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Assessment of Cloud Computing Success Factors for Sustainable Construction Industry: The Case of Nigeria

Ayodeji Emmanuel Oke [1], Ahmed Farouk Kineber [2,*], Ibraheem Albukhari [3], Idris Othman [2] and Chukwuma Kingsley [1]

[1] Department of Quantity Surveying, School of Environmental Technology, Federal University of Technology, Akure 340271, Nigeria; emayok@gmail.com (A.E.O.); Chukwumank@gmail.com (C.K.)
[2] Department of Civil & Environmental Engineering, Univeristi Technologi PETRONAS, Seri Iskandar 32610, Perak, Malaysia; idris_othman@utp.edu.my
[3] Department of Islamic Architecture, College of Engineering and Islamic Architecture, Umm Al-Qura University, Makkah 21955, Saudi Arabia; Inbukhari@uqu.edu.sa
* Correspondence: A.farouk.kineber@gmail.com

Abstract: Cloud Computing has become a valuable platform for sustainability in many countries. This study evaluates the cloud computing implementation and its Critical Success Factors (CSFs) towards ensuring sustainable construction projects in Nigeria. Data were collected from previous literature, supplemented by a quantitative approach via a questionnaire survey. Data were collected from 104 construction professionals while cloud computing CSFs were examined using Relative Importance Ranking (RII) and Exploratory Factor Analysis (EFA). The results show that cloud computing's awareness level is 96.2%, which means that the respondents are aware of cloud computing concept. Furthermore, the result shows that most of the respondents are adopting the concept. The analysis of the CSFs indicated that reliable data storage, performance as well as cost of accessibility and availability were the four most significant CSFs to cloud computing applications. Analysis of the CSFs through EFA generated four main components which include human satisfaction, organization, client's acceptance, and industry-based. Consequently, this study contributed to existing body of knowledge by highlighting the cloud computing CSFs for achieving sustainable construction project. As such, the results could be a game-changer in the construction industry—not only in Nigeria but also in developing nations where construction projects are implemented through similar style and procedure. This study would be a benchmark for supporting decision-makers to improve data fragmentation, in which the use of data is paramount to the execution of construction works. Finally, the results of this study would be useful for enhancing sustainability and general management of construction projects through cloud computing implementation.

Keywords: cloud computing; critical success factors; sustainability; sustainable construction; exploratory factor analysis; construction management

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1. Introduction

Construction is a complex and dynamic industry. A construction project involves activities and components that are huge in number and interrelated in nature that significantly affect society, community, and environment over their whole life cycle. Construction projects represent more than 40% of universal power generation and account for 30% of gross Green House Gas (GHG) emissions in developing nations and developed countries [1]. Around 40 percent of Europe and the USA's total strength and resources are consumed in construction [2,3]. In developing countries, the project sustainability of the construction industry is very frightening [4]. These countries have undergone rapid growth, but there is no question that the construction industry plays a vital role in ensuring basic living standards [5]. Beach et al. [6] stated that the construction industry is a highly decentralized, data-intensive, project-based market, with heavy data exchange and processing requirements across the life cycle of its goods depending on several different professionals and companies (primarily buildings). The method of planning, reconstructing, rebuilding, and running a building includes conventional disciplines (architectural, structural, mechanical, and electrical engineering) and many modern careers in fields such as environmental science and waste management. Many of these occupations have heavy standards for data sharing. The construction industry requires adequate information storage and communication between professionals involved. Communication and collaboration can be accomplished by the use of information control systems, such as the introduction of cloud computing. Ahuja et al. [7] claimed that structured communicating information facilitates the convergence of multiple project phases. The use of common internet or the joint use of databases may also contribute to successful knowledge exchange. With technologies evolving exponentially, goods and services of enhanced information technology (IT) are available across the globe every day. This phenomenon places huge pressure on building managers to prepare, introduce, and incorporate new technological strategies for these changes. High-performance processing capacity is generated by cloud-based data centers that analyze vast volumes of IoT data to provide useful insight into decision making [8]. Therefore, looking at the approaches that can be used to assist in this situation, we must consider the advances in cloud computing and their impact on the construction industry [9]. Consequently, plans must be built to implement the principle of sustainable growth [10] and enhancement of "sustainable construction" through improving data fragmentation where the use of data is paramount to the execution of all construction works should be adopted.

Sustainability can address current needs without reducing the potential of coming generations [11]. Kibert [12] agreed that sustainable construction is implementing a sustainable ecosystem with ecological values and effective utilization of energy. It is also clarified as an initiation process before and after the construction companies have left the project [13]. According to Wolstenholme et al. [14], the construction industry should be modernized by introducing efficient automated, novel, and sustainable construction practices. Enhancing sustainable activities at the outset of a construction project is strongly encouraged to track its success. Cloud computing can accomplish this proposed building resilience by delivering remote access to computing services across the internet through information and communication technology (ICT) techniques globally. Cloud computing is now poised to change sustainable economic practices around the world into a multifaceted approach to sustainable management through its intrinsic pay-per-use platform, accessibility, scalability, and other functions [15], which the cost and economics represent as success indicators for construction projects [16]. Computing services were provided through shared server networks used by multiple users simultaneously [17]. It offers high-performance computational resources to process high-volume IoT (Internet of Things) data to provide useful information to improve decision-making [18]. According to Tehrani and Shirazi [19], Cloud computing is a modern phenomenon that lets SMEs solve many sustainability problems, including cost and risk management. It uses services as a commodity and only pays for the resources it needs. The bulk of cloud computing systems are shared-resource providers. As the servers do not need to go excessively unused, which decreases costs considerably as software creation rises, measurement, application hosting, content storage, and distribution costs have been drastically reduced.

Although previous studies discussed cloud computing benefits, limited effort has been made to determine cloud computing implementation in the construction industry in developing countries. Academic literature on the use of cloud computing in the construction industry is minimal and comprehensive. There has been work on confidence models and cloud computing implementation techniques. Security is getting more and more relevant as cloud computing is taken into account. Kim [20] argued that there is a range of questions that consumers had about the implementation of cloud services. This involves affordability, protection, and safety, help, interoperability, and enforcement. Compliance with these is usually only applicable to the organisation. Both issues are the same ones that customers have always had, such as on-site devices and applications. To a large degree, consumers are freshly informed of the issues that their records, software, and computational capabilities will no longer be under their influence. It is hypothesized that there is a concordance on cloud computing implementation on construction projects. Therefore, this research will contribute to the studies on cloud computing as an evolving field by exploring problems relevant to its implementation in the Nigerian construction industry. There is a need to evaluate the level of awareness and support of the top key players in the construction industry, regardless of the matrix hierarchy observed in the industry. Consequently, what are the awareness, level of practice and critical success factors (CSFs) to implement cloud computing in the Nigerian construction industry? In this regard, this study aims to assess the adoption of cloud computing practices in Nigerian construction, with a view to examining the application areas, awareness level, and success factors for the adoption of cloud-based computing technology in the construction industry. This study would be useful by sustainable construction projects' stakeholders in their quest to implement cloud computing. The findings could affect how construction projects are carried out in Nigeria and in developing countries where construction projects are similarly carried out [21]. The rest of this paper consists of a literature review followed by the adopted research method. Results of the analyzed data were explained while findings were also discussed considering previous literature. Key findings and future recommendations are presented in the conclusion section.

2. Related Work

Sustainability issues have been highlighted in multiple studies [22]. Transforming corporate sustainability goals and initiative plans is a complex process [23]. Consequently, there is a balance to be found between social sustainability, economic, and environmental aspects [22,24]. The advent of sustainability in the construction sector has led to a quest for realistic ways to infuse this idea into current working environments [25]. The need for environmental development and an ambitious corporate social responsibility ethic applied across businesses are factors that may also promote the massive use of cloud computing is the key strategic phases. Muhammad Abedi1 [26] decided that the introduction of cloud computing in the delivery of construction projects would contribute to the creation of sustainable construction partners that would be more helpful, more united, and would increase the viability of working together efficiently, in comparison to traditional methodologies and procedures. Through working on cloud systems, building partners may store and obtain development data in real-time.

Several reports have indicated that the advent of mobile devices such as laptops, smartphones, and personal digital assistants may boost the capacity to collect on-site details in real-time. Proof of this can be seen from mobile apps that have been built to track the sustainable development program of the project. The program imports a sustainable building plan into a Microsoft Excel spreadsheet. Construction workers in the office or at any location can, however, have access to and act on the construction site material. The on-demand self-service functionality of cloud storage is advantageous. Cloud computing is more versatile than most computing paradigms. Unlike conventional storage models, cloud computing is a stand-alone venue, which ensures that users can connect and utilize the technology anywhere they have access to the network [19].

In addition, cloud computing enables SMEs to focus more on their core profitable and sustainable business and creativity. Enterprises need to accomplish their effectiveness in improving company value over a long period of time, based on creating an effective business model [27]. All resources, including effort and time, normally devoted to the IT department of the company, can now be spent on other critical business areas. Small and medium-sized businesses, whose primary industry is not IT, do not need to be bothered with preserving or updating their information systems (IS). Rather, they should focus on their core sector to boost the performance and competitiveness of their businesses. It also encourages them to become more creative and to discover new ways of doing business [19]. Afolabi [28] considers that cloud computing helps companies to meet their productivity targets by saving resources, making them more efficient, increasing their operating performance and efficiency, and focusing on their core business rather than non-core operations such as managing and updating infrastructure.

One of the enticing, sustainable benefits of cloud computing is the pricing model, where users pay only what they need. Another similarly linked aspect is the reduction of investment charges through the usage of cloud technology, whereby the user is not forced to participate in the procurement of IT resources [29]. There is no question that the pay-per-use paradigm and the scalability features of cloud computing deliver real advantages to cloud customers. For small and medium-sized businesses in sub-Saharan Africa, minimizing the initial expense of building up IT infrastructure services and reducing operating costs are important concerns to address while utilizing the cloud. Cloud computing helps minimize operational expenses and personnel expertise; the usage of the cloud has also contributed to a decrease in licensing prices for these SMEs to buy from tech vendors. At the same time, the expense of retaining large computational facilities that depend heavily on energy, which is extremely unstable in many parts of Africa, is partly mitigated [30]. Cloud computing is a stand-alone venue, which ensures that the technology can run on a number of computers, independent of the local hardware utilized for the software, rendering it valuable to cloud computing. Cloud computing is more versatile than most computing paradigms. Unlike conventional storage models, cloud computing is a stand-alone venue, which ensures that users can connect and utilize the technology anywhere they have access to the network [19].

CSFs are deemed activities and procedures that must be taken to certify that quality control among stakeholders in the construction industry is successfully enforced and implemented [31]. However, many researchers were exclusively concerned with detecting cloud computing CSFs by the construction stakeholders; there is a lack of appropriate studies about Nigeria. Reducing this shortcoming and filling this gap was obvious by creating an opinion survey of construction stakeholders in Nigeria. The aim is to investigate the CSFs of cloud computing implementation to accomplish sustainable construction projects.

3. Research Methods

This research aims to improve the Nigerian construction industry's sustainable delivery by exploring and evaluating CSFs for the implementation of cloud computing. Figure 1, adopted from Othman et al. [32] Buniya et al. [33], illustrates the study's research stages. It is vital to highlight that the approach adopted for this research is similar to the following researches; Kim et al. [34]; Buniya et al. [35]; Luvara and Mwemezi [36]; Kineber [37] and Shen and Liu [38]. The research started with a critical review of prior studies to select cloud computing CSFs. RII and EFA analyses were carried out; observations were also addressed while different conclusions and recommendations were presented.

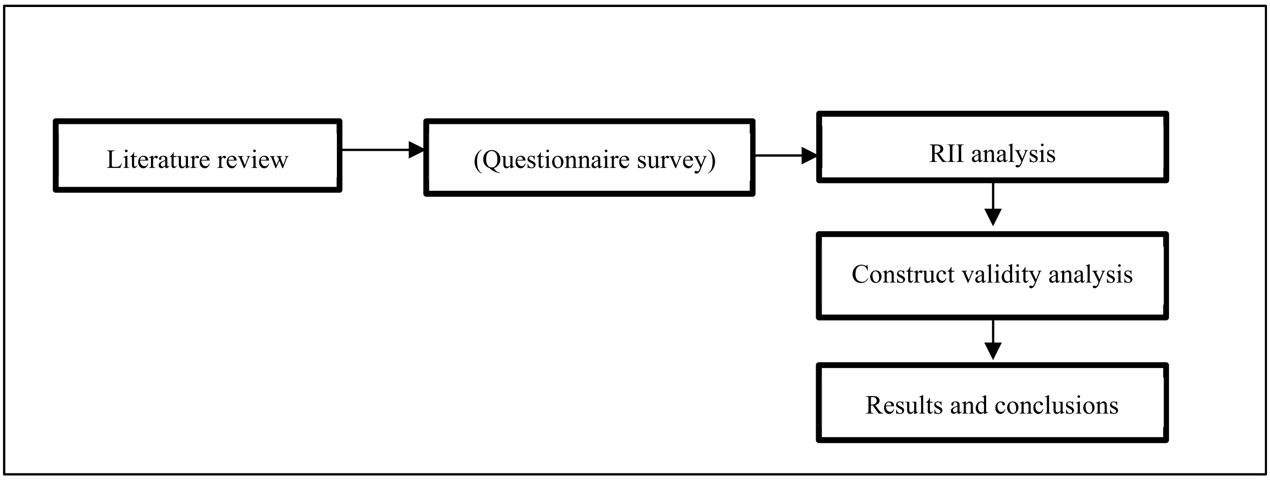

Figure 1. Research flowchart.

3.1. Quantitative Study (Questionnaire Survey)

To categorize and explore the CSFs of cloud computing, the questionnaire survey was subsequently adopted, which examined these CSFs. This questionnaire survey helped to assess the following aspects: (1) attitudes, perceptions, and corporate norms, and (2) linkages between factors, mainly cause-and-effect relationships [39]. The test method (questionnaire) is first proposed by Fellows and Liu [40] to evaluate the questionnaire's intelligibility, the ease of answering, the consistency, and the capacity to construct the questionnaire and decide the time needed for the analysis and sample. This questionnaire study's responses have been focused on perceptions of their involvement in delivering the project, especially architects, engineers, quantity surveyors, and builders. Management experts, general builders, heavy-duty contractors, special contractors or subcontractors, construction staff and managers, operators and users of the building site are all participants in the construction industry.

3.1.1. Relative Importance Index of Cloud Computing CSFs

Besides identifying the cloud computing CSFs, this study used the Relative Importance Index (RII) based variables to reveal the most significant cloud computing CSFs in the Nigerian construction industry. Salleh [41] recognized RII as a statistical approach used to establish the ranking of many reasons, and it is a highly used tool for ranking factors [42–44]. Five-point Likert and RII shall evaluate the responses' events' frequency, and intensity shall be assessed by Equation (1) [45,46].

$$RII = \frac{\sum W}{A \times N} = \frac{5n_5 + 4n_4 + 3n_3 + 2n_2 + 1n_1}{5 \times N} \quad (1)$$

Since W represents the participant's weighting to each attribute, A is the largest value, and N is the total number of respondents. Based on these parameters, the statistical means, the standard deviations, and the RII conducted. Consequently, this measure's ranking is used to cross-compare the relative significance of the CSFs observed by the participants. As a result, this analysis has revealed the most important cloud computing CSFs that have catered to the introduction of cloud computing in the Nigerian construction industry.

3.1.2. Construct Validity Analysis

Exploratory Factor Analysis (EFA) Confirmatory and Factor Analysis (CFA) methods are commonly used for factor analysis. In this research, CFA is used to test the structure underlying various variables in certain theories. On the other hand, EFA is used to collect knowledge about interactions and several factors and limit many variables to a few underlying structures. It is one of the Statistical Package features for the Social Sciences (SPSS) [47].

In the present study, core multivariate analysis techniques, such as EFA, sponsored by the researcher to investigate the primary constructs of cloud computing CSFs. It has been used to determine the validity of the constructs by determining the adequacy of the specific constructs' measurement components (i.e., the measurement models) in terms of their non-dimensionality, reliability, and validity. "It is worth noting that Principal Component Analysis (PCA) was chosen over Principal Axis Factoring (PAF), Image Factoring, Maximum probability, and alpha Factoring since PCA is more reliable and less conceptually complex" [48]. PCA is supported with no prior hypothesis or model and when preliminary solutions are defined in the EFA [47]. Thompson [49] stated that PCA is the default type in many statistical programs and is thus most commonly used in EFA. The varimax rotation approach was favored over direct oblimin or Promax since varimax rotation maximizes load dispersion between variables. Varimax is also suitable for smaller factor analysis and is an outstanding standard concept that simplifies factors [50]. The number of respondents can be seen as a representative sample around the relevant ranges [51]. Consequently, the 15 identified parameters, and with the filled questionnaires obtained from 103 respondents used in the present research, are also deemed appropriate for factor analysis [52].

4. Data Collection

This research focuses on the adoption of cloud computing practices for the effective execution of construction works in the Nigerian construction industry, a convenient sampling technique was adopted to get the available information from the targeted population. The sampling technique was adopted due to the large population of construction stakeholders in the country.

The samples of the study using the EFA analysis must be between 45 respondents, and 61 respondents were approved and considered with comparatively short responses. However, all appropriate statistical tests were carried out [52]. For the current study, the sample number is 137, and the reverted and acceptable are 104, which with a proportion of around 76%, which is well within the range [52]. In the initial part of the questionnaire, separate objects gather demographic responses from participants. In the second part, the cloud computing CSFs were rated using "a 5-point Likert scale with 5 = very high, 4 = high, 3 = average, 2 = low, and 1 = very low" and often used in several previous studies [53,54]. The data obtained from this rating was used to compute the Relative importance Index (RII) as well as standard deviation results. Same was also used for factor analysis computation. Table 1 indicate 15 possible cloud computing CSFs identified from previous studies.

Table 1. Cloud computing CSFs.

S/N	CSFs	[55]	[15]	[29]	[19]	[56]	[57]	[58]	[59]
1	Competitive pressure from within the industry	✓	✓		✓	✓	✓		✓
2	Size of the organization	✓	✓	✓	✓				✓
3	Capacity of the organization	✓	✓	✓	✓				✓
4	Structural template (necessary infrastructure needed)	✓	✓	✓	✓				✓
5	Specialized human resources	✓	✓	✓	✓				✓
6	Nature of the industry	✓	✓		✓	✓	✓		✓
7	Technological advancement	✓			✓		✓	✓	✓
8	Willingness of clients							✓	✓
9	Availability							✓	✓
10	Reliable data storage			✓	✓			✓	
11	Performance			✓					✓
12	Cost of accessibility								
13	Perceived ease of use	✓				✓			✓
14	Privacy		✓			✓			
15	Client's readiness								✓

5. Results and Findings

5.1. Background Information of Respondents

This section examined the basic characteristics of respondents as well as participants' understanding and awareness of cloud computing technology. From the analysis in Table 2, it can be deduced that most of the firms have between 6 to 10 years of professional operation with (28 respondents representing 26.9%), 11 to 15 years of professional experience has a frequency of 24 (23.1), less than five years is with a frequency of 10 (13.5%) while 15 to 20 years have the frequency of 9 (8.7%) and above 21 years share with of 1 frequency (1.0%). It can be said that most registered firms have been in operation for between 6 to 10 years. Quantity surveyors are 41 representing 39.4% of the professionals, Architects with a frequency of 26 and 25% of the collected data, Engineers amount for 21.2% of the respondents. Regarding the registration of respondents with their respective professional regulatory bodies, 27 are registered with QSRBN (Quantity Surveyors Registration Board of Nigeria) indicating 26% of the respondents, 12.5% are registered with CORBON (Council of Registered Builders of Nigeria), 24% are registered with ARCON (Architects Registration Council of Nigeria) while 21 are registered with COREN (Council for the Regulation of Engineering in Nigeria). The analysis also shows the level of academic qualification of the respondents with indications that majority of the respondents are bachelor degree

(BTech/BSc) holders with 46 (44.2%) of the respondents, Master's Degree (MSc/MTech) holders are 39 (37.5%), Ph.D. holders are 13 (12.5%) while HND (higher national Diploma) holders come last with a distance 6 (5.8%) of the respondents. In the analysis, it can be deduced that the involvement of construction professionals with cloud computing practices is very high, with the result in Table 2 showing 95.2% of the respondents have been involved in cloud computing practices. Furthermore, the cloud's awareness is very high, with the result in Table 2 showing that 96.2% of the professionals are familiar with cloud computing and the practices.

Table 2. Demographic characteristic frequency distribution.

Variable	Characteristics	Number of Respondents	(%)
Years of operations of the organization	Less than 5 years	10	9.60
	6 to 10 years	28	26.90
	11 to 15 years	24	23.10
	15 to 20 years	9	8.70
	Above to 21 years	1	1.00
Profession	Architect	26	25.0
	Builder	15	14.4
	Quantity surveyor	41	39.4
	Engineer	22	21.2
	Total	104	100.0
Professional qualification	QSRBN	27	26.00
	CORBON	13	12.50
	ARCON	25	24.00
	COREN	21	20.20
	NO QUALIFICATION	18	17.30
Academic qualification	HND	6	5.80
	B.Sc/B.Tech	46	44.20
	MSc/MTech	39	37.50
	PhD	13	12.50
Involvement of cloud computing practices	Yes	99	95.20
	Maybe	3	2.90
	Missing	2	1.90
Awareness	YES	100	96.20
Awareness	MAYBE	3	2.90
	NO	0	0.00

5.2. RII of Success Factors Influencing Cloud Computing Adoption

The approach was used in this study to assess the relative importance of CSFs influencing cloud computing application. The value of the RII set is between 0 and 1, and 0 is not used. It is read as follows; the higher the RII value, the more important tasks are and vice versa. As suggested by Chen et al. [60]. The transition matrix is an evaluation of the RII with an acceptable degree of significance and a derived level of value from the RII, as follows:

High (H)	0.8 < RII < 1.0
High-Medium (H-M)	0.6 < RII < 0.8
Medium (M)	0.4 < RII < 0.6
Medium-Low (M-L)	0.2 < RII < 0.4
Low (L)	0.0 < RII < 0.2

Table 3 and Figure 2 show that reliable data storage is the most influencing success factor driving the adoption of cloud computing in the construction industry, with a high level RII value of 0.89, which significantly shows that it is of high importance to the construction industry.

Table 3. The relative importance of cloud computing CSFs.in the Nigerian construction industry.

CSFs	Code	RII	Std. Deviation	Rank	Importance Level
Reliable data storage	CSF1	0.89	0.61	1	H
Performance	CSF2	0.852	0.56	2	H
Cost of accessibility	CSF3	0.826	0.59	3	H
Availability	CSF4	0.818	0.54	4	H
Perceived ease of use	CSF5	0.812	0.56	5	H
Technological advancement	CSF6	0.806	0.65	6	H
Nature of industry	CSF7	0.794	0.66	7	H-M
Privacy	CSF8	0.78	0.70	8	H-M
Capacity of organization	CSF9	0.778	0.72	9	H-M
Competitive pressure from within the industry	CSF10	0.754	0.68	10	H-M
Specialized human resources	CSF11	0.752	0.66	11	H-M
Structural template	CSF12	0.748	0.70	12	H-M
Size of the organization	CSF13	0.728	0.85	13	H-M
Client's readiness	CSF14	0.706	0.69	14	H-M
Willingness of clients	CSF15	0.694	0.69	15	H-M

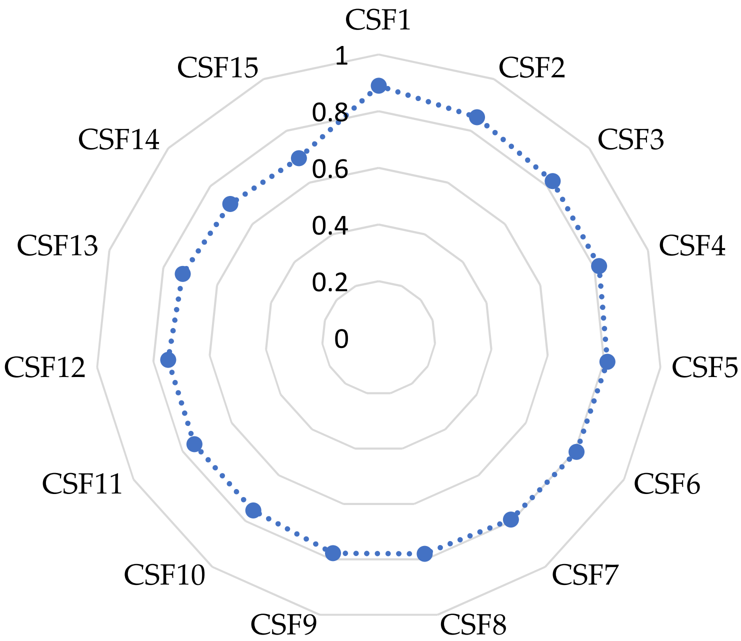

Figure 2. RII levels for cloud computing CSFs.

Clients willingness and readiness can be considered slightly above average with both sharing 0.65, respectively. At the same time, drivers such as performance, perceived ease of use, availability, cost of accessibility, privacy, nature of the industry, size of an organization, specialized human resources, competitive pressure from within the industry and structural template can also be deduced to be good drivers of cloud computing adoption according to the analysis.

5.3. EFA for Cloud Computing CSFs

Several well-known parameters for the factorability of a connection have been used. KMO can be adopted to assess factor homogeneity and it is popularly adopted to evaluate whether the variables' partial correlations are minimum [61]. Table 4 shows the Kaiser–Meyer–Olkin Measure of Sampling Adequacy (KMO). The data retrieved were suitable for factor analysis to be carried out, and Bartlett's Test of Sphericity for correlation adequacy between the variables was highly significant. Bartlett's Test of Sphericity indicates whether a data or the sampling considered can be used for factor analysis. The sampling adequacy test was carried out, making use of Kaiser–Mayer–Olkin (KMO = 0.77), which signifies 77% of the data gathered were satisfactory for factor analysis [61]. Table 4 also shows that the p-value considered is <0.05, which implies that the data is suitable for factor analysis with a degree of freedom of 105 and an approximate chi-square of 683.97 for this data, Bartlett's test is highly significant (p-value = 0.000), suggesting that the correlation is an identity matrix, which means that the correlation matrix of all the item listed has a significant correlation at the 5% level. Therefore, exploratory factor analysis is appropriate [51,62].

Table 4. KMO and Bartlett's test result related to VM activities.

KMO and Bartlett's Test		
Kaiser–Meyer–Olkin measure of sampling adequacy.		**0.77**
Bartlett's Test of Sphericity	683.97 105 0.00	785.87 55 0.00

As shown in Table 5, Principal Component Analysis (PCA) revealed the presence of four components with eigenvalues exceeding 1, explaining 23.1, 19.6, 12.7, and 12% of the variance, respectively. However, inspection of the scree plot revealed a clear break after the second component. The point where the slope of the curve is leveling off indicates the number of factors that should be generated by the analysis (Figure 3).

A model with four items may be adequate to represent success factors influencing cloud computing adoption in Nigerian construction. The factor grouping based on the varimax rotation is shown in Table 6, and each variable weighs heavily on only one of the factors. Before the interpretation of the four extracted factors, it is important to name these factors. The naming of these factors was based on the uniqueness of the variables under each group. Each factor is labeled and interpreted as shown in Table 7: industry-based factor, organization factor, client's acceptance, and human satisfaction.

Table 5. Success Factors Total Variance Explained.

Component	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.93	32.87	32.87	3.47	23.14	23.14
2	2.32	15.45	48.32	2.93	19.56	42.69
3	1.77	11.82	60.14	1.90	12.67	55.36
4	1.07	7.15	67.29	1.79	11.93	67.29
5	0.93	6.17	73.46			
6	0.67	4.47	77.93			
7	0.61	4.09	82.03			
8	0.59	3.92	85.95			
9	0.43	2.86	88.81			
10	0.41	2.70	91.51			
11	0.37	2.48	93.99			
12	0.30	1.20	95.98			
13	0.22	1.49	97.47			
14	0.20	1.31	98.78			
15	0.18	1.22	100.00			

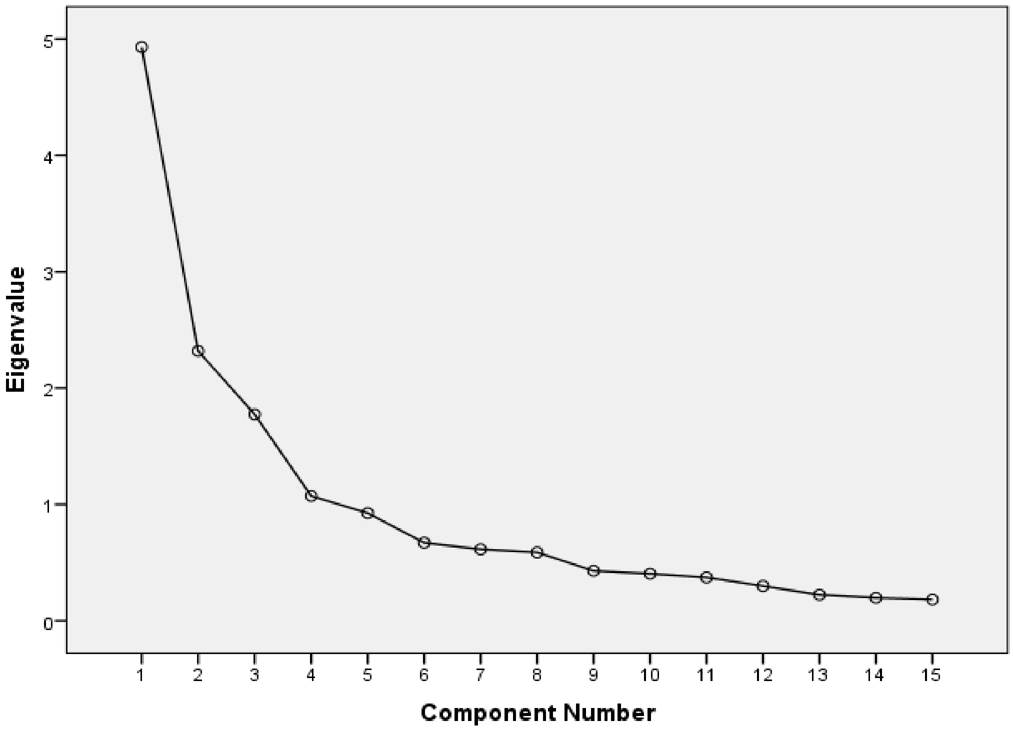

Figure 3. The scree plot of loading of the success factors influencing the adoption of Cloud Computing in Nigerian construction industry.

Table 6. Success Factors Rotated Component Matrix.

CSFs	F1	F2	F3	F4
Competitive pressure from within the industry	−0.21	0.53	0.17	0.61
Size of the organization	0.02	0.88	−0.07	0.07
Capacity of organization	0.21	0.71	0.05	0.06
Structural template	0.12	0.82	0.10	0.08
Specialized human resources	0.32	0.64	0.20	0.09
Nature of industry	0.03	0.10	0.15	0.82
Technological advancement	0.42	0.00	0.12	0.71
Willingness of clients	0.13	0.07	0.87	0.31
Clients readiness	0.17	0.15	0.91	0.07
Privacy	0.63	−0.25	0.33	−0.03
Availability	0.77	0.04	0.02	0.12
Perceived ease of use	0.69	0.21	0.06	−0.13
Performance	0.81	0.28	0.15	0.04
Cost of accessibility	0.64	0.17	0.26	0.24
Reliable data storage	0.71	0.21	−0.04	0.15

Rotated Component Matrix of factors influencing women wellbeing in the construction industry.

Table 7. Related component of the success factors influencing the adoption of cloud computing in the Nigerian construction industry.

Factor Component	Variables	Factor Loading
Human-Satisfaction	Availability	0.77
	Privacy	0.63
	Perceived ease of use	0.69
	Performance	0.81
	Cost of Accessibility	0.64
	Reliable Data Storage	0.71
Organization Factor	Size of Organization	0.88
	Capacity of Organization	0.71
	Structural Template	0.82
	Specialized Human Resources	0.64
Clients Acceptance	Willingness of Clients	0.87
	Clients readiness	0.91
Industry based factor	Competitive pressure from within the industry	0.61
	Nature of Industry	0.82
	Technological Advancement	0.71

6. Discussion

Construction projects significantly influence the economy, culture, and the social over their entire life cycle [63] and more productive and sustainable processes, specialized procedures and materials have been implemented. [64]. In the sustainability perspective of construction companies, it has been observed that they face a range of challenges when they mature and have a positive societal, and economic influence [65]. The construction industry needs significant, sustainable growth [66]. Consequently, techniques are required to have a clear view of the situation of project adoption [67]. Cloud computing has been identified as being able to bring sustainability to construction initiatives because it uses a variety of information technologies, substantial procedures, facilitated climate change, constructive scheduling, and collaborators and professional disciplines. However, Cloud Infrastructure integration analysis focused on factors that influence the effective adoption of Cloud Computing in developing countries.

Nonetheless, no single research has explored or assessed the CSFs that inspire the implementation of cloud computing in the construction industry. The current study is aimed to fill this gap by highlighting the cloud computing CSFs for achieving the construction project sustainability, using Nigeria as a case study. The following parts discussed the EFA factors according to the analysis mentioned above.

The first factor is human satisfaction, and it contains six items: availability, privacy, perceived ease of use, performance, cost of accessibility, and reliable data storage. Those that received higher loading are performance, availability, and reliable data storage. These findings support the position of Gangwar, Date and Ramaswamy [58], who examined performance and availability as the factors that influence the adoption of cloud computing. The second principal factor is labeled as organization factor, which accounts for 19.6% of the observed total variance and contains four items: size of organization, capacity of organization, structural template, and specialized human resource. Those that received higher loading are: size of organization and structural template, which are related to the findings of Oliveira, Thomas and Espadanal [55], Gangwar, Date and Ramaswamy [58] that firm size and structural template are needed for the adoption of cloud computing and that bigger firms having the wherewithal to facilitate the adoption of cloud computing. The third principle factor is categorized as the Client's acceptance. This accounts for 12.7% of the total variance and contains two items: the willingness of clients and clients' readiness, which agree with [19] result that top management support and willingness of stakeholders efficiently influence the adoption of cloud computing the construction industry. The last principal factor is the industry-based factor, which comprises of nature of the industry, competitive pressure from within the industry, and technological advancement. This corroborates Oliveira, Thomas and Espadanal [55]'s assertion that technological advancement, competitive pressure from within the industry, and the Nature of the Industry highly influence the adoption of cloud computing in the construction industry in order to improve the innovation during the project life cycle since Innovation is one of the biggest forces that could be maintained by a realistic approach to resource enhancement [68].

The analysis disclosed some CSFs for the adoption of cloud services. Public engagement with the legislative system for the implementation of the right policies Frameworks are the needs of developed countries [69]. Cell telephony broadcasting, for example, took place in many developing countries, such as India Sharma et al. [70], China Liu et al. [71] and Brazil Mahan et al. [72], following government interference by appropriate policies. Chen [73] also highlighted the role of government policy and their effect on technology. The higher share of Chinese companies in the global cloud market was the product of government policy on structural and economic factors Kshetri [74]. Specific guidance on privacy and legal enforcement for cloud providers can help them to resolve the challenges they face in delivering cloud services, such as the lack of clarity perceived by users [69]. Protection and standardisation of cloud technology at national level help to control this infant industry and improve service efficiency. The concept of identified variables and partnerships, along with policies in place, will help emerging countries to implement cloud infrastructure in various fields, thus bridging the digital gap between developed and developing countries. In addition, senior management wants to hire and include processes to train employees with expertise and skills to improve their absorption ability to build cloud-based applications/products and to procure and incorporate cloud services offered by providers. Providers should follow diverse policies specific to the market demands and needs of nations [69]. Service providers can concentrate on knowledge raising by holding small seminars on firm-level specific programmes.

7. Conclusion

This research aims at examining the current level of adoption of cloud computing in construction projects in Nigeria, as well as rating and prioritizing the adoption of cloud computing CSFs, which were gathered from previous studies and analyzed by RII and EFA. The study has revealed that the adoption of cloud computing in Nigeria's construction sector is very high. The bulk of surveyed companies that use cloud computing, with 95.2 percent of respondents engaging in cloud computing activities. The analysis of the collected data was based on descriptive statistical tools. In this study, the RII evaluated the cloud computing CSFs among construction stakeholders. The CSFs ranking established that secure data storage, efficiency, usability cost, and availability were the four most important CSFs for cloud computing applications. The knowledge derived from this study is meant to be useful in practice and academia. Results may also define possible success points in practice such that sufficient standard disciplinary steps may be proactively implemented based on cloud computing characteristics. The study offered insights into current knowledge and hypotheses, including CSFs of cloud computing technology for sustainable construction management. This will help stakeholders shouldered with the responsibility of monitoring and controlling construction activities with the required skills and necessary details for sustainable management of construction projects. Additionally, the findings of this study lead to the introduction of cloud computing in Nigeria's construction projects by understanding the goal of cloud computing to develop the sustainable construction industry.

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