Most Prevalent Barriers to the Implementation and Adoption of Cloud Computing by Construction Professionals in Nigeria

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Abstract:- The construction industry strives for swift, high-quality project completion within budget constraints. Despite leveraging literature and management tools, human decision flaws and collaboration gaps persist, hindering efficiency. The rise of Industry 4.0 in the Architectural, Engineering, and Construction (AEC) sector promises to address these issues. Acknowledging the industry's interconnected nature, a decision support system utilizing cloud technologies becomes essential for streamlined project delivery. This study aims to identify the prevalent challenges hindering the implementation and adoption of Cloud Computing (CC) in the Nigerian construction industry, integrating existing studies, while uncovering established barriers and identifying those tailored to the Nigerian construction ecosystem. Targeting experienced professionals, the research employs structured interviews and questionnaires for data collection, unraveling intricacies through Descriptive Statistics, Exploratory Factor Analysis (EFA), and Relative Importance Index (RII) methodologies. The EFA analysis categorizes identified barriers into technical factors across seven groups: Socio-economic factors, Data Privacy, Security, Governance, Awareness and Knowledge, Services and Infrastructures, Training and Education, and Organizational Culture, Environment, and Trust, offering insights into the underlying structure. Results highlight Access to internet facilities, Cost of cloud services, and Operational costs as primary obstacles to CC implementation. Simultaneously, Unstable economic conditions, Unwillingness of organizations to fund Cloud Services not included in the initial contract, and Absence of power infrastructure emerge as significant impediments to CC adoption by construction professionals in Nigeria. Further data examination confirms a limited adoption of existing cloud technologies, indicating huge potentials once broadband internet barriers are resolved, with Microsoft, Apple, and zohoboxplatforms being prominent market.

Keywords:- *Cloud Computing, Construction, Services, Barriers, Adoption, Implementation, Nigeria.*

I. INTRODUCTION

The field of construction operates as a decentralized, data-driven, and project-centric industry, involving extensive data exchange and processing requirements throughout the product lifecycle, as highlighted by [24]. This necessity spans across various professions and companies, particularly in the realm of building projects, encompassing traditional disciplines like architectural, structural, mechanical, and electrical engineering, as well as emerging subject matter occupations related to environmental science and waste management. Despite the valuable contributions of these disciplines in planning, reconstructing, rebuilding, and operating buildings, as indicated by [8], there exists a notable challenge of fragmentation within these disciplines. This fragmentation is often attributed to the multitude of individual participants, each pursuing their unique objectives. This challenge becomes particularly pronounced in construction projects with diverse stages, leading to conflicts in information management among stakeholders. While many professions, as mentioned by [29], impose stringent data-sharing requirements, the construction industry demands robust data storage and communication among all project stakeholders. Information control systems, such as cloud computing (CC), can be deployed to alleviate challenges related to communication and collaboration among project stakeholders, as suggested by [27]. The rapid advancement of technology, as noted by [15], enables IT-enabled services on a global scale, fostering project convergence and successful knowledge exchange through internet servers and shared databases. Cloud-based data centers, as articulated by [15], offer high-performance processing capabilities by analyzing large volumes of IoT (Internet of Things) data, providing valuable insights for decision-making. Cloud computing is transforming the way individuals, businesses, and governments store, process, and leverage computing power, as emphasized by [19]. With the widespread availability of IT-enabled services like the cloud, facilitated by internet connectivity and shared databases, these technologies are increasingly utilized to enhance the convergence of various project phases and successful knowledge exchange [28].To address the information management challenges among construction project stakeholders, building managers must foster the adoption and integration of new and advanced technologies in construction project management and delivery. This study is designed to achieve four primary objectives: (1) investigate the familiarity of Nigerian construction professionals with existing cloud computing services, (2) explore barriers to the implementation of cloud computing technologies by construction professionals in Nigeria, (3) determine the most prevalent barriers to implementation, and (4) assess the adoption of cloud computing services by construction professionals in the Nigerian construction industry.

ISSN No:-2456-2165

A. Used Cases of cloud computing Technology in Construction.

According to [25], the delivery of cloud computing services, enabling remote access to computing services via the internet using ICT approaches, is deemed feasible in construction. This approach can contribute to achieving building resilience, as highlighted by [15]. Despite being an evolving area with significant potential, cloud services offer various advantages, including economy [30], scalability [16], security [34], storage [5], and collaboration [32], when utilized by construction professionals. Companies in the construction industry actively seek innovative approaches to minimize infrastructure and operating costs, leading to challenges in managing extensive IT infrastructure requiring specialized human resources and training [5]. However, the poor profit margins in the Nigerian construction industry make the cost of hosting a cloud service a potential obstacle to the adoption of IT solutions into construction [33].Cloud computing technology bridges this gap, providing significant economic advantages and allowing construction companies, particularly small and medium enterprises (SMEs), to access high-end computing facilities and applications that would otherwise be too expensive to purchase [14] (Othman et al., 2021). This can result in decreased overall project delivery costs, offering construction businesses competitive and operational benefits, along with increased agility [30]. Through the elimination of ownership and operational expenses, allowing payments only for the service used [8], the scalability and on-demand nature of cloud services present unique advantages to the construction industry [3]. Research conducted by [3] utilized the scalability feature of cloud service to propose a Building Information Modelling (BIM) -Governance model.According to [5], cloud computing enables construction companies to acquire IT resources as services tailored to the specific requirements of each construction project, diminishing the economic feasibility of investing in higher-capacity infrastructure, as traditional capital investments in computing facilities become less essential. This allows the construction industry to access high-performance servers with powerful central processing units (CPUs), graphics processing units (GPUs), and exceptionally fast Solid-state Drive (SSD) drives. As noted by [16], with this potential, SMEs can compete on an equal footing with larger corporations without a significant initial investment. The Architecture, Engineering, and Construction (AEC) sector, characterized by its highly fragmented, data-intensive, and project-based nature, relies on diverse professions and firms with stringent data processing and sharing needs requiring high security measures [2]. However, most construction firms in operation in Nigeria, around 63%, operate as SMEs [2], with over 50% of construction companies unable to afford personal security infrastructure for construction data protection [34].Common cloud security measures include encryption, the use of up-to-date security software, cyber insurance security coverage, security audits, and, notably, Virtual Machines [31], creating a logical abstraction layer that allows applications, operating systems, and system services to function in a conceptually separate system environment. Collaboration in a common data environment is strongly promoted through cloud services, underscoring the significance of teamwork and collaboration among experts for the successful completion of projects [14]. [35] emphasizes the importance of a Common Data Environment (CDE), typically provided as a cloud service, serving as a virtual storage facility for collecting and managing documentation related to building projects, minimizing the risk of misunderstandings and data loss. An example of such a platform is the use of BIM, which [13] suggests is more than just a technical shift but also a process transformation model. CDE represents a BIM Level 2 maturity instrument where 3D models are used to generate project design outputs and managed through various professional platforms. During the planning, construction, and operation stages of a building, project participants share varied information from different domains using agreed procedures, enabling engagement in negotiations, brainstorming, discussions, knowledge-sharing, and collaborative efforts to complete tasks, often aimed at producing an executable deliverable and its supporting artifacts. Table 1 provides an overview of the identified barriers from the literature.

Table 1: Barriers to the Adoption and Implementation of Cloud Computing Technologies

		(Luvara& Mwemezi, 2017), (Dahiru & Abubakar, 2018b), (Bello, S. A., Oyedele, 2021)	**(Yiu et al., 2018), (Othman et al, 2021), (Buniya, M. K., Othman, 2021)**	**(Olanrrewaju et al., 2022), (Akinlabi &Dahunsi, 2022), (Jain et al,. 2014)**	**(Okoye et al., 2014), (Dahunsi&Owoseni, 2014)**	**(petri et al., 2015b), (Buniya et al., 2021), (Luvara, et al., 2017)**
A	**Barriers to the Implementation of Cloud Computing Technology**					
	Access to internet facilities	✓		✓	✓	
	Poor network connection	✓		✓	✓	
	Access to sufficient bandwidth			✓	✓	

		✓				
	Availability of wired service	✓		✓		
	Compatibility of cloud tools and machines	✓		✓	✓	
	Cost of purchase cloud services for construction project management	✓		✓	✓	
	Cost of renting cloud resource for construction operations	✓		✓	✓	
	Cost of data/document/file and information sharing	✓			✓	
	Operational cost of integrating cloud technologies for construction use	✓				
	willingness of construction organizations to bear the additional cost of organizing workshop training for construction workers on Cloud computing technologies				✓	
B	**Barriers to Adoption of Cloud Computing Technology**					
	Storing construction design and financial information in shared resources would pose serious treats to the construction industry			✓	✓	
	Unavailability of data protection strategies to block data leakage			✓	✓	
	The fear of data bridge from service providers	✓		✓	✓	
	Unavailability of data security and privacy laws	✓			✓	
	Discrepancies of ownership of data	✓				✓
	Liberty to share data with another member of the team					✓
	The need to define access level for the different category of stakeholders involved in the production and management of building data					✓
	Lack of contractual provisions to support cloud technologies	✓		✓		
	Regulatory ambiguities from government body				✓	
	Fear of high level of taxation on cloud users in the construction industry				✓	
	Unstable economic situation of the nation				✓	
	Unavailability of government strategies for the adopting of cloud technologies	✓				✓
	Lack of awareness of Cloud Computing Technologies and services by practitioners in the Nigeria construction industry	✓			✓	
	Failure to admit ignorance in certain specialized aspects on project development	✓				
	Absence of demand for Cloud Computing Technologies			✓		✓
	Insufficient studies on Cloud Computing Technologies			✓	✓	
	The availability of cloud service providers			✓	✓	
	Limited cloud service provider in Nigeria				✓	

	Absence of power infrastructure project				✓	
	The problem of power grid - steady electric power supply				✓	
	Absence of training on Cloud Computing Technologies			✓		
	Lack of time to conduct Cloud Computing studies by construction professionals					✓
	Lack of technical knowledge Cloud Computing Technologies	✓				
	Willingness of construction project stakeholders to learn new technologies					✓
	Unsupportive industrial norms	✓				
	Unconducive work environment					✓
	Inadequate facilitation skills and training on Cloud Computing Technologies	✓				
	Reluctancy of construction workers and practitioners to accepting new technological innovations					✓
	unwilling of stakeholders to give their private and commercial information such as project cost to a third-party					✓
	Absence of standards guiding the use of cloud platforms	✓		✓		
	Difficulties in establishing mutual project objectives between stakeholders in the construction industry					✓
	Unwillingness of clients to fund cloud Computing services used in their project					✓
	Fear of losing time implementing Cloud Technologies during project execution due to very tight project schedules		✓			
	Absence of procurement and contract strategies for the implementation of Cloud technologies			✓		✓
	Poor collaboration and working relationships among construction project stakeholders					✓

B. Current stage in the Nigeria Construction industry.

As outlined by [9], the execution of construction projects involves a diverse range of processes, necessitating a centralized platform that brings together all project stakeholders. Such a platform facilitates transparency, real-time data analysis, and prevents the loss of construction project data. The construction industry is witnessing a shift where stakeholders no longer need to own information technology (IT) resources [25]. With the integration of cloud computing into the construction sector, new opportunities for growth and the incorporation of intelligent technologies emerge, aiding construction stakeholders in making informed decisions and enhancing the success of project delivery, particularly in Nigeria [11]. This integration facilitates remote collaboration and real-time data storage [8].

However, the deployment of cloud computing services on construction sites remains an emerging area in Nigeria's construction industry. Despite the global discourse on the importance, use cases, benefits, and challenges of cloud computing, only 4% of the literature in this domain originates from Nigeria [4]. Moreover, existing studies primarily focus on the benefits and challenges of adopting cloud technologies from a global perspective. This reflects the early stages of incorporating these services into Nigeria's global economy. While much of the existing research is centered on the financial and IT sectors, only a few studies address potential use cases of cloud computing in the construction industry [10].

In the literature reviewed, none of the studies conducted in Nigeria have specifically identified new barriers tailored to professionals involved in the Nigeria construction industry, presenting an opportunity for gathering novel information [10]. As emphasized by [10], "Nevertheless, as the use of cloud computing grows in sub-Saharan Africa, and some of the risks and challenges become more apparent, users (providers inclusive) in the region will have many lessons to learn." Therefore, there is a pressing need for increased research activities, especially studies focused on cloud computing within the Nigeria construction industry [5].

C. Barriers to the Adoption of Cloud Computing

While numerous challenges may impede the implementation and adoption of cloud computing in Nigeria, some of these challenges are unique to the construction industry. As construction professionals increasingly

ISSN No:-2456-2165

recognize these challenges, existing literature has covered some of them. [17] highlighted the vital need for a continuous flow of data for various site teams involved in construction projects, emphasizing the importance of ensuring that this data is consistently reliable and accessible. [8] underscored the potential of mobile/cloud Building Information Modeling (BIM) technology during construction stages, providing benefits such as progress tracking, schedule coordination, and clash prevention, provided primary challenges are effectively addressed [37].The overarching conclusion is that mobile/cloud technology can enable real-time monitoring of progress, coordination, clash detection, and data exchange across project teams, regardless of their locations [7]. Interoperability is identified as a critical factor for the successful implementation of mobile/cloud BIM technology, as assessed in mobile/cloud BIM computing technologies [18]. [23] pinpointed contractual challenges, lack of data ownership, and contractual inadequacies as significant obstacles to the adoption and integration of mobile/cloud BIM technology. Further exploration of issues related to data security, ownership, and stability is recommended [22]. The authors are optimistic that the use of mobile/cloud BIM technology will enhance secure collaboration.However, challenges persist in the form of reluctance to collaborate and cultural differences, acting as barriers to the adoption of mobile/cloud BIM technologies. Additionally, training time and costs are identified as significant hindrances to BIM adoption through mobile/cloud technologies. Research suggests a shortage of qualified professionals and experts in BIM implementation and adoption within the construction industry [24]. Nevertheless, the authors propose that "industry leaders" and professional organizations play a pivotal role in promoting continuous professional development training and integrating mobile/cloud BIM technology into both professional and higher education. Conversely, [38] supports the adoption of open standard file formats to facilitate data sharing and exchange among diverse systems.Furthermore, the authors advocate for a central web-hosted server to promote transparency and long-term cloud development. Issues of ownership and intellectual property rights demand more attention, and construction contracts should be tailored to meet these needs. The absence of such contracts can impede the adoption or acceptance of these technological innovations by construction stakeholders. Given the data exchange platform, other researchers advocate for a common data environment, encouraging project team collaboration.This study aimed to narrow the knowledge gap and enhance the understanding of cloud computing adoption among construction professionals in Nigeria. Specifically targeting professionals directly engaged in construction activities, the research sought to contribute to existing knowledge regarding barriers impacting the implementation and adoption of cloud computing in the Nigerian construction sector. Additionally, the study aimed to identify the predominant challenges hindering the full exploration of cloud technologies within the Nigerian construction industry.

II. RESEARCH METHOD

This study employs both quantitative and qualitative techniques. To gather data from a targeted audience, a qualitative interview was conducted using a pilot question with selected construction professionals familiar with the cloud platform. The goal was to identify new information not contained in the list of barriers identified from literature. A questionnaire survey containing modified lists was then utilized in a quantitative manner to collect information from a larger audience of construction professionals. The purpose of the questionnaire survey was to triangulate data from the population, improve, and expand by investigating and elaborating through data analysis some of the issues identified. Additionally, it aimed to explore the experiences of the sample population in relation to the topical issues that would be revealed after analyzing the data from the questionnaire survey.The study's target respondents were construction professionals in Lagos State, and the data used in this study were gathered from construction professionals in Lagos State. The model employed for the purpose of this research is shown in Fig 1.0.

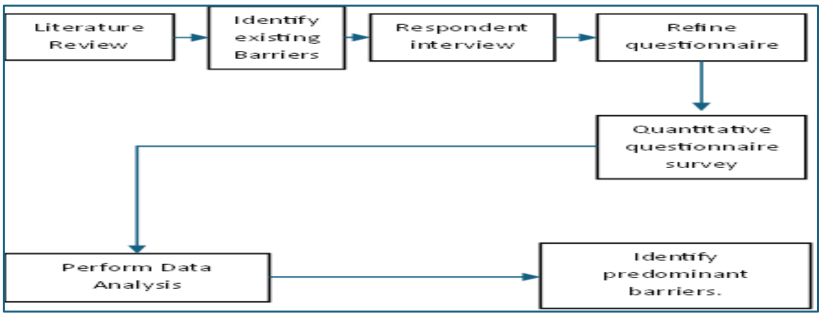

Fig. 1: Research model curated from [7]; [24]

Construction professionals in Lagos State were the studies. target respondents and the data used in this research was collected from construction professionals in Lagos state.

A. *Data Requirement*

For this study, both primary and secondary data were collected. Primary data on the barriers to the implementation and adoption of cloud computing in the Nigerian construction industry were gathered from construction professionals currently working in various construction firms under examination, while secondary data were obtained from a review of other relevant literature.

B. *Sample Size and Techniques*

A sample is a specimen, or a portion of a population taken to show that the rest of the population is comparable [12]. As part of this study, a random sample of ten (10) construction professionals in Nigeria was asked closed-ended questions as a pilot survey. The aim was to confirm the peculiarity of the globally existing barriers to the

ISSN No:-2456-2165

implementation and adoption of cloud computing, which were deduced from the literature reviewed, and to identify new barriers tailored to the Nigeria construction industry, thereby adding to the existing knowledge. Furthermore, a basic random sampling approach and process were used to select the sample from the population to ensure all respondents have an equal chance, respectively. Because of the nature and goals of the study, statistical sampling procedures were used to collect data. This type of sampling is less prone to bias because only these groups could be of benefit to the study's subject. The sample size will be calculated using Yaro Yamane's formula. The needed sample size is denoted as "n."

N= is the population size
1=is a constant and
E= is the assumed

error margin or level of significance was taken as 5% or 0.05. Therefore, e^2 = 0.0025. The error margin of 5% or 0.05 implies that 95% confidence level is absorbed.

In calculating the sample size, the result is as follows: -

$$n = \frac{60}{1+60(e0.0025^2)} = \frac{60}{1.003} = 59.98 \cong 60. \quad (1)$$

Therefore, a sample size of 60 was used.

C. Method of Data Collection

In this research involving construction professionals in Lagos, Nigeria, questionnaires were utilized as the primary data collection method. Prior to distributing the questionnaires, a model inspired by [21] was applied in a pilot survey conducted through one-on-one sessions with selected construction professionals. These individuals, chosen for their expertise in cloud computing and familiarity with cloud services, provided valuable insights. The pilot survey yielded new variables, which were then incorporated to enhance the final questionnaire before being administered to a wider audience.The questionnaire encompassed demographic information and delved into various barriers hindering the implementation of cloud computing by construction professionals in Nigeria. This section outlined primary factors identified in existing literature, accompanied by the variables used to measure these factors. Additionally, the survey explored respondents' familiarity with cloud computing platforms and tools. The concluding segment identified diverse barriers to the adoption of cloud computing by construction professionals in Nigeria, utilizing nominal scales to gauge responses. Questions from the pilot survey were adapted from existing literature, and the questionnaires issued to the final audience were refined with new insights derived from the respondents in the pilot survey.

D. Method of Data Analysis

The data collected through the study instruments were analyzed and processed using the Statistical Package for Social Sciences (SPSS) and XLSTAT. Excel was employed for tasks such as editing, coding, and tabulation, facilitating the creation of a concise summary. Descriptive and exploratory statistics [36] were applied on a nominal scale to assess the data and calculate the Relative Importance Index (RII).

III. RESULTS AND DISCUSSION

A. Rate of Response

Sixty (60) questionnaires were disseminated among construction professionals in Lagos State to enhance the sample size. Out of these, forty-eight (48) completed questionnaires were collected, deemed satisfactory after thorough editing for completeness. This set of forty-eight questionnaires constitutes eighty percent (80%) and is acknowledged as an effective response rate. The summarized details are presented in Table 2 below:

Table 2: Responses to questionnaires

Respondents	No of questionnaires sent out	Good Response received	Percentage response received
Construction Professionals in Lagos state	60	48	80
Total	**60**	**48**	**80**

A response rate of eighty percent(80%) was considered well enough for the study.

B. Demography of the Respondents

The collected data unveiled significant insights into respondents' characteristics within the construction industry, encompassing details such as their roles, educational background, professional affiliations, organizational affiliations, and years of experience. The representation of various professions, including engineers, quantity surveyors, construction managers, builders, and architects, provided a diverse perspective within the study. Engineers emerged as the predominant professional group, followed by quantity surveyors, construction managers, builders, and architects. Academically, the findings demonstrated a well-grounded respondent group, with 56.25% holding first degrees, 35.42% possessing second degrees, and the remaining respondents holding Higher National Diplomas. Additionally, respondents displayed a range of professional memberships, spanning from Graduate/Probationer to Fellow levels.Analyzing respondents' involvement in the construction industry, the results indicated that 68.75% had between 1 to 10 years of experience, while 29.17% reported 11 to 20 years of industry experience. None of the respondents reported having more than 30 years of experience, suggesting that the participants have a contemporary understanding of industry trends.Exploring organizational forms, the study revealed that 43.75% of respondents were affiliated with contracting organizations, 29.17% worked in private client organizations, 20.83% were associated with consulting firms, and the remaining respondents were engaged with public client organizations. This comprehensive data provides a nuanced understanding of the diverse professional backgrounds and experiences contributing to the study.

Table 3: Demographic of the Respondent

Variable	Level	Frequency	Percentage
Involvement in the construction industry	1 -10 years	33	68.75
	11 -20years	14	29.17
	21 to 30	1	2.08
	30 years above	0	0
Highest academic qualification	M.Sc.	17	35.42
	HND	4	8.33
	B.Sc.	27	56.25
Profession of the respondents	Engineering	23	47.92
	Quantity Surveying	12	25
	Architecture	3	6.25
	Construction Management	5	10.42
	Building	5	10.42
Membership of Professional Body	NSE	12	25
	COREN	15	31.25
	NIQS	13	27.08
	ARCON	3	6.25
	NIOB	5	10.42
Professional Body	Graduate /Probational Member	13	27.08
Grade of Membership	Corporate member	30	62.5
	Fellow member	4	8.33
	In view	1	2.08
Organization Forms	Private client organization	14	29.17
	Consulting organization	10	20.83
	Contracting organization	21	43.75
	Public client organization	3	6.25
Number of Employees	1 - 5 employees	7	14.58
	5-99 employees	17	35.42
	100-499 employees	18	37.5
	500 + employees	6	12.5

C. Challenges of the Implementation and Adoption of Cloud Computing in Nigeria

This section delves into respondents' perspectives on the perceived barriers to the adoption and implementation of cloud computing in Nigeria. While numerous barriers have been identified in existing literature, the study unearthed additional obstacles specifically tailored to the context of Nigerian construction professionals. These novel barriers emerged through both the interview process and questionnaire responses, enriching the understanding of challenges unique to the construction industry in Nigeria. The detailed findings of these new, industry-specific barriers are summarized in Table 4.

Table 4: New Barriers Identified Tailored to the Nigeria Construction Industry.

S/N	Barriers	Status
A	**Barriers to the Implementation of Cloud Computing Technology**	
	Financial strength of small and medium enterprise construction companies in Nigeria	**New Barrier**
B	**Barriers to Adoption of Cloud Computing Technology**	
	Unwillingness of organizations to fund Cloud Services when not included in project cost	**New Barrier**
	Unwillingness of organizations to sponsor Cloud training for construction workers	**New Barrier**
	Possibility of team member to deny the ownership of construction data shared on Cloud platform	**New Barrier**

Table 5 reveals diverse perceptions among construction professionals. For issues such as poor network connection (IBAR 2) and the operational cost of integrating cloud technologies (IBAR 10), respondents show a substantial level of concern, with mean values of 4.085 and 4.426, respectively. Meanwhile, factors like access to sufficient internet bandwidth (IBAR 3) and the availability of wired service (IBAR 4) reflect moderate levels of concern, with mean values of 3.936 and 3.553, respectively. The high mean values for financial strength of small and medium enterprise construction companies (IBAR 9) at 4.298 and cost-related barriers (IBAR 6, 7, 8) suggest significant apprehension. On the other hand, willingness of organizations to fund training (IBAR 11) exhibits notable concern with a mean of 4.021. The standard deviations vary, indicating differing degrees of consensus among respondents.

D. Most Prevalent Challenges of the Implementation of Cloud Computing in Nigeria

Table 5: Mean and SD of the identified variables

Code	Variables	Observations	Obs. without missing data	Mean	Std. deviation
IBAR 1	Access to internet facilities	47	47	3.681	1.181
IBAR 2	Poor network connection	47	47	4.085	0.929
IBAR 3	Access to sufficient internet bandwidth	47	47	3.936	0.791
IBAR 4	Availability of wired service	47	47	3.553	0.928
IBAR 5	Compatibility of cloud tools and machines	47	47	3.830	1.028
IBAR 6	Cost of purchase of cloud services for construction project management	47	47	4.319	0.810
IBAR 7	Cost of renting cloud resource for construction operations	47	47	4.170	0.732
IBAR 8	Cost of data/document/file and information sharing	47	47	3.979	0.737
IBAR 9	Financial strength of small and medium enterprise construction companies in Nigeria	47	47	4.298	0.749
IBAR 10	Operational cost of integrating cloud technologies for construction use	47	47	4.426	0.617
IBAR 11	Willingness of construction organizations to bear the additional cost of organizing workshop training for construction workers on Cloud computing technologies	47	47	4.021	1.073

The correlation matrix in Table 6 elucidates relationships among barriers to the implementation of cloud computing technologies, denoted as IBAR 1 to IBAR 11. These findings help identify patterns and potential areas of focus for addressing concerns in implementing cloud computing among construction professionals in Nigeria. The bold values in the correlation matrix shown below indicate strong correlations between the respective variables. Some noteworthy correlations include a positive relationship between access to internet facilities (IBAR 1) and various barriers, especially cost-related ones (IBAR 6, 7, 8), the financial strength of small and medium enterprises (IBAR 9), and operational cost (IBAR 10). This indicates that limited internet access significantly contributes to these barriers. Furthermore, a positive correlation is noted between poor network connection (IBAR 2) and operational cost (IBAR 10), suggesting that individuals concerned about poor network connections may also worry about the operational costs of integrating cloud technologies. Conversely, the willingness of organizations to fund training (IBAR 11) displays a mixed correlation. It exhibits positive connections to certain barriers like the compatibility of cloud tools and machines (IBAR 5) and financial strength (IBAR 9) but negative correlations with others such as poor network connection (IBAR 2) and cost-related barriers (IBAR 6, 7, 8). This implies that organizations willing to invest in training may have specific concerns while being less troubled by others.

Table 6: Correlation Matric of identified barriers

Variables	IBAR 1	IBAR 2	IBAR 3	IBAR 4	IBAR 5	IBAR 6	IBAR 7	IBAR 8	IBAR 9	IBAR 10	IBAR 11
IBAR 1	**1.0**										
IBAR 2	0.0	**1.0**									
IBAR 3	**0.3**	0.2	**1.0**								
IBAR 4	**0.3**	0.0	**0.5**	**1.0**							
IBAR 5	**0.3**	0.0	**0.7**	**0.6**	**1.0**						
IBAR 6	-0.1	**0.4**	0.1	0.1	0.1	**1.0**					
IBAR 7	-0.1	**0.3**	0.1	0.1	0.0	**0.7**	**1.0**				
IBAR 8	0.2	0.3	0.0	0.0	0.1	**0.4**	**0.4**	**1.0**			
IBAR 9	**0.4**	0.2	0.0	0.0	0.2	**0.3**	**0.3**	**0.5**	**1.0**		
IBAR 10	0.1	0.2	0.1	0.0	0.2	**0.3**	**0.3**	**0.4**	**0.5**	**1.0**	
IBAR 11	0.1	0.2	**0.4**	0.2	**0.4**	0.2	0.2	0.2	**0.3**	**0.5**	**1.0**

Table 7 unveils the results of the Principal Component Analysis (PCA) conducted on variables labeled as F1 to F8, shedding light on inherent patterns and dimensionality within the dataset. The PCA endeavors to expose latent structures embedded in the data, with eigenvalues serving as pivotal metrics to delineate the extent of variance explained by each principal component. The cumulative percentages depicted in the table guide the determination of the optimal number of factors utilized for grouping the variables. Notably, the foremost principal component (F1) presents the highest eigenvalue of 2.976, elucidating 27.058% of the total variability within the dataset. Simultaneously, the second principal component (F2) exhibits an eigenvalue of 1.875, making a substantial contribution by explaining 17.047% of the variability.Expanding further, the combination of the first two principal components (F1 and F2) accounts for a cumulative variability of 44.105%, while the inclusion of the first three (F1-F3) explains 52.614% of the dataset's variability. Delving further into the analysis, the fourth principal component (F4) showcases an eigenvalue of 0.858, explaining 5.271% of the dataset's variability. Although F4 has a lower eigenvalue compared to the preceding components, data between F1-F4 accounts for more than 50% of the variability of the data. The first four principal components collectively capture a substantial portion of the inherent patterns within the dataset, while the factor between F5-F8 only contributes a little above 4% to the variability f the data set. This reinforces the significance of these components in characterizing the barriers to the implementation of cloud computing in Nigeria.

Table 7: Variance in Barriers

	F1	F2	F3	F4	F5	F6	F7	F8
Eigenvalue	**3.0**	**1.9**	0.9	0.6	0.2	0.1	0.0	0.0
Variability (%)	27.1	17.0	8.5	5.3	2.0	0.9	0.2	0.0
Cumulative %	27.1	44.1	52.6	57.9	59.9	60.9	61.1	61.1

The Scree plot in fig 2 was pivotal as an alternative in determining the optimal number of factors within which the barriers were grouped. The point of convergence on the scree plot played a crucial role in identifying the suitable number of factors that can be recognized as currently impeding the implementation of cloud computing by construction professionals in the Nigerian construction industry. Consequently, factors beyond the four (4) identified were not further scrutinized. As the plot shows little or no difference between the rest of the factor.

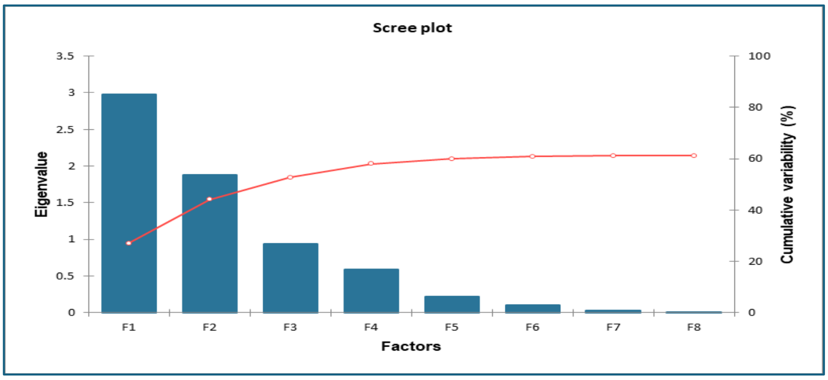

Fig. 2: Scree Plot of the loading of the barriers to the implementation of CC.

Table 8 presents the loadings, which are correlation coefficients between each barrier (IBAR 1 to IBAR 11) and the identified factors (F1 to F4) derived from the Principal Component Analysis (PCA). These loadings offer valuable insights into the underlying structure of the barriers, aiding in the categorization of these barriers into distinct factors based on their correlations.In Factor 1 (F1), several variables, such as Access to internet facilities (IBAR 1), Poor network connection (IBAR 2), Access to sufficient internet bandwidth (IBAR 3), Availability of wired service (IBAR 4), and Compatibility of cloud tools and machines (IBAR 5), display notably high positive loadings. This suggests that Factor 1 is primarily associated with barriers related to internet access, network connection, and compatibility of cloud tools and machines.Factor 2 (F2) exhibits positive loadings for Cost-related barriers, including Cost of purchase of cloud services for construction project management (IBAR 6), Cost of renting cloud resource for construction operations (IBAR 7), Cost of data/document/file and information sharing (IBAR 8), and Operational cost of integrating cloud technologies for construction use (IBAR 10). Additionally, Financial strength of small and medium enterprise construction companies in Nigeria (IBAR 9) shows a positive loading on Factor 2, indicating an association with financial aspects of cloud technology implementation. Factor 3 (F3) demonstrates positive loadings for financial strength of small and medium enterprise construction companies in Nigeria (IBAR 9) and Operational cost of integrating cloud technologies for construction use (IBAR 10). This suggests that Factor 3 is linked to barriers associated with the financial aspects of implementing cloud technologies. Conversely, Factor 4 (F4) exhibits a negative loading with Willingness of construction organizations to bear the additional cost of organizing workshop training for construction workers on Cloud computing technologies (IBAR 11). This negative loading indicates an inverse relationship between Factor 4 and the willingness of organizations to fund training for construction workers in cloud computing technologies.

Table 8: Correlation between variables and factors

	Variables	F1	F2	F3	F4
IBAR 1	Access to internet facilities	0.372	-0.413	0.367	0.468
IBAR 2	Poor network connection	0.387	0.254	-0.195	-0.044
IBAR 3	Access to sufficient internet bandwidth	0.520	-0.640	-0.295	-0.064
IBAR 4	Availability of wired service	0.366	-0.601	-0.264	0.262
IBAR 5	compatibility of cloud tools and machines	0.527	-0.714	-0.054	-0.061
IBAR 6	Cost of purchase of cloud services for construction project management	0.659	0.499	-0.483	0.231
IBAR 7	Cost of renting cloud resource for construction operations	0.588	0.498	-0.385	0.077
IBAR 8	Cost of data/document/file and information sharing	0.540	0.314	0.236	0.223
IBAR 9	Financial strength of small and medium enterprise construction companies in Nigeria	0.707	0.225	0.595	0.187
IBAR 10	Operational cost of integrating cloud technologies for construction use	0.626	0.192	0.265	-0.400
IBAR 11	Willingness of construction organizations to bear the additional cost of organizing workshop training for construction workers on Cloud computing technologies	0.611	-0.141	0.078	-0.633

Table 9 provides a succinct overview of the Relative Importance Index (RII) for barriers influencing the implementation of cloud services by construction professionals in Nigeria. Notably, "Access to internet facilities" stands out as the most critical factor, earning the top rank with an RII score of 0.71. This underscores the pivotal role that internet accessibility plays in hindering the adoption of cloud technologies in the construction industry.Following closely, the "Cost of purchase of cloud services for construction project management" and the "Operational cost of integrating cloud technologies for construction use" claim the second and third positions, emphasizing the significant impact of financial considerations on cloud technology adoption. These findings highlight the imperative for targeted strategies and interventions to address cost-related challenges faced by construction professionals. Conversely, the "Availability of wired service" emerges as the least impactful barrier, ranking eleventh with an RII score of 0.23. While other factors contribute to varying degrees, the clear prominence of cost-related barriers signals a crucial area for focused attention and strategic planning in facilitating the successful implementation of cloud computing services in the Nigerian construction industry.

Table 9: The Relative Importance Index (RII) of the Barriers affecting the implementation of CC

Code	Variables	Weighted Value	Weighted Avg	RII	Rank
IBAR 1	Access to internet facilities	170	240	0.71	1
IBAR 6	Cost of purchase of cloud services for construction project management	127	240	0.53	2
IBAR 10	Operational cost of integrating cloud technologies for construction use	124	240	0.52	3
IBAR 9	Financial strength of small and medium enterprise construction companies in Nigeria	120	240	0.50	4
IBAR 5	Compatibility of cloud tools and machines	108	240	0.45	5
IBAR 11	Willingness of construction organizations to bear the additional Cost of organizing workshop training for construction workers on Cloud computing technologies	107	240	0.45	6
IBAR 2	Poor network connection	101	240	0.42	7
IBAR 7	Cost of renting cloud resource for construction operations	84	240	0.35	8
IBAR 3	Access to sufficient internet bandwidth	78	240	0.33	9
IBAR 8	Cost of data/document/file and information sharing	68	240	0.28	10
IBAR 4	Availability of wired service	55	240	0.23	11

E. Most Prevalent Challenges the Adoption of Cloud Computing in Nigeria.

The table 10 presents survey results on various factors influencing the adoption of cloud computing technologies in the Nigerian construction industry. Each row corresponds to a specific factor (coded as BAR1 to BAR39), with associated variables, mean scores, and standard deviations. The mean scores indicate the respondents' average perceptions of each factor on a scale from 1 to 5, where higher scores suggest greater concern or agreement. For example, BAR12, "Unstable economic situation of the nation," has a mean score of 4.2, indicating a relatively high level of concern among respondents regarding the impact of economic instability on cloud adoption. Similarly, BAR25, "Unsupportive industrial norms," has a mean score of 3.8, suggesting a moderate level of concern about industry norms affecting cloud technology acceptance. Low standard deviation (SD) values, observed in factors like BAR12 and BAR23 ("Lack of technical knowledge of Cloud Computing Technologies"), indicate consistent and widely shared concerns among respondents. Moderate SD values, found in factors like BAR2 ("The unavailability of data protection strategies") and BAR17 ("Insufficient studies on Cloud Computing Technologies"), reflect a moderate degree of variability, suggesting reasonable agreement. Conversely, high SD values in factors like BAR14 ("Lack of awareness of Cloud Computing Technologies") and BAR33 ("Unwillingness of clients to fund Cloud Computing Services") indicate diverse opinions, highlighting less consensus on their importance. This implies that some respondent rated this BAR as saturated and may or may not be considered significant variable currently impeding the adoption of cloud services in Nigeria.

Table 10: Mean and SD of the barriers hindering the adoption of cloud computing.

Variable	Mean	Std. deviation
BAR1	3.1	1.2
BAR2	3.7	0.9
BAR3	3.9	0.9
BAR4	3.7	0.9
BAR5	3.9	1
BAR6	3.8	0.9
BAR7	3.8	1
BAR8	3.5	1
BAR9	3.8	0.9
BAR10	3.8	1
BAR11	3.9	1
.	4.2	0.8
.	4	1
.	4.1	1
.	3.9	0.9
BAR39	3.7	1

The table 11 provides the results of a factor analysis, revealing the contribution of different factors (F1 to F19) to the overall variability in the dataset. These variables were loaded, and the eigenvalue of these variables were determined. The number of factors were not predetermined but was automatically generated. The table helps prioritize and understand the importance of each factor generated while focusing on the most influential factors and providing a cumulative perspective on the collective explanatory power of the datasets. Eigenvalues, representing the amount of variance explained by each factor, are presented alongside the variability percentages and cumulative percentages. The most influential factor appears to be F1 with an eigenvalue of 18.477, capturing a substantial 47.376% of the total variability. This suggests that F1 plays a dominant role in explaining patterns within the dataset. The subsequent factors, such as F2 to F19, contribute progressively smaller eigenvalues, indicating diminishing importance in explaining variability. The variability percentages associated with each factor provide additional insights into their individual contributions. For instance, F2 contributes 5.138% of variability, and F3 adds 4.81%. Collectively, the first five factors (F1 to F5) account for 65.163% of the total variability, emphasizing their significance in summarizing the dataset. The cumulative percentages further illustrate the combined explanatory power of the identified factors. By F5, more than 65% of the total variability is explained, reaching 81.533% by F16. This cumulative approach aids in understanding how much of the dataset's variability is captured as more factors are considered.

Table 11: Percentage Variance between Eigenvalue Factorsgenerated.

Factors	Eigenvalue	Variability (%)	Cumulative (%)
F1	18.477	47.376	47.376
F2	2.004	5.138	52.514
F3	1.876	4.81	57.324
F4	1.75	4.488	61.812
F5	1.307	3.351	65.163
F6	1.167	2.993	68.156
F7	1.027	2.633	70.79
F8	0.978	2.509	73.298
F9	0.811	2.079	75.377
F10	0.557	1.428	76.805
F11	0.442	1.134	77.939
F12	0.386	0.99	78.929
F13	0.356	0.912	79.842
F14	0.245	0.628	80.47
F15	0.218	0.559	81.029
F16	0.197	0.504	81.533

F17	0.149	0.383	81.917
F18	0.126	0.322	82.238
F19	0.075	0.192	82.431

These factors are also shown on the Scree plot in Fig 3 and the point of convergence of the graph represents the factor areas. Although there is no standard naming to this factor [5].The scree plot as well as the table 10 also shows that the more than 70% of the total variants of the barriers affecting the adoption of cloud computing as identified by construction professions in Nigeria were accommodated by these seven factors. As such, we can conclude that the rest of the factors are insignificant to affecting the adoption of cloud computing in Nigeria.

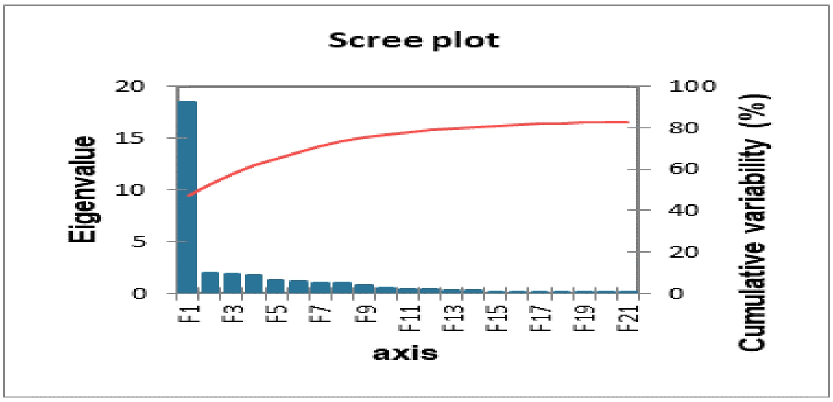

Fig. 3: Scree Plot showing Factors grouping of the barriers to the adoption of CC in Nigeria

Table 12 presents the factor loadings, representing the correlation coefficients between each barrier (BAR1 to BAR39) and the identified factors (F1 to F7) extracted from the Principal Component Analysis (PCA). This analysis offers insights into the underlying structure of the barriers, facilitating their categorization based on their correlations with the identified factors.Factor 1 (F1): Variables such as the storage of construction design and financial information in shared resources, unavailability of data protection strategies, fear of data breach from service providers, unavailability of data security and privacy laws, and lack of data transaction policy from the government exhibit relatively high positive loadings. Factor 1 is associated with barriers related to internet access, network connection, and compatibility of cloud tools and machines.Factor 2 (F2): This factor is positively loaded with cost-related barriers, including the cost of cloud services, financial strength of construction companies, and operational costs. Factor 2 suggests challenges related to the financial aspects of implementing cloud technologies.Factor 3 (F3): Positive loadings for financial strength of construction companies and operational costs characterize Factor 3, indicating its association with barriers related to the financial aspects of implementing cloud technologies.Factor 4 (F4): This factor is negatively loaded with the willingness of construction organizations to bear the additional cost of organizing workshop training for construction workers on Cloud computing technologies. It signifies an inverse relationship between Factor 4 and the willingness of organizations to fund training.Factor 5 (F5): Barriers related to the lack of awareness of Cloud Computing Technologies, the failure to admit ignorance in specialized aspects, and the absence of demand for Cloud Computing Technologies exhibit positive loadings. Factor 5 is associated with awareness, knowledge, and demand-related barriers.Factor 6 (F6): Factors related to unsupportive industrial norms, an unconducive work environment, inadequate facilitation skills and training, and the reluctance of construction workers and practitioners to accept new technological innovations exhibit positive loadings. Factor 6 is indicative of barriers associated with industry norms, work environment, and the human factor.Factor 7 (F7): This factor is characterized by barriers related to the reliability of cloud computing platforms, the absence of standards guiding the use of cloud platforms, difficulties in establishing mutual project objectives, and the unwillingness of clients to fund Cloud Computing Services. Factor 7 represents challenges associated with technical aspects, standards, and stakeholder collaboration in cloud computing adoption.The categorization of these factors helped in categorizing the identified barriers into distinct factors, enabling targeted interventions and strategies to resolve issues hindering the implementation and adoption of CC by the construction professionals within the Nigeria ecosystem.

Table 12: Correlation between identified barriers and the factor

	F1	**F2**	**F3**	**F4**	**F5**	**F6**	**F7**
BAR1	0.247	-0.038	0.114	-0.044	0.400	0.215	0.291
BAR2	0.755	0.283	0.309	0.042	0.155	-0.069	-0.099
BAR3	0.755	0.233	0.228	-0.033	0.029	0.170	-0.127
BAR4	0.757	0.016	0.391	-0.214	0.103	-0.004	-0.055
BAR5	0.763	0.349	0.222	-0.056	-0.009	-0.092	-0.039
BAR6	0.707	0.010	-0.148	0.267	-0.079	0.292	0.129
BAR7	0.795	-0.162	-0.188	0.307	-0.065	0.228	-0.111

ISSN No:-2456-2165

BAR8	0.778	0.017	-0.048	0.346	0.023	0.250	-0.094
BAR9	0.854	0.086	0.164	0.162	0.077	0.013	0.027
BAR10	0.711	0.152	0.497	0.035	0.096	-0.004	-0.030
BAR11	0.772	0.071	0.046	0.374	-0.121	0.083	0.143
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BAR39	0.736	0.011	-0.213	-0.053	-0.043	-0.170	0.069

Table 13 shows the relative importance index of the factors that were identified from literatures as well as those included by the respondent of the interview as tailored to the Nigeria construction Industry.The table 12 shows that the unstable economic situation of the country as well as the unwillingness of organizations to fund cloud services when not included in project cost, absence of power infrastructure project - electric power supply, lack of awareness of cloud computing technologies and services by practitioners in the Nigeria construction industry, unwillingness of clients to fund cloud computing services used on their project, Lack of technical knowledge of Cloud Computing Technologies, Unwilling of stakeholders to give their private and commercial information such as project cost to a third-party, Unavailability of government strategies for the adoption of cloud technologies and Willingness of construction project stakeholders to learn new technologies are the Ten (10) most significant barriers to the adoption of Cloud computing technologies by the construction professionals in Nigeria. Out of this ten barriers, two (2) of highest ranked barriers, that is, the unwillingness of organizations to fund cloud services when not included in project cost and the unwillingness of clients to fund cloud computing services used on their project ranking 2nd and 4th respectively BAR 34 and 33 were variables that were not found in the literatures, but were new information recorded from interviewing various construction professionals who were able to contribute to the existing knowledge by tailoring this barrier to the Nigeria construction industry. These two barriers also have a high level of significance to the adoption of CC, as compared to others. The other factor that is more predominant is the Knowledge base. This is very important for a successful adoption of CC in the Nigeria construction industry. From the factor and variable table, BAR 34 and BAR 33 also has a high level of significance to the factors group of seven (7) factors as identified from the Exploratory Factor Analysis. Data Privacy, Data Security,Data Governance, Level of Awareness, Service providers and Infrastructures, Training and Education and Organization culture, Environment and Trust. While these were initially assumed Ho and grouped into these categories, the Exploratory factor Analysis helped to prove this hypothesis, confirming from correlation between variables, that there are seven most significant factor group for the variables with great level of significance, with variance greater than 70 % at the 7th factor analysis.

Table 13: The Relative Importance Index (RII)

Code	Variables	Weighted Value	Weighted Avg	RII	Rank
BAR12	Unstable economic situation of the nation	197	240	0.820833	1
BAR34	Unwillingness of organizations to fund Cloud Services when not included in project cost	196	240	0.816667	2
BAR20	Absence of power infrastructure project - electric power supply	195	240	0.8125	3
BAR14	Lack of awareness of Cloud Computing Technologies and Services by practitioners in the Nigeria construction industry	194	240	0.808333	4
BAR33	Unwillingness of clients to fund Cloud Computing Services used on their projects	194	240	0.808333	4
BAR23	Lack of technical knowledge of Cloud Computing Technologies	191	240	0.795833	5
BAR29	Unwilling of stakeholders to give their private and commercial information such as project cost to a third-party	191	240	0.795833	5
BAR13	Unavailability of government strategies for the adoption of cloud technologies	190	240	0.791667	6
BAR24	Willingness of construction project stakeholders to learn new technologies	190	240	0.791667	6
BAR28	Reluctancy of construction workers and practitioners to accepting new technological innovations	190	240	0.791667	6
BAR35	Unwillingness of organizations to sponsor Cloud training for construction workers	189	240	0.7875	7

BAR22	Lack of time to conduct Cloud Computing studies by construction professionals	188	240	0.783333	8
BAR27	Inadequate facilitation skills and training on Cloud Computing Technologies	186	240	0.775	9
BAR5	The lack of data transaction policy from the government	184	240	0.766667	10
BAR11	Fear of high level of taxation on cloud users in the construction industry	184	240	0.766667	10
BAR15	Failure to admit ignorance in certain specialized aspects on project development that may need the intervention of cloud computing services and technologies to resolve	182	240	0.758333	11
BAR17	Insufficient studies on Cloud Computing Technologies	182	240	0.758333	11
BAR31	Absence of standards guiding the use of cloud platforms	181	240	0.754167	12
BAR6	Discrepancies of ownership of construction data (documents, etc.) in a cloud platform	180	240	0.75	13
BAR7	Freedom to share construction data with another member of the team	180	240	0.75	13
BAR26	Unconducive work environment	179	240	0.745833	14
BAR3	The Fear of data breach from service providers	178	240	0.741667	15
BAR21	Absence of trainings on Cloud Computing Technologies	178	240	0.741667	15
BAR32	Difficulties in establishing mutual project objectives between stakeholders in the construction industry	178	240	0.741667	15
BAR39	Possibility of team member to deny the ownership of construction data shared on Cloud platform	178	240	0.741667	15
BAR9	Lack of contractual provisions to support cloud construction data transaction	177	240	0.7375	16
BAR10	Regulatory ambiguities from government body	177	240	0.7375	16
BAR25	Unsupportive industrial norms	177	240	0.7375	16
BAR37	Absence of procurement and contract strategies for the implementation of Cloud Technologies	177	240	0.7375	16
BAR4	The unavailability of data security and privacy laws	176	240	0.733333	17
BAR38	Poor collaboration and working relationships among construction project stakeholders	176	240	0.733333	17
BAR2	The unavailability of data protection strategies to block data leakage	175	240	0.729167	18
BAR36	Fear of losing time implementing Cloud technologies during project execution due to very tight project schedules	175	240	0.729167	18
BAR16	Absence of the demand for Cloud Computing Technologies and Services	174	240	0.725	19
BAR19	Limited cloud service providers in Nigeria	174	240	0.725	19
BAR30	Reliability of cloud computing platforms	172	240	0.716667	20
BAR8	The lack of access levels for the different categories of stakeholders involved in the production and management of building data using cloud computing services	165	240	0.6875	21
BAR18	The unavailability of cloud service providers	158	240	0.658333	22
BAR1	The storage of construction design and financial information in shared resources would pose serious treats to the construction industry	145	240	0.604167	23

F. Most Predominant Cloud Services Currently in Use by Construction Professionals

Table 14: Cloud Computing Services used by construction professionals

Variables		**Cloud Technologies**	**Weighted Value**	**Weighted Avg**	**RII**	**Rank**
		Zohobox	94	240	0.070833333	1
Cloud Computing Platforms		iCloud	129	240	0.05	2
		Intel	116	240	0.05	2

ISSN No:-2456-2165

		Adobe Creative Cloud	109	240	0.045833333	3
		Amazon web Service	110	240	0.041666667	4
		[Microsoft Azure	116	240	0.041666667	4
Communication tools		Microsoft Office	188	240	0.029166667	1
		Google Mail	190	240	0.025	2
		Google Drive	185	240	0.025	2
		Dropbox	161	240	0.020833333	3
		Yahoo	184	240	0.016666667	4
Cloud Software		Salesforce.com	82	240	0.091666667	1
		IBM	110	240	0.054166667	2
		BIM Neutral60	126	240	0.054166667	2

Table 14 provides valuable insights into the cloud service preferences among construction professionals in Nigeria, encompassing technologies, platforms, communication tools, and software. The ranking is determined by factors like weighted value, weighted average, and the Relative Importance Index (RII).

Notably, Microsoft Office emerges as the dominant communication platform, reflecting its widespread usage among construction organizations and stakeholders. The significance of Microsoft Office, particularly in documentation and communication across project sites, underscores its pivotal role in the Nigerian construction industry.

Interestingly, the adoption of iCloud and Zohobox highlights a notable shift towards Apple platforms in the construction sector. This trend suggests a growing preference for platforms with robust technical requirements suitable for mobile cloud computing. The implications are optimistic, indicating a smooth transition for construction professionals into mobile cloud computing applications, especially as broadband internet availability improves.

Furthermore, the strong affinity for Salesforce among construction professionals is a noteworthy trend. The equal ranking of IBM and BIM software underscores a substantial potential for rapid learning, operation, and implementation of cloud services by Nigerian construction professionals. This insight bodes well for the industry's readiness to embrace and integrate cloud services in the near future. Overall, Table 13 not only outlines the current landscape of cloud service usage but also offers strategic insights for stakeholders navigating the evolving dynamics of cloud adoption in the Nigerian construction industry.

IV. CONCLUSION

The study aimed to recognize and prioritize challenges within the domain of Cloud Computing (CC) in the context of the Nigerian construction industry. A comprehensive analysis of existing studies was conducted to pinpoint barriers elucidated in the literature. Leveraging the identified barriers, the research delved into understanding their impact on the implementation and adoption of CC by construction professionals in Nigeria. Additionally, the study explored the potential existence of new barriers specifically tailored to the construction ecosystem in Nigeria. Beyond those outlined in the literature, the research identified and investigated three new barriers. Utilizing Descriptive Statistics, Exploratory Factor Analysis (EFA), and Relative Importance Index (RII) methodologies, the study scrutinized the implications of these barriers on the implementation and adoption of CC services and applications by construction professionals in Nigeria.The study primarily centered on experienced and registered construction professionals in Nigeria. Using the Exploratory Factor Analysis (EFA) component, the study identified technical factors that could impede the implementation of cloud computing. This analysis pinpointed the two most influential factors: the unavailability of broadband internet and the financial aspects associated with operating and subscribing to cloud services. Moreover, the EFA analysis played a crucial role in categorizing the identified variables, acting as barriers to the adoption of cloud technologies by construction professionals. These barriers were grouped into seven distinct categories: Socio-economic factors, Data Privacy, Security, Governance, Level of Awareness and Knowledge, Services and Infrastructures, Training and Education, and Organizational Culture, Environment, and Trust among project stakeholders in construction.Subsequent to the EFA analysis, the study employed Relative Importance Index (RII) analysis to evaluate and rank the identified obstacles. The RII results highlighted that Access to internet facilities, Cost of purchase of cloud services for construction project management, and Operational cost of integrating cloud technologies for construction use were the foremost barriers hindering the implementation of cloud technologies by construction professionals in Nigeria. Simultaneously, the Unstable economic situation of the nation, Unwillingness of organizations to fund Cloud Services when not included in project cost, and Absence of power infrastructure project - electric power supply emerged as the three most significant barriers impeding the adoption of cloud computing services in the Nigerian construction industry.Beyond addressing challenges to the implementation and adoption of Cloud

Computing services, this study provided fresh insights into the exposure of construction professionals in Nigeria to mobile technologies. Analysis of the data suggests that these professionals have not fully embraced most existing cloud technologies currently in use in the industry. Instead, they appear more accustomed to general platforms for information management and storage, with Microsoft packages being the prevalent communication platform. Additionally, construction professionals predominantly use Apple and ZohoBox platforms, indicating substantial potential for the implementation of cloud computing technologies once the primary barriers related to broadband internet are addressed.

In conclusion, this study has shed light on the intricate landscape of Cloud Computing (CC) challenges within the Nigerian construction industry. By identifying and investigating both existing and new barriers, we have deepened our understanding of the impediments constraining the implementation and adoption of CC services by construction professionals. The research emphasizes the need for tailored approaches, as evidenced by the identification of five new barriers specifically tailored to the Nigerian construction ecosystem. The categorized barriers, ranging from socio-economic factors to organizational culture, underscore the multifaceted nature of challenges faced by construction professionals. The Relative Importance Index (RII) analysis revealed the prominence of barriers such as access to internet facilities, costs, and operational challenges. Importantly, the study validates the significance of considering geographical nuances in research, as highlighted by the specific barriers identified in the Nigerian context. As we look forward, the insights into professionals' exposure to mobile technologies and their preferred platforms indicate a promising trajectory for the adoption of cloud computing technologies in the construction sector once primary barriers are addressed. This research not only contributes to the academic discourse but also offers practical implications for project managers, construction stakeholders, and cloud service providers navigating the evolving cloud business landscape in Nigeria.

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