construction industry over the years [. As a result, construction workers depend on large-scale construction equipment to execute projects, and computer systems to aid in planning, forecasting, and organizing construction operations, all of which are crucial in deciding whether or not a construction project will be viable and if the construction firm can remain in operation [2].

It is no longer surprising that interdisciplinary integration in Nigeria's construction industry have been weak over the years, painting a negative picture of an enterprise that has had to deal with the segmentation problem over the years. Not only has this segmentation lead to haphazard implementation and unregulated project efficiency, but the regular coordination breakdowns have also contributed to escalated costs and extended project execution time. It is the strong reliance of many construction companies on traditional means of communication, such as the exchanging of drawings and related paper records that underlines the need for the Building Information Modeling (BIM) method to be adopted in modern projects [3].

BIM is a process of integrating and disseminating information around a network of project team members. It enables the project team to work simultaneously on a project in real time and to construct a building directly from a digital model [4]. [5]opined that any process and technology that allow the geometrical modeling, input of information and generate a methodology to manage the essential building design and project data in digital format can be referred to as BIM. BIM provides an integrated system that can be used to simulate the behaviour of buildings in a real-world system, provide information about quantities and properties of building elements and documents design information in an integrated database [1][6]. [7] observed that BIM is significantly altering the way that the Construction Industry creates and cares for its assets; mostly because it allows the identification and reduction of errors and design conflicts before they actually happen and reduces process waste by eliminating rework.

BIM has tremendous promise. For example, [8] defined some of their ability to include: value added project delivery; design and development integration; effective communication; and enhanced building processes. Similarly, [9]assert that BIM is a powerful design, project, construction and facility management tool that ensures coordination among project stakeholders. In the same vein BIM will improve competitiveness and efficient cooperation among stakeholders [10]. Despite the outstanding capabilities of BIM, so many developing countries are yet to adopt it. However, its adoption and application in Architecture, Engineering and Construction (AECs) industry in sub-saharan Africa and precisely Nigeria, appears bleak and thus most studies cannot empirically account for its level of adoption and the stage/level where Nigerian construction world operates BIM[11][12]. The question now is - what are the possible reasons for its non-adoption? [13] asserted that identifying the barriers to BIM's adoption could enhance its acceptance.
For the construction industry in Nigeria to grow, the adoption of BIM is non-negotiable; and for adoption to be easy and readily possible, there is a great need to empirically identified not just the barriers but the critical barriers of BIM adoption tailored for Nigeria and capturing the Nigeria construction business environment; thereby proffering sustainable solutions and this therefore necessitated the study.

Aim of the Study
The aim of the study is to determine expert perception of empirical investigation into the critical barriers of building information modeling (BIM) adoption and maturity level in Nigeria.
Therefore, to overcome these barriers, answers are to be provided to the following research objectives:

1. To identify the critical barriers of adopting building information system in construction project management service delivery in Nigeria.
2. To assess the effect of each barrier in adopting BIM in Nigeria.
3. To identify the current BIM maturity level operated in Nigeria
4. To identify and assess existing approaches in overcoming barriers to adopting Building Information Modeling in Nigeria.

To the best of our knowledge, this is the first paper to attempt this approach to unraveling the BIM maturity level in Nigeria. The rest of the paper is arrange as thus:

2. METHODOLOGY
A key component of statistical analysis is data collection. Primary and secondary data are the two categories into which many information-gathering techniques in research fall [14]. As the name implies, primary data is information that the researcher gathers for the first time, whereas secondary data is information that has already been gathered or created by others [14]. Both primary and secondary sources derived the data used for this study. The primary data was obtained by means of a systematic close-ended questionnaire and the secondary data was obtained from the related literature which the researcher checked. A total number of 60 structured questionnaires were sent to construction professionals in five (5) cities of South Eastern Nigeria namely Owerri, Awka, Enugu, Abakiliki and Umuahia who are practicing as Construction Engineers, Quantity Surveyors, Construction Managers, Architects, Facility Managers, Project Managers, or Academics. The questionnaire was designed based on the information that was gathered during the literature review. A 5-point likert type scale was used for the questionnaires. This scale measured the extent to which the respondents agreed or disagreed with the factors presented to them. A random sampling method was adopted for the purposes of this research. This method was preferred since it gave all the targeted respondents an equal chance and opportunity of being selected [15].
The data were then analyzed using the Statistical Package for the Social Sciences (SPSS) version 23; with the frequencies. Then principal component analysis of factor analysis were conducted to reduce the large set of variables that we had to a small set that still contains most of the information in the original variables or large, thus giving us a dimensionality reduction, after which a set of multiple linear regression of the factors were being considered. The next section of the article presents the findings of the survey and some discussions.

3. RESULTS AND DISCUSSION
3.1 Demographic Profile of Respondents
Table 1 belowdepicts the details of the respondents involved in the survey. The details include their gender, profession and specialization.

Table 1: Demographic Profile of Respondents

Item	Characteristics	Frequency	Percentage (%)	Total
Gender	**Male**	48	80	
	Female	12	20	60
Profession	**Architecture**	12	20	
	Civil/Structural Engineering	19	31.7	
	Building Engineering	3	5	
	Mechanical Engineering	6	10	
	Electrical Engineering	6	10	
	Quantity Surveying	9	15	
	Construction/Project Management	5	8.3	60

Specialization	**Contractor/Construction**	24	40	
	Designer/Consultant	26	43.4	
	Client	5	8.3	
	Development Authority/Government Agency	5	8.3	60

The table shows that majority of the respondents are of the male gender, which confirms the gender difference in the construction industry in Nigeria. Furthermore, the table reveals that majority of the respondent's specialization are the designer/consultant and contractor/construction categories.

3.2Respondents BIM Awareness and Usage 2022, 2023 and 2024

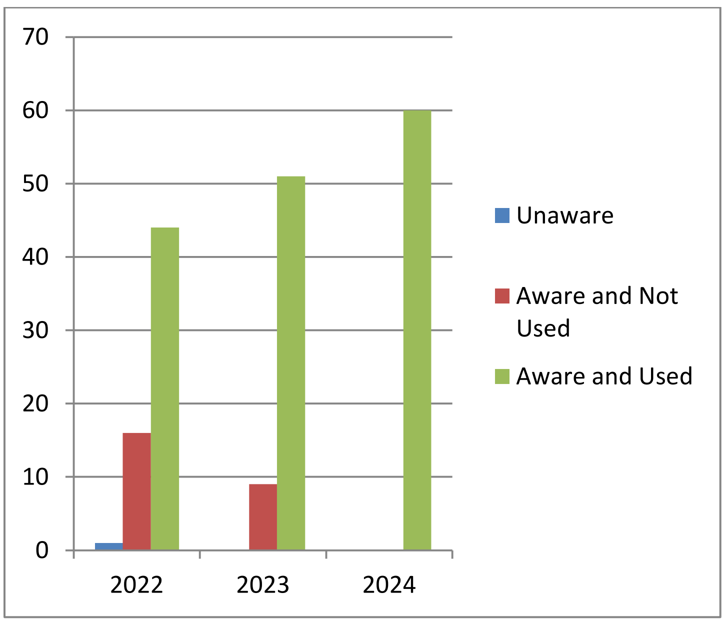

Figure 1: Chart showing the BIM Awareness and Usage by Respondents for Three Years Span

Figure 1 above reveals that firstly, the respondents which are a sample representation of the entire professionals in the industry in Nigeria have been aware of the concept of BIM, however, as the year progressed; the professionals do not only get aware of the concept but rather use it for jobs in their expertise. But the latent question remains that at which maturity level of BIM are they operating, and do they use it? This question is answered below in this study.

3.3 BIM Maturity Level in Nigeria

Table 2: BIM Maturity Level in Nigeria

	0% Adoption	1-25% Adoption	26-50% Adoption	51-75% Adoption	76-100% Adoption
BIM Maturity Level 0 (Unmanaged CAD)	0	0	0	0	60
BIM Maturity Level 1 (Managed CAD)	0	0	0	0	60
BIM Maturity Level 2 (Managed 3D CAD)	0	0	0	18	42
BIM Maturity Level 3 (Integrated BIM)	0	39	21	0	0
BIM Maturity Level 4 (Integrated BIM with Data Integration)	45	15	0	0	0
BIM Maturity Level 5 (Integrated BIM with Artificial Intelligence)	60	0	0	0	0
BIM Maturity 6 (Digital Twin)	60	0	0	0	0

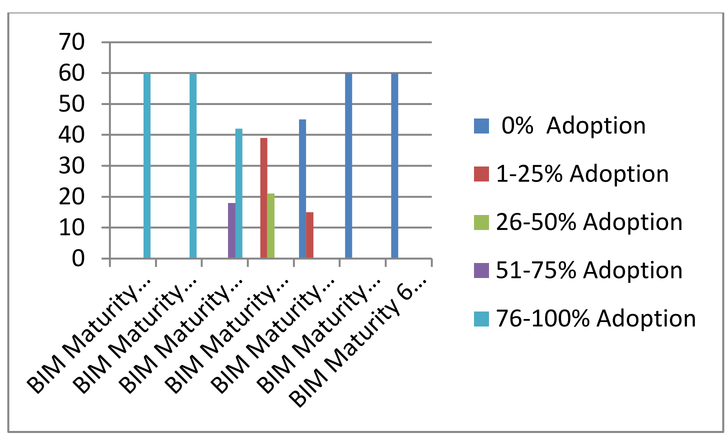

Figure 2: Chart showing BIM maturity level in Nigeria

Currently there are six BIM maturity levels globally, this maturity levels refers to the stages of adoption and implementation of BIM in an organization, project or nation. Based on [16] BIM Maturity Model, the six maturity levels are Level 0 (Unmanaged Computer Aided Design (CAD)), at this level, there is no standardized process or protocols for CAD data management with limited collaboration and data sharing. From table 2 and figure 2 above, all the experts (60 of them) affirm that the AEC industry in Nigeria has an adoption rate of 76-100% maturity in this level. This depict that there is full adoption of this level/stage by professionals, project organizations and firms in AEC in industry in Nigeria. The second level which is level 1 (Managed CAD) connotes standardized process or protocols for CAD data management with basic data management and collaboration and from the results, all the experts also affirm that the AEC industry in Nigeria has an adoption rate of 76-100% maturity in this level. This means that the AEC industry in Nigeria has passed the BIM maturity level 1. However the result reveals that the AEC industry in Nigeria is currently at BIM maturity level 2 which is the stage of managed 3D CAD with a widespread adoption of 3D CAD modeling and a standardized data management. Out of the 60 experts, 18 affirm that the AEC industry in Nigeria has an adoption rate of 51-75% of BIM maturity level 2 while 42 affirm that the AEC industry in Nigeria has adoption rate of 76-100% of BIM maturity level 2. For BIM maturity level 3 (Integrated BIM) which is full implementation of BIM across organizations and the use of BIM for construction sequencing, cost estimation and facilities management etc, 39 out of the 60 experts affirm that the AEC industry in Nigeria is still within adoption rate of 1-25%, while 21 indicate that the adoption rate in this level is within 26-50%. This is a clear indication that the general adoption rate of BIM maturity level 3 in Nigeria is relatively low, and as such inference can be drawn on this premise stating that the AEC industry in Nigeria has only achieved commendable adoption of BIM maturity level 2. With this inference, further results in table 2, figure 2 in appendix shows that for BIM maturity level 4 which is integrated BIM with data integration (integrating BIM with other data sources such as sensors, FM systems, GIS etc), AEC industry in Nigeria has more 0% adoption rate than 1-25% adoption; and for maturity level 5 (Integrated BIM with AI- use of AI machine learning to automate BIM processes, use of robotics, UAVs, IoTs with BIM and maturity level 6 (Digital Twin- digital replica of buildings, real time monitoring with IoTs, design accuracy etc); the experts indicate that the AEC industry has 0% adoption rate.

3.4 Variables Dimensionality Reduction

A multivariate analysis of Principal Component Analysis was used to reduce the big set of variables to a small set that still contained the majority of the information in the original variables or large set. As an eigenvector-based multivariate analysis, it was frequently used it to reduce the dimensionality of the variables, concentrating on its three four key areas: variance explanation with eigenvalue, KMO and Bartlett's test, determinant of correlation matrix, and scree plot.

Because none of the correlation matrix's eigenvalues are non-positive numbers, the test result revealed that the correlation matrix is not a non-positive definite (NPD), implying that there are no linear dependencies between the variables and that there are no more variables in the analysis than cases. The determinant correlation matrix was 0.04, which above the permissible limit of 0.001 (see table 3 below):

Table 3: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.614
Bartlett's Test of Sphericity	Approx. Chi-Square	962.574
	Df	300
	Sig.	.000

Table 3 above presents two tests that demonstrate the data's eligibility for structure detection. A statistic known as the Kaiser-Meyer-Olkin Measure of Sampling Adequacy shows what percentage of the variance in our variables may be due to underlying causes. In general, high scores (around 1.0) suggest that a factor analysis might be helpful for our data. It is likely that the factor analysis results will not be very helpful if the value is less than 0.50. But according to table 3, the study's sample size is sufficient and may thus be used for factor analysis, as shown by the KMO measure of sampling adequacy of 0.614.

Table 4: Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.998	23.990	23.990	5.998	23.990	23.990	3.135	12.539	12.539
2	2.655	10.621	34.611	2.655	10.621	34.611	2.686	10.743	23.282

3	2.491	9.963	44.574	2.491	9.963	44.574	2.601	10.405	33.687
4	1.748	6.991	51.565	1.748	6.991	51.565	2.093	8.374	42.060
5	1.708	6.834	58.398	1.708	6.834	58.398	2.026	8.105	50.165
6	1.527	6.109	64.508	1.527	6.109	64.508	1.903	7.613	57.778
7	1.206	4.822	69.330	1.206	4.822	69.330	1.897	7.590	65.368
8	1.114	4.457	73.787	1.114	4.457	73.787	1.545	6.180	71.548
9	1.089	4.356	78.143	1.089	4.356	78.143	1.398	5.590	77.138
10	1.017	4.066	82.209	1.017	4.066	82.209	1.268	5.071	82.209
11	.780	3.119	85.329						
12	.598	2.390	87.719						
14	.476	1.906	91.959						
15	.421	1.685	93.645						
16	.349	1.395	95.040						
17	.298	1.193	96.233						
18	.255	1.019	97.253						
19	.190	.759	98.011						
20	.158	.632	98.643						
21	.137	.549	99.192						
22	.105	.420	99.612						
23	.046	.182	99.794						
24	.037	.149	99.943						
25	.014	.057	100.000						

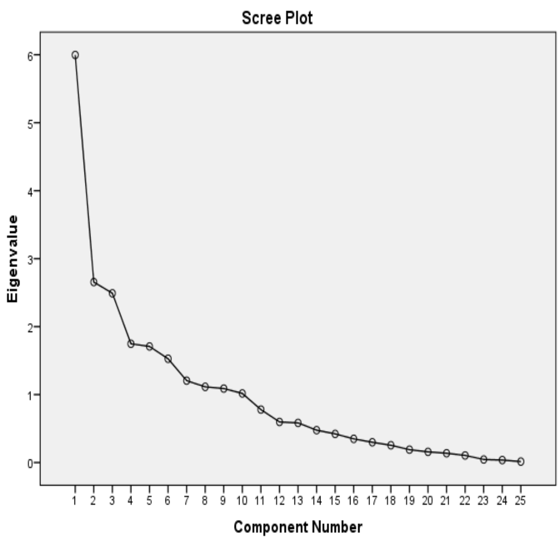

Figure 3: Screen Plot showing the eigenvalue of factors reduced to ten from twenty-five using eigenvalue set at 1 as benchmark

Furthermore, from table 4 and figure 3 above, the obtained factors reduced to ten (10) factors from original twenty five (25) factors. Since eigenvalue was set at 1 as benchmark, therefore all factors with eigenvalue from the benchmark and above was considered not multi-colinear and will serve as the independent variables of the study. The scree plot further x-rayed this outcome; therefore, the factors considered by results are listed below in table 5 with bold characters.

Table 5: Component Matrix[a]

	Component									
	1	2	3	4	5	6	7	8	9	10
1.The lack of highly skilled cross trained staff with both construction and IT skills	.175	.198	.367	-.251	-.494	-.442	.006	.133	.311	-.002
2.Poor State of Electricity	.681	.022	.259	-.310	-.336	-.266	.041	-.009	.115	.053
3.Poor and low-speed internet connectivity	.618	-.153	-.164	.119	.383	-.255	.169	-.228	-.129	.378
4.Interoperability risks between different programs used	.025	-.109	-.133	.263	.593	-.517	.041	.122	.153	.261
5.Lack of standardization and Protocols	.021	.218	.366	.169	-.005	.571	.464	-.075	.291	.019
6.Lack of Political Will/ Government Participation/Support	-.686	.154	.030	.397	.159	.026	.085	.013	.319	.072
7.Lack of Object Libraries for Nigerian Environment	.589	-.213	-.160	-.380	.022	-.055	-.173	.119	.187	.040
8.Lack of Cyber-Physical Systems Infrastructure	.334	-.015	.218	-.133	-.266	.191	.514	.230	-.081	.264
9.Industry Cultural Resistance	.395	-.263	-.262	.033	.294	.189	.210	.189	.007	-.591
10.High Investment Cost	.630	-.342	-.161	.328	-.205	.085	.082	.232	.031	.044
11.Clash of Detection	.445	-.067	-.212	.667	-.251	.067	.025	.257	.016	.054
12.Non adoption of Internet of Things (IoTs) in Nigeria Industry space	.364	.809	-.081	.145	.110	.110	-.162	-.126	.229	-.054
13.Clash of Ownership of BIM Data	.099	.797	-.231	-.118	.019	-.023	.064	.235	-.305	.048
14.Design Delegation and Professional Responsibility	.464	-.072	-.453	-.083	.029	.284	-.108	.070	.258	.355
15.Intellectual Property	.26	-.1	-.6	-.2	-.0	.24	-.2	.34	.25	.00

Issue	8	30	13	58	22	2	73	8	7	2
16.Insurability Issue	.575	-.143	-.223	-.311	.199	.119	.082	-.352	-.121	-.234
17.Lack of BIM skills	.553	-.036	-.014	.548	-.336	-.129	-.197	-.161	-.136	-.173
18.Lack of BIM training	.795	-.097	.054	.246	-.256	-.039	-.114	-.311	-.053	-.030
19.Conspiracy Theory of 5G Network	.503	.651	-.041	.057	.089	.045	-.188	-.235	.292	-.061
20.Fear of change	.252	.661	-.165	.001	.035	.018	-.019	.289	-.465	.051
21.Data Translation Issue	.768	.020	-.145	-.128	.045	-.020	.345	-.206	-.102	.083
22.Reluctance of Some Stakeholders to use BIM	.384	.224	.008	.000	.242	-.448	.389	.171	.263	-.327
23.BIM software availability Issue	.383	-.120	.541	.119	.181	-.115	-.188	.365	-.090	-.149
24.Lack of collaboration among Stakeholders	.501	-.062	.659	-.042	.383	.225	-.182	.090	-.074	.081
25.Lack of Additional Project Finance to Support BIM	.539	-.028	.653	-.023	.290	.253	-.235	.069	.014	.078

3.5 Critical Barriers to BIM Adoption in Nigeria

3.5.1 Regression Result

Table 6: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.953	.909	.900	.64550	.909	107.728	9	50	.000

Considering table 6 above, it reveals that the Multiple Regression Coefficient "R" is 0.953 which indicates a high positive relationship between the Dependent variable Y and the Independent variables (X1-X10). R^2 ,which is the coefficient of multiple determination was observed to be 90.9%. The F-Test (ANOVA) table is shown in table 7 below:

Table 7 ANOVA

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	224.433	9	44.887	107.728	.000[b]
	Residual	22.500	50	.417		
	Total	246.933	59			

Considering the ANOVA analysis table displayed in the appendix, the result shows that it stands to determine whether there is a statically significant relationship between the variables stated. From table 6, the significance level is 0.000 which is less than 0.05. This implies that there is statistical significant relationship between the variables.

Table 8: Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
1 (Constant)	-8.632	3.871		-2.230	.030

Lack of highly skilled cross trained staff with both construction and IT skills	.397	.077	.335	5.133	**.000**
Poor State of Electricity	.384	.085	.321	4.934	**.000**
Poor and low-speed internet connectivity	.357	.069	.302	4.521	**.000**
Interoperability risks between different programs used	.368	.066	.686	2.542	**.010**
Lack of standardization and Protocols	-.059	.058	-.129	-1.006	.319
Lack of Political Will/ Government Participation /Support	.221	.051	.210	4.362	**.000**
Lack of Object Libraries for Nigerian Environment	-.067	.069	-.141	-1.211	.332
Lack of Cyber-Physical Systems Infrastructure	.362	.111	.165	2.901	**.000**
Industry Cultural Resistance	.367	.092	.317	4.793	**.000**
High Investment Cost	.353	.128	.177	2.754	**.008**

However, table 8above shows the coefficient of each of the explanatory variablesX1-X10, which are found to be 0.000, 0.000, 0.000, 0.010, 0.319, 0.000, 0.332, 0.000, 0.000 and 0.008 respectively. This result is a further explanation on the ANOVA table. It reveals that X1 (Lack of highly skilled cross trained staff with both construction and IT skills), X2 (Poor State of Electricity), X3 (Poor and low-speed internet connectivity), X4(Interoperability risks between different programs used), X6 (Lack of Political Will/ Government), X8 (Lack of Cyber-Physical Systems Infrastructure), X9 (Industry Cultural Resistance) and X10 (High Investment Cost) with the significance level 0.000, 0.000, 0.000, 0.010, 0.000, 0.000, 0.000 and 0.008 respectively are all variables that are responsible for that significance of the model, and thus are the critical barriers to the adoption of BIM in Nigeria.

Hence, the model is thus summarised in the equation below; Y=-8.632+0.397X1(Lack of highly skilled cross trained staff with both construction and IT skills)+0.384X2(Poorstateofelectricity)+0.357X3(Poor and low-speed internet connectivity) +0.368X4(Interoperabilityrisksbetweendifferentprogramsused)+0.221X6(LackofPoliticalWill/Government)+0.362X8(Lackofcyber-physicalsystemsinfrastructure)+0.367X9(IndustryCulturalResistance)+0.353X10 (High Investment Cost)-------------------------------- (1)

From the analysis of the study, the explained variable, Adoption of BIM (Y), was observed to possess some measures of relationship with the explanatory variables. Adoption of BIM (Y) has a moderate positive relationship (R=0.953) with the explanatory variables (X1-X10). Also, the coefficient of determination value of 90.9% was determined. This statistics explains the variation in Adoption of BIM (Y) by the explanatory variables. This implies that 9.9% variation in Adoption of BIM (Y) is left unaccounted for by the explanatory variables, which could be termed as error in the model. Also, the adjusted coefficient of determination value of 90.0% was determined, meaning that 10% of the variation in Adoption of BIM (Y) is explained by the explanatory variables. Hence, the F-statistics with the value of 107.728 and probability of 0.000 indicates that the independent variables are jointly significant in explaining the variation in the dependent variable Adoption of BIM (Y).

Looking at the model for individual contributions of the independent variables,X1-X4, X6, X8-X10 showed a positive significant relationship with Adoption of BIM (Y)depicting that 1% increase in X1-X4, X6, X8-X10 will cause 0.397%, 0.384%, 0.357%, 0.368%,0.221%, 0.362% , 0.367% or 0.353% increase in Y. Whereas X5 and X7 are not significant.

Therefore the critical barriers to adoption of BIM in Nigeria are ranked in table 9 below:

Table 9: Ranking of the Barrier factors according to their coefficient or impact significance

Variable Designation	Barriers	Rank
X1	Lack of highly skilled cross trained staff with both construction and IT skills	1st
X2	Poor State of Electricity	2nd
X9	Industry Cultural Resistance	3rd
X3	Poor and low-speed internet connectivity	4th
X8	Lack of Cyber-Physical Systems Infrastructure	5th
X6	Lack of Political Will/ Government Participation/Support	6th
X10	High Investment Cost	7th
X4	Interoperability risks between different programs used	8th

4. CONCLUSION

Nigeria is among the developing countries where BIM awareness is increasing over years, but however, BIM adoption in the country still remains at an unacceptable level. This trend tends to affect the progress of the construction industry in Nigeria, especially at this focus of the world construction industry on Industry 4.0 and Construction 4.0 which centers on the use of advanced technology to drive construction, such as Internet of things (IoTs), Cyber-Physical systems, Intelligence systems and unmanned aerial vehicles etc. The obvious truth remains that the industry in Nigeria may not keep to track to global best practices and technological advancement as regards BIM, if they still battle with issue of adoption and do not improve in experts and firms BIM maturity level. However, this study found out that top among the critical barriers to adoption of BIM in Nigeria is not the presumed challenge of electricity and internet connectivity, but rather lack of highly skilled cross trained staff with both construction and IT skills. IT knowledge is sacrosanct to BIM application, and so avoidance or ignorance use of IT tools by construction professionals in Nigeria has hampered on the adoption of BIM in Nigeria.

Furthermore, other barriers like electricity challenge and low-speed internet connectivity also contributed to the failure of adoption, but beyond that is the issue of industry cultural resistance, where most professionals are afraid of change and also most firms delves into phobia for system change. More to all this is the lack of infrastructure for cyber-physical systems in majority of construction firms in Nigeria, where real time monitoring is achieved. The further challenge to cyber-physical systems in the construction industry space in Nigeria is the internet connection which has remained a nightmare to firms in need of real time construction projects management. Currently Nigeria broadband penetration is seemingly not adequate and as such the 4G technology is not yet robust in the country, as the technology currently is operational in few cities in the country. This however is a de-motivation to the application of IoT in BIM which at least requires the 5G network for excellent real time use and monitoring.

The study also found out that due to high cost of procuring many BIM tools and infrastructures such as licensed software, collaborative packages, unmanned aerial vehicles, workstation, facility management infrastructure etc, many firms in Nigeria avoid the adoption of BIM due high cost of investment and lack of government support and political will.

The study recommends that there is need for training and retraining of stakeholders in the built industry in Nigeria to appreciate the need for BIM. Also, the issue of enabling infrastructure such as the internet infrastructure by first boosting the wide coverage of 4G technology all over the 774 local governments of the country and embrace the 5G technology in the country. Construction firms should abhor the industry cultural resistance and embrace the concept and application of industry 4.0 in their project planning, implementation and monitoring systems. Industry 4.0 which is the fourth industrial revolution with digital data as its key component and with increased access to accurate, real –life data throughout all stages of an asset's lifecycle-from design through construction and maintenance; helps to achieve time and cost efficiencies and also reduce errors.

There should be prove of a company's competency in using the BIM during bidding process for government projects in order to qualify for tendering and award for any construction projects.

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