

Local Cloud Computing Service Adoption in Nigeria: Challenges and Solutions

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Abstract: Cloud momentum seems unstoppable in Nigeria, as businesses and organizations in the country see less and less advantage in the slog of maintaining their infrastructure. The shift to the cloud in today's COVID-19 driven world has created an opportunity for investments to improve local cloud computing services. However, there are key challenges that must be addressed by the local cloud service providers in the country in order not to lose out to the foreign cloud service providers. This paper assessed the challenges to local cloud computing services adoption among sixty-seven (67) businesses and organizations in Nigeria. The research employed a non-probability purposive sampling approach. The surveyed data were obtained through an online form which was distributed via LinkedIn. Descriptive and inferential analysis was used in analyzing the collected data via IBM SPSS software. Findings from the research showed the key challenges to include inadequate awareness of local cloud service vendors, poor innovation and local content, inadequate cloud infrastructure, local cloud vendor interoperability issue, national insecurity, shortages in skilled personnel, Service Level Agreement (SLA), security strategies, privacy, compliance terms, and requirements issues. Thus, adequate local cloud service offerings, skilled personnel, and the IT infrastructural backbone of the country have to be well established to increase the trust in local cloud computing, open up Nigeria to offshore markets while driving economic competitiveness and growth.

Index Terms: Cloud computing, Cloud providers, Cloud services, Cloud challenges, COVID-19, Nigeria.

1. Introduction

The popular trend in today's COVID-19 driven world is 'Cloud Computing'. As defined by the National Institute of Standards and Technology (NIST), "*cloud computing is a model for enabling convenient, ubiquitous, on-demand network access to a common pool of configurable computing resources (e.g., servers, networks, storage, services, and applications) that can be rapidly provisioned and released with minimal management effort or service provider interaction*" [1-4]. It provides a modern alternative to the vulnerabilities of the conventional, non-cloud-based technology architecture [5]. From a business angle, it is understood as an economic model for renting computing resources. It allows organisations to use ready-to-use application services via a "pay-as-you-go" model that saves time, resources, and cost [6-8].

Historically, computing has gone through evolutions over the years starting in the 1960s with mainframe data centre computing [9]. This was preceded by personal/minicomputer computing. At a later stage, we landed into an era of the distributed framework called the Client-Server computing which led to the actualization of the Web and the Internet. Presently, virtualization within networks has led to the evolution of cloud computing [2, 10, 11].

Services offered on the cloud are available in various service models such as Infrastructure as a Service (IaaS), Software as a Service (SaaS), and Platform as a Service (PaaS) [5, 3]. Also, four deployment models were identified for cloud architectural solutions; private cloud, community cloud, hybrid cloud, and public cloud [10, 7, 12-14].

While cloud computing is receiving huge acceptance in advanced countries, supported by the respective governments, its adoption in Nigeria remains relatively poor as local organisations find it hard to overcome their resistance and reluctance towards having their technological assets managed and hosted by third parties [15]. Infrastructural issues such as erratic electricity supply, poor internet service quality, complicated legal framework are part of the militating factors [6, 12]. These factors for the slow uptake of cloud computing in the country have denied Nigeria important revenue gains and growth opportunities, competitiveness, skills development, job creation, etc. [6, 12].

Fortunately, the COVID-19 lockdown has challenged businesses operating their critical facilities on-premise; from managing facility spares, staffing those facilities round the clock, arranging fuel supply and logistics, and making sure everything continues operating to support their organisations during the lockdown [16]. Thus, the organisations that will come out of the pandemic stronger must master the balance between investing to grow tomorrow and cutting costs to survive today. Today, most organizations are now adopting remote working, e-learning solutions, and virtual collaboration, all of which are enabled by the cloud-based infrastructure to protect their business [16, 5].

Indeed, cloud-service vendors are emerging as the superheroes of these times with telecommunications firms differentiating their offerings while broadening their revenue sources by taking advantage of their existing infrastructure and offering cloud computing services [5, 15]. The prediction is that even after this pandemic, there will be an addition in the number of organisations relying on these vendors to effectively conduct business. Organisations would be more connected and more comfortable with cloud solutions and the reliance on local cloud service vendors for connectivity would generally be better than pre-COVID-19 days [5].

This is because businesses and organizations with their cloud services hosted locally experienced exceptional performance from quick and easy access to their data while mitigating risks of submarine cable outages. Also, it allows them to know the physical location of their data, despite being in the cloud, which helps them comply with the data sovereignty requirements of Nigeria. Further, fault resolution and technical support are better and faster as they can work more quickly with their cloud service vendor, and determine security techniques that are tailored to suit their specific needs. Besides, there is no foreign exchange component, leading to stability in cost [17, 18].

While the demand is growing as seen in the exceptional increase in demand for cloud resources of cloud service providers, the supply needs a lot of work [5]. This creates an opportunity for investments to improve local cloud computing services. Domestic cloud companies like Layer3Cloud, CyberCloud, Rack Center, Internet Solutions Nigeria, Cloudflex Computing Services Limited, VELVOT Nigeria Limited, Descasio Limited, GloCloud, MainOne's MDXi, and MTN Cloud will need to increase their capacity to support the increasing demand [19].

Meanwhile, organisations such as Amazon, Microsoft, Google, Alibaba, etc. see an opportunity for growth fuelled by increasing demand. Thus, by deepening their play and making an early entry into the Nigerian cloud space, they can build the infrastructure for future demand and capture a huge stake in the sector [19].

This highlights the imperative for reliable cloud computing services by local cloud service vendors. However, the increasing move by businesses to the local cloud will require local cloud service providers in the country to address key challenges in order not to lose out to the foreign cloud vendors. Thus, in this paper, we assess the challenges and proffered solutions underneath the success of local cloud computing services adoption in Nigeria. The study is significant as it helps create public attention of local cloud computing service vendors in Nigeria.

The paper is structured as follows—in the next section, 2, the paper provides a review of related literature. This is followed in Section 3 by the study research questions and research hypotheses in Section 4. In Section 5, we explain the research methodology adopted. The key challenges that must be addressed by the local cloud service vendors in the country are assessed and discussed in Section 6. Section 7 proffered solutions underneath the success of local cloud computing services adoption in Nigeria. Finally, Section 8 provides the paper's conclusion.

2. Literature Review

The literature review proves that several cloud computing studies in Nigeria are available and reviewing them is the best way to unravel the connections among each other. In [20], the authors provided an analysis of the cloud computing security challenges with a focus on the cloud computing types and the service delivery types. Cloud interoperability, service level agreement (SLA), charging model, costing model, security were the major challenges highlighted.

[21] offered an insight into cloud computing and its history while investigating the resistance of businesses to the usage of cloud services. Also, the author discussed the prospects of leveraging cloud computing in offering business services and operations in the leading sectors of Nigeria. Finally, the paper suggested approaches to overcoming the resistive attitudes towards cloud computing.

[11] presented an overview of cloud computing. The study included an explanation of the deployment models of cloud computing, the service model of cloud computing, the terminologies used in cloud computing, the attributes of cloud computing, the trend of cloud computing, and its challenges.

[12] studied the factors mitigating cloud computing adoption in Nigeria. First, the authors presented the advantages and disadvantages of cloud computing. They outlined the issues preventing the uptake of cloud computing and factors favoring and nurturing the adoption of cloud computing by businesses in Nigeria. Finally, suggestions for the uptake of cloud computing by stakeholders in Nigeria were provided.

[22] explored the fundamental ideas of cloud computing and how it can be leveraged to overcome challenges such as lack of basic information technology (IT) infrastructure, high tariff, slow network services, etc., and enhance IT usage/economic development in the West Africa sub-region.

[23] discussed the state of cloud uptake in small and medium enterprises (SMEs) in Nigeria, the issues and challenges faced by its adoption by SMEs. These challenges as provided included government policies, infrastructure,

security, reliability, the user's trust, service providers, payment, etc. Finally, the impact of cloud service uptake in Nigeria was presented.

[24] surveyed the nature and level of cloud computing adoption and deployment among IT experts and companies in Nigeria. The author identified the major challenges in the full adoption and deployment of cloud computing to include security, privacy, and forensic. Finally, suggestions to sustain the need for progression in cloud computing were elucidated.

[3] discussed the gains cloud services hold for the economy of Nigeria. Also, the study identified and reviewed the issues of the uptake of cloud services in the country. Further, the authors proposed a deployment model for cloud computing to overcome the challenges facing cloud computing in Nigeria about the operation and deployment of cloud services and platforms.

[10] studied cloud computing in Nigeria. The paper presented a review of the challenges and benefits caused by the uptake of cloud computing. Further, the study proposed ways of maximizing the gains of cloud computing while minimizing the issues that could occur as a result of its adoption.

[1] investigated cloud computing adoption in Nigeria. The authors highlighted the challenges and gains of adopting cloud services while discussing the services offered by cloud computing. Suggestions were made on methods to increase the uptake of cloud computing in the country.

[2] examined the issues of cloud computing uptake in Nigeria, considering the country's peculiarities' concerning infrastructural development. The study established the huge benefits derivable from the adoption of cloud computing by businesses in the country. However, the issues as highlighted in the study could be mitigated with efforts by the major stakeholders and government.

[4] analyzed and compared the issues facing the uptake of cloud computing from Norway and Nigeria. An institutional theory perspective was adopted as a framework for analysis. Findings from both countries showed that there were various challenges to cloud computing uptake that are related but affect adoption decisions in various ways.

[9] investigated the state of cloud computing adoption in Nigeria. The study discussed the fundamental concepts of cloud computing, characteristics, the major stakeholders, deployment models, and service models. Findings from the study showed that implementation of cloud computing had started, and was thriving in the business, finance, and oil sectors of Nigeria. Recommendations on expanding participants of cloud computing to include the health sector, small and medium scale enterprises, etc. were suggested.

[25] studied the factors responsible for the slow uptake of cloud computing in organisations in Nigeria. The study focused on the perception of non-IT and IT staff towards cloud computing. Besides, the authors reviewed the related studies on cloud adoption in enterprises to understand the motivating factors behind cloud computing adoption. A developed 3AI (Acceptance, Awareness, Adoption, and Integration) model was conceptualized that analysed the workflow involved in cloud services adoption. Findings from the study identified cyber threats, privacy issues, employee misconception of job loss, and data theft as major delimitative reasons.

[26] examined the adoption of cloud computing in government organisations in Nigeria, the gains, issues faced when deploying cloud computing, and the solutions to these challenges. Findings from the study revealed that the wreckage of infrastructure, lack of stable power, lack of awareness, and insecurity were among the challenges for the slow adoption. However, the authors noted that having qualified staff to handle security issues, spending more on IT infrastructure, and creating awareness on cloud computing could address these problems.

[27] investigated the challenges and impact of cloud computing on small and medium enterprises (SME's) in Nigeria. The impacts identified range from reshaping and extending organisation values, provisioning IT infrastructures, and outreach to giving a competitive advantage to organisations subscribed to it. Further, the study highlighted the challenges to include vendor lock-in, data vulnerability, and restricted control over the infrastructure by the subscribers.

[28] appraised the trends, challenges, and significance of the application of cloud computing in the electronic-learning system in North-East, Nigeria. Findings from the study showed that cloud computing played an important role in improving teaching and learning activities. Also, security was identified as a major issue to the successful deployment of cloud computing applications.

[29] presented an analysis of leading local cloud computing solution vendors concerning their operations, availability, deployment model, responsiveness, speed, repudiation offer, authenticity while educating users on the vendor or to select for their numerous services.

[30] examined the issues of the uptake of cloud computing in government organizations in Nigeria with a focus on IT administrators' view of fault tolerance and data security. The results of the multiple regression were significant with the perception of data security being the singular significant predictor of IT administrators' intention for cloud computing adoption.

While the previous studies have focused on cloud computing architecture, costs, potential applications, and benefits, the challenges and solutions underneath the success of local cloud computing service vendors in Nigeria in order not to lose out to the foreign cloud providers have received little attention in today's COVID-19 driven world. This study hopes to fill the gap.

3. Research Questions

The following questions were raised in line with the objectives of this study:

- What are the key challenges facing local cloud services adoption by businesses and organisations in Nigeria?
- How can these challenges be addressed by both the government/regulatory bodies and local cloud service providers?

4. Research Hypotheses

The following hypotheses were formulated in their null forms.

- There is no significant difference in the local cloud service awareness mean level of survey respondents across industries
- There is no association between national insecurity and the geographical region of the respondent's organization as a challenge facing local cloud services adoption.

5. Research Methodology

The methodology for the study is discussed as follow:

5.1. Sampling design

The study employed a non-probability purposive sampling technique. The sampling technique was influenced by the desire to avoid the duplication of a business or organization's participation in the study. However, a total of sixty-seven (67) businesses and organizations cut across the six geographical regions (that is, North-Central-17 (representing 25.4%), North-West-7 (representing 10.4%), North-East-2 (representing 3.0%), South-East-5 (representing 7.5%), South-South-8 (representing 11.9%), South-West-28 (representing 41.8%)) participated in the study conducted in August 2020. For this reason, the research results cannot be generalized to the whole of Nigerian society. However, it is possible to draw implications from the survey to businesses and organizations with a similar operation.

All respondents were high-ranking staff with a clear understanding of what cloud computing is. Table 1 shows there was one respondent (that is, 1.5%) each from the following six industries: Audit, Consulting & Analytics, Legal profession, Manufacturing, Marketing Services, and Transportation, travel and tourism, two (that is, 3.0%) were from the Non Governmental organization (NGO) sector; four (that is, 6.0%) were from Financial services and Government (Agencies/parastatals); seven (that is, 10.4%) were from the Energy and natural resources sector; 19 (that is, 28.4%) were from the Education industry while 25 (that is, 37.3%) operate in the IT and Technology sector.

Also, 24 (that is, 35.8%) of the organizations in the research survey were large organizations with annual revenue exceeding 100 million naira and another 4 (that is, 6.0%) with annual revenue between 51 million and 100 million naira, thus putting them in the financial capacity to invest in both on-premise and cloud computing. Further, 10 (that is, 14.9%) of the organizations generate less than a million naira as annual revenue, another 6 (that is, 9.0%) generating between 1 million and 50 million naira while 3 (that is, 4.5%) generates zero revenue. However, 20 (that is, 29.9%) of survey respondents do not know the organization's approximate annual revenue in naira. This is likely because the respondent's position in the organization does not relate to finance.

5.2. Data collection

For the study, data were obtained through an online questionnaire form. The research online questionnaire form was created via Google Form. The form link was distributed by the researchers via LinkedIn. The use of Google Form allows for the data to be generated digitally, imported, and analyzed for descriptive and inferential statistics via SPSS software.

5.3. Data analysis techniques/tool

The choice of SPSS software as the statistical tool for the study was influenced by the researcher's familiarity with the software. Also, the one-way analysis of variance (One-way ANOVA) was picked as the inferential test statistics because of its relevance to investigate the significance of the difference in mean of awareness level of survey respondents across industries while the Chi-Square of Independence was influenced by its usefulness to explain the association between national insecurity and the geographical region of respondent's organization with regards to local cloud service adoption.

Table 1. Cross-tabulation of survey organizations (revenue and industry)

		Organisation's approximate annual revenue in naira						Total	
		1 million - 50 million naira	51 million -100 million naira	Do not know	Less than 1million naira	No revenues (e.g. early-stage startups)	Over 100 million naira		
Industry that the organisation primarily operate within	Education	Count	1	0	6	4	3	5	19
		Organisation's approximate annual revenue in naira	16.7%	0.0%	30.0%	40.0%	100.0%	20.8%	28.4%
	IT and technology	Count	4	2	8	4	0	7	25
		Organisation's approximate annual revenue in naira	66.7%	50.0%	40.0%	40.0%	0.0%	29.2%	37.3%
	Energy and natural resources	Count	0	0	2	0	0	5	7
		Organisation's approximate annual revenue in naira	0.0%	0.0%	10.0%	0.0%	0.0%	20.8%	10.4%
	Legal	Count	0	0	0	1	0	0	1
		Organisation's approximate annual revenue in naira	0.0%	0.0%	0.0%	10.0%	0.0%	0.0%	1.5%
	Manufacturing	Count	0	0	0	0	0	1	1
		Organisation's approximate annual revenue in naira	0.0%	0.0%	0.0%	0.0%	0.0%	4.2%	1.5%
	Government (Agencies/parastatals)	Count	0	1	3	0	0	0	4
		Organisation's approximate annual revenue in naira	0.0%	25.0%	15.0%	0.0%	0.0%	0.0%	6.0%
	Financial services	Count	1	0	0	0	0	4	5
		Organisation's approximate annual revenue in naira	16.7%	0.0%	0.0%	0.0%	0.0%	16.7%	7.5%
	Non-Governmental organization (NGO)	Count	0	0	1	0	0	2	3
		Organisation's approximate annual revenue in naira	0.0%	0.0%	5.0%	0.0%	0.0%	8.3%	4.5%
	Marketing Services	Count	0	0	0	1	0	0	1
		Organisation's approximate annual revenue in naira	0.0%	0.0%	0.0%	10.0%	0.0%	0.0%	1.5%
	Consulting & Analytics	Count	0	1	0	0	0	0	1
		Organisation's approximate annual revenue in naira	0.0%	25.0%	0.0%	0.0%	0.0%	0.0%	1.5%
	Total	Count	6	4	20	10	3	24	67
		Organisation's approximate annual revenue in naira	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

6. Results and Discussion

The study results on the key challenges confronting local cloud computing service adoption in the country are presented and discussed as follow;

6.1. Inadequate awareness of local cloud service vendors

Inadequate awareness has been identified as the leading challenge affecting the uptake of local cloud computing in the country. Ninety-Seven Percent (97.0%) of all respondents agreed that adequate awareness can help create the right perception of local cloud computing benefits and alleviate the concerns of various stakeholders towards local cloud vendors adoption compared to 3.0% who consider it insignificant as shown in Fig. 1.

This could be a consequence considering that foreign cloud vendors such as Amazon, Microsoft, and Google are more established and well known by businesses and organisations in the country. Given the market potential, this

insight is important to the local cloud vendors as it shows the extent of the foreign cloud vendors' penetration within the past years.

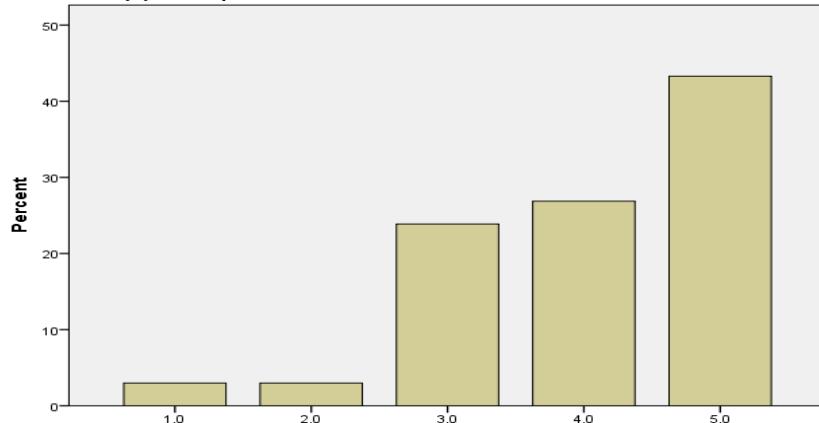


Fig.1. Inadequate awareness of local cloud service vendors as a challenge to local cloud computing adoption (1 -not significant, 5 -very significant)

As shown in Table 2, there is no statistical difference in the local cloud service awareness mean level of survey respondents across industries with regards to local cloud service adoption.

Table 2. ANOVA of awareness level of survey respondents across industries

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	12.892	9	1.432	1.408	.206
Within Groups	57.973	57	1.017		
Total	70.866	66			

Note: Significant level = 0.05

6.2. Poor innovation and local content

Another leading building block to local cloud uptake lies in the development of cloud computing content. 26.9% of the surveyed respondents strongly agreed that local cloud vendors lack the bespoke infrastructure suited to their needs, or that offers a closer cultural fit, indicating that the closeness of the fit is vital to most organisations compared to the 1.5% that considered it is insignificant as seen in Fig. 2.

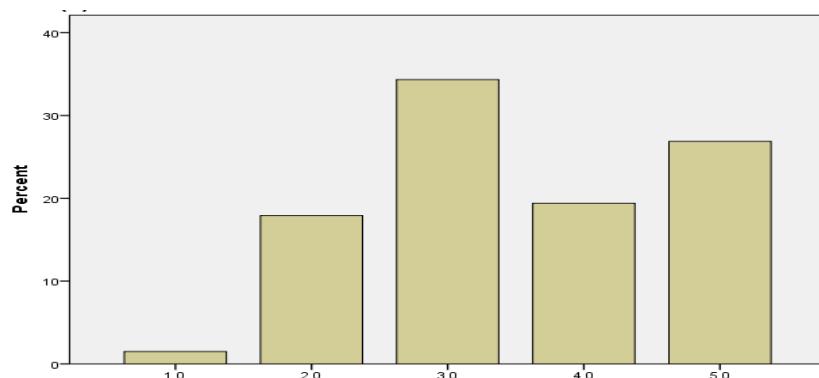


Fig.2. Poor innovation and local content of local cloud service vendors as a challenge to local cloud computing adoption (1 -not significant, 5 - very significant)

This finding provides an economic opportunity for local cloud vendors to invest in local and relevant content given that most cloud solutions and service vendors in the country are Third-party providers and they act as intermediaries between businesses and the source vendors of cloud services which are major foreign cloud platforms.

6.3. Inadequate cloud infrastructure

Another issue faced by local cloud computing service providers in Nigeria is inadequate infrastructure (that is, fast internet connectivity, electricity, backbone networks, etc.) on which the cloud runs. 98.5% of all IT strategists say they fully understand the impact of this problem compared to 1.5% who revealed it was insignificant as shown in Fig. 3.

Inadequate infrastructure impacts the installation and expansion of data centers across Nigeria which are mainly

concentrated in Lagos [26, 28]. With this challenge, local cloud service providers are not then able to leverage on the gains of economies of scale unlike foreign vendors such as Google, Microsoft, and Amazon. Economies of scale is the ability to do things at a lower cost per unit when operating at a bigger scale [13]. This cost advantage is an important benefit in cloud computing. Hence, local cloud service vendors are not then able to pass on these gains to businesses in the form of lesser prices compared to what one can get with the foreign cloud vendors.

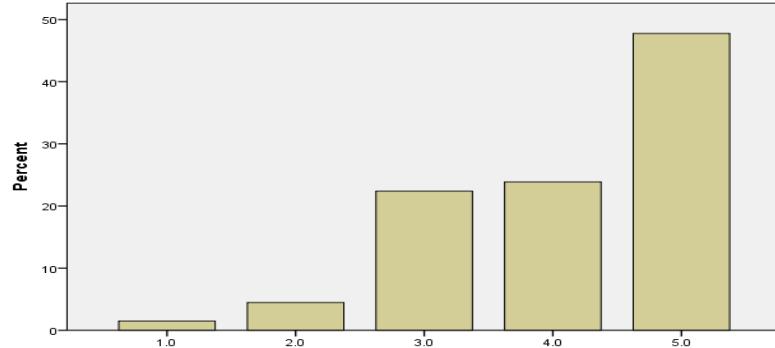


Fig.3. Inadequate cloud infrastructure as a challenge to local cloud computing adoption (1 -not significant, 5 -very significant)

6.4. Local cloud vendor interoperability issue

For 97.0% of all surveyed respondents, the local cloud vendor interoperability issue is a key challenge to local cloud vendors' adoption compared to 3.0% who answered that it was insignificant as seen in Fig. 4.

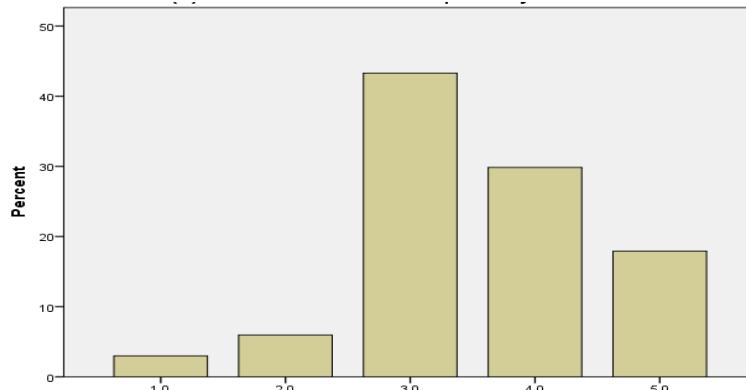


Fig.4. Local cloud vendor interoperability issue as a challenge to local cloud computing adoption (1 -not significant, 5 -very significant)

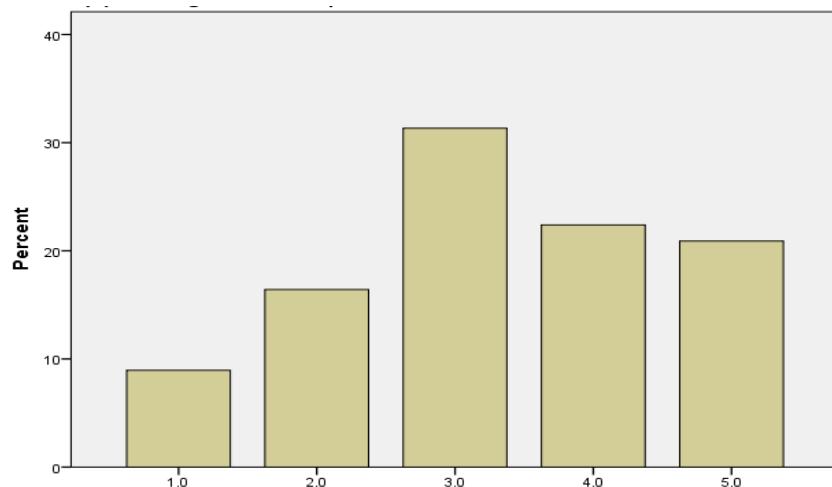


Fig.5. Shortages in skilled personnel as a challenge to local cloud computing adoption (1 -not significant, 5 -very significant)

This illustrates how dissatisfied the subscribers are that each local cloud vendor offering in the country has its way of how cloud clients/users/applications interact with the platform. This restricts the ability of businesses and organisations in Nigeria to pick from alternative local vendors/offerings simultaneously to maximize resources at

various tiers within a business. Standardization seems to be a perfect approach to solve the interoperability problem. Unfortunately, as local cloud service computing just begins to take off, the interoperability issue has not been featured on the burning agenda of local cloud service providers in the country.

6.5. Shortages in skilled personnel

Shortages in skilled personnel seem to be a leading limitation to the uptake of local cloud service vendors by businesses and organisations in the country. A majority of all respondents, 91.0%, agreed the skilled personnel needed for a full-blown cloud deployment by local cloud service vendors in Nigeria are few compared to 9.0% who answered it was insignificant as shown in Fig. 5.

Further analysis of the data revealed that 65.7% are either not sure (that is, 47.8%) or do not believe (that is, 17.9%) local cloud vendors have the required competency as seen in Table 3. This is in agreement with [26] that skilled personnel and engineers within Nigeria are not trained firsthand and therefore are not comfortable creating new solutions to run on the underlying cloud infrastructure among others.

Table 3. Local cloud vendors in-house skills ability in managing organisations' infrastructure and applications

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Maybe	32	47.8	47.8
	No	12	17.9	65.7
	Yes	23	34.3	100.0
	Total	67	100.0	100.0

6.6. Security strategies, privacy, compliance terms and requirements issues

In terms of business culture and attitudes, security, privacy, compliance terms, and requirements remain the major challenge by businesses and organisations in Nigeria when selecting a cloud provider. A majority of all respondents strongly admitted they do not trust that their businesses and organisations content will be safe and protected from unauthorized access and hackers when hosted locally as revealed in Fig. 6. Also, they fear that the existence of standardized regulatory requirements that cloud providers must abide by (e.g., International Organization for Standardization (ISO), Cloud Security Alliance (CSA) STAR Certification, and the International Electrotechnical Commission (IEC) 27018) is not yet adhered to by most local cloud service vendors. Worst still, only 4.5% believe that poor data protection and privacy enforcement is insignificant to local cloud computing adoption in Nigeria.

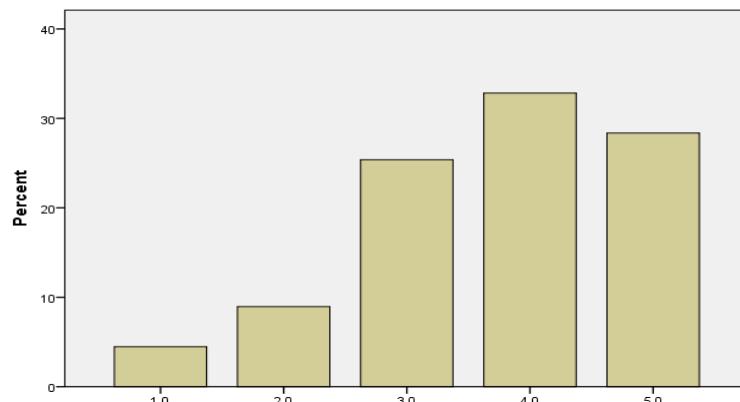


Fig.6. Poor security strategies, privacy, compliance terms and requirements as a challenge to local cloud computing adoption (1 -not significant, 5 -very significant)

When questioned specifically about security and cloud computing, 83.6% of the surveyed respondents said they consider foreign cloud computing service vendors to be more secure for complex and mission-critical applications as seen in Table 4.

6.7. Service level agreement (SLA)

Businesses and organisations must have guarantees from cloud vendors on service offers for uptime and connectivity [14, 29]. Ideally, these are offered through SLAs agreed between the cloud vendors and organisations. However, the local cloud service vendors in the country often fail to live up to their SLAs as strongly stated by 26.9% of surveyed respondents compare to the 3.0% that feel otherwise as shown in Fig. 7. This might not be unconnected with factors such as national insecurity, unstable power supply, and poor broadband internet in the country as reported by [25] and [27].

Table 4. Local vs foreign cloud computing service vendors for mission-critical applications

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Foreign cloud computing service vendors (e.g Amazon, Microsoft, Google etc)	56	83.6	83.6	83.6
	Local cloud computing service vendors (e.g Layer3Cloud, CyberCloud, Cloudflex Computing Services Limited, Descasio Limited etc)	11	16.4	16.4	100.0
	Total	67	100.0	100.0	

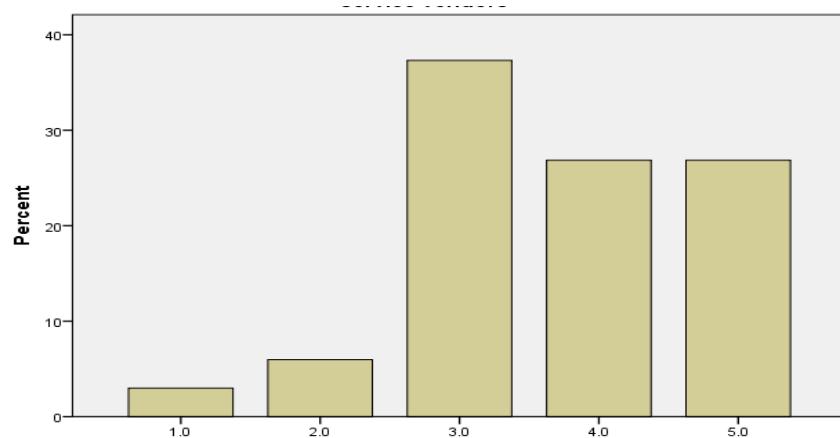


Fig.7. Poor SLA as a challenge to local cloud computing adoption (1 -not significant, 5 -very significant)

In comparison, Amazon web services SLA as reported by [32] commits to an annual uptime percentage of 99.95% over 365 days which is good enough for most businesses and organizations in the country. It follows that organizations are uncomfortable entrusting applications to local cloud providers when they are not certain local cloud vendors can guarantee high availability and quality service.

6.8. National insecurity

About 90 percent (95.5%) of all surveyed respondents believed that national insecurity has played a key challenge in the uptake of local cloud services by businesses and organisations in the country compared to 4.5% who considered it insignificant as seen in Fig. 8.

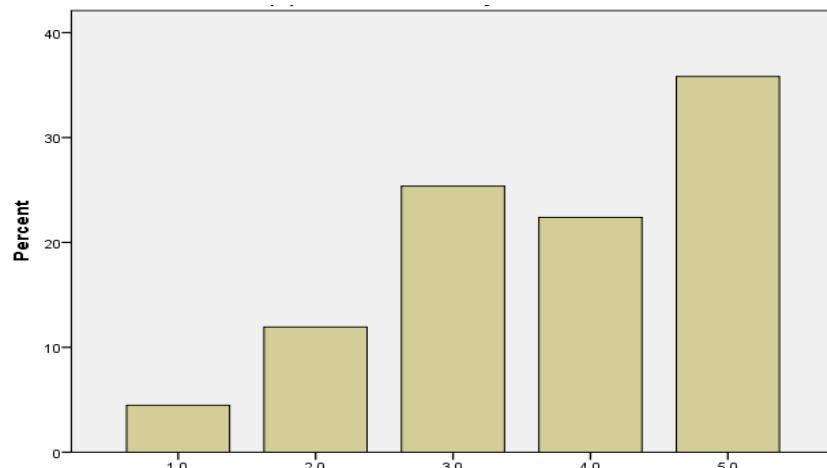


Fig.8. National insecurity as a challenge to local cloud computing adoption (1 -not significant, 5 -very significant)

This finding supports the argument by [26] that insecurity faced in some parts of Nigeria is an issue to cloud infrastructure. According to the authors, 150 base stations were lost due to flooding and bombing in 2012. Also, fiber cables laid across Nigeria have many times been vandalized leading to disruption of service which has hindered the

ability of local cloud vendors to have their service available 24/7 and subsequently discourages potential organisations from adopting local cloud services.

As shown in Table 5, there exists no association between national insecurity and the geographical region of the respondent's organization as a challenge facing local cloud services adoption.

Table 5. Chi-Square of association between national insecurity and the geographical region of the respondent's organization

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	24.109 ^a	20	.238
Likelihood Ratio	27.524	20	.121
Linear-by-Linear Association	.274	1	.600
N of Valid Cases	67		

Note: Significant level = 0.05

7. Suggested Solutions to these Challenges

There are two ways in which the solution to the challenges of local cloud computing adoption in Nigeria can be approached:

7.1. Government and regulatory bodies

About 88.1% of the surveyed respondents as shown in Table 6 agreed that the government is not doing enough and must make cloud computing one of its priorities by creating an enabling regulatory environment to facilitate investment in the infrastructure resources needed to support local cloud computing adoption.

Table 6. Government not doing enough in promoting local cloud computing adoption

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Agree	22	32.8	32.8
	Disagree	1	1.5	34.3
	Neutral	7	10.4	44.8
	Strongly agree	25	37.3	82.1
	Strongly disagree	12	17.9	100.0
	Total	67	100.0	100.0

For example, the reduction in the Right of Way (RoW) levy for every metre of fibre being deployed should be for all state governments as it will facilitate investment in the broadband infrastructure and connect more businesses and organisations in the country to faster broadband for local cloud services. Also, the government has the opportunity to lead by example by using the local cloud as a means to deliver efficient service as defined by the "Cloud First" policy in the National Cloud Computing Policy Version 1.2. This way, the government will encourage organisations to feel comfortable trusting their businesses to these local vendors.

Similarly, supporting the adoption and development of green power sources or renewable can help encourage investments in cloud infrastructure and data centers. Regulation that includes the enforcement of data protection laws and similar intellectual property rights protection regimes must be fully enforced. Adequately implementing such laws would give organisations the confidence to adopt local cloud computing services including permitting their valuable data to be stored in a data center knowing that the data will be fully protected. Also, in case of a breach, they could easily ask the right government agencies to take appropriate action including seeking justice from the legal system.

Besides, having a good regulatory regime that ensures that local cloud vendors keep to their end of the agreement and deliver the right services with minimal interruption would be an important source of motivation to businesses and organizations to adopt local cloud-computing services. Also, there will be a need to boost security in the country to help safeguard cloud infrastructure. The declaration of ICT infrastructure as a national asset by the federal government is a step in the right direction.

7.2. Local cloud service providers

Local cloud service vendors should give attention to the needs of businesses and organisations on a local level by offering services that are relevant in needs, culture, and financial capabilities, etc. as against presuming that cloud computing services are a global service that does not need to be tailored on a user-per-user basis. Also, some of the services the local cloud vendors can offer to businesses and organisations in the country according to survey respondents include new offerings in e-services (that is, e-commerce, e-finance, e-government, e-medicine, and telemedicine), consulting purposes, operational reduction complexity, cost reduction, and modernization of legacy IT as shown in Table 7.

In the current environment, local cloud service vendors not only have to meet their SLAs but are required to keep up with the increased request and demand for flexibility. Also, the need for wider national awareness of local cloud

services at the stakeholder and subscriber level is, therefore, a paramount necessity. This is to help create and develop the right perception of local cloud service computing which will result in its adoption. Awareness can be ensured through seminars, workshops, technical IT meetings, etc.

Apart from these cloud vendor-level orientations, prospective businesses and organisations must be assisted to get familiar with the privacy statement involved with all aspects of local cloud service computing. Businesses and organisations must be informed of the data or information collected from them and as such, businesses and organisations will be able to know the level of security they require. Further, local cloud vendors must ensure they meet the existence of standardized regulatory requirements that cloud providers must abide by to help build the element of trust. Lastly, there is the need to build local knowledge and skills in cloud computing to ensure the self-reliance of the local cloud service vendors in the cloud ecosystem

Table 7. Purpose for cloud computing adoption

	Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Ability to cut costs	9	13.4	13.4
	Add new capabilities or features	5	7.5	20.9
	Better model for licensing/upgrades	1	1.5	22.4
	Consulting purposes	1	1.5	23.9
	Creation of new offerings or services	6	9.0	32.8
	Do not know	5	7.5	40.3
	Modernization of legacy IT	8	11.9	52.2
	None of the above	18	26.9	79.1
	Reduce capital expenditures	3	4.5	83.6
	Reduce operational complexity	10	14.9	98.5
We support cloud users (Microsoft Azure) to assist with issue resolution		1	1.5	100.0
Total		67	100.0	100.0

8. Conclusion

Cloud momentum now seems unstoppable in Nigeria, as businesses and organizations in the country see less and less advantage in the slog of maintaining their infrastructure. As we enter challenging economic times occasioned by COVID-19, more than ever, organizations are going to need stability in cost, fast and easy access to their data while mitigating risks of submarine cable outages offered by hosting their cloud services locally.

Findings from the research showed the key challenges to local cloud computing service adoption include inadequate awareness of local cloud service vendors, poor innovation and local content, inadequate cloud infrastructure, local cloud vendor interoperability issue, national insecurity, shortages in skilled personnel, Service Level Agreement (SLA), security strategies, privacy, compliance terms, and requirements issues. Further, there is no statistical difference in the mean of awareness level of survey respondents across industries based on the ANOVA test. Also, there exists no association between national insecurity and the geographical region of the respondent's organization based on the Chi-Square of Independence test with regards to local cloud service adoption.

Thus, for the sustainability of the local cloud network, electricity, skilled personnel and ICT infrastructural backbone of the country have to be well established. The need for adequate government involvement in policymaking, creating a favorable environment for local investors, and adequate local cloud service offerings are some improvements required on the side of the government and local cloud computing service vendors. We believed from the respondent's responses that if these solution approaches are adopted, it would boost the trust in local cloud services usage by businesses and organisations, open up Nigeria to offshore markets while driving economic competitiveness and growth.

References

- [1] Muhammed, K., Zaharaddeen, I., Rumana, K., and Turaki, A. M. (2015). Cloud Computing Adoption in Nigeria: Challenges and Benefits. International Journal of Scientific and Research Publications, 5(7), 2250-3153.
- [2] Nnadozie, C. E. (2016). The Challenges of Cloud Computing Adoption in Nigeria. International Journal of Computer and Information Engineering, 10(11), 1970-1975.
- [3] Okoye Francis, A., Obodoeze Fidelis, C., and Asogwa Tochukwu, C., (2014). Cloud Computing in Nigeria: Prospects, Challenges, and Operation Framework. International Journal of Engineering Research & Technology (IJERT), 3(6), 2107-2113
- [4] Dahiru, A. A., and Abubakar, H. (2017). Cloud Computing Adoption: A Cross-Continent Overview of Challenges. Nigerian Journal of Basic and Applied Sciences, 25(1), 23-31.
- [5] Aderibigbe N, Bakinson B., Azumara J., Mbakwe C., David, E. and Akaluzia T (2020). COVID 19 Opportunities in the Technology Sector. Jackson, Etti and Edu. Retrieved June 6, 2020, from <https://www.jacksonettiedu.com/covid-19-opportunities-in-the-technology-sector/> pp 1-7

- [6] Ogunjobi M., (2015). Barriers to Cloud Computing Adoption in Nigeria. TheGuardian. Retrieved June 6, 2020, from <https://guardian.ng/technology/barriers-to-cloud-computing-adoption-in-nigeria/>
- [7] M'rhaourh, I., Okar, C., Namir, A., and Chafiq, N. (2018). Challenges of Cloud Computing Use: A Systematic Literature Review. In MATEC Web of Conferences (Vol. 200, p. 00007). EDP Sciences.
- [8] AVASANT (2020). An Essential Primer for the Journey to Cloud in the Post-COVID World. Infoworld. Retrieved 14 June 2020, from https://www.infoworld.com/resources/203823/an-essential-primer-for-the-journey-to-cloud-in-the-post-covid-world?utm_source=Adestra&utm_medium=email&utm_content=Title%3A%20An%20Essential%20Primer%20for%20the%20Journey%20to%20Cloud%20in%20the%20Post-COVID%20World&utm_campaign=Infoworld%20US%20First%20Look&utm_term=Infoworld%20US%20Editorial%20New%20sletters&utm_date=20200727163321
- [9] Iwuchukwu, U. C., Atimati, E. E., Ndukwe, C. I., and Iwuamadi, O. C. (2017). The State of Cloud Computing in Nigeria. IOSR Journal of Electrical and Electronics Engineering (IOSR-JEEE), 12(3), 84-93.
- [10] Dahunsi, F. M., and Owoseni, T. M. (2015). Cloud Computing in Nigeria: The Cloud Ecosystem Perspective. Nigerian Journal of Technology, 34(1), 209-216.
- [11] Evwiekpaefe, A. E., and Ajakaiye, F. (2013). The Trend and Challenges of Cloud Computing: A Literature Review. Academic Journal of Interdisciplinary Studies, 2(10), 9-15.
- [12] Dogo, E. M., Salami, A., and Salman, S. (2013). Feasibility Analysis of Critical Factors Affecting Cloud Computing in Nigeria. International Journal of Cloud Computing and Services Science, 2(4), 276.
- [13] ITU (2017). Question 3/1: Access to cloud computing: Challenges and opportunities for developing countries. Retrieved 14 June 2020, from https://www.itu.int/dms_pub/itu-d/opb/stg/D-STG-SG01.03.1-2017-PDF-E.pdf
- [14] NITDA (2019). National Cloud Computing Policy Version 1.2. National Information Technology Development Agency. Retrieved 14 June 2020, from https://nitda.gov.ng/wp-content/uploads/2019/08/NCCPolicy_New.pdf
- [15] Gillwald, A., Moyo, M., Odufuwa, F., Frempong, G., and Kamoun, F. (2014). The Cloud Over Africa. Research ICT Africa, 1-33
- [16] Businesswire (2019). The Cloud Market in West Africa, 2018-2019. Retrieved 14 June 2020, from <https://www.businesswire.com/news/home/20190220005647/en/Cloud-Market-West-Africa-2018-2019---Broadband>
- [17] Egbueje E., (2019). Cloud Computing In Nigeria and Its Potentials For Growth. Layer3. Retrieved June 6, 2020, from <https://layer3.ng/blog-details/53/cloud-computing-in-nigeria-and-its-potentials-for-growth>
- [18] BusinessDay (2020). Covid-19 Proved that Colocation, Cloud Computing Offer Competitive Costs and Reduced Operational Intensity. Retrieved June 6, 2020, from <https://businessday.ng/interview/article/covid-19-proved-that-colocation-cloud-computing-offer-competitive-costs-and-reduced-operational-intensity/>
- [19] Idris A (2020). Africa's Cloud Computing Industry is Set to Grow as Data Adoption Rises. Techcabal. Retrieved June 6, 2020, from <https://techcabal.com/2020/05/29/africas-cloud-computing-industry-is-set-to-grow-as-data-adoption-rises/>
- [20] Kuyoro, S. O., Ibikunle, F., and Awodele, O. (2011). Cloud Computing Security Issues and Challenges. International Journal of Computer Networks (IJCN), 3(5), 247-255.
- [21] Ume, A. (2012). The Fear and "Phobia" of the Cloud and Cloud Computing. Journal of Educational and Social Research, 2(8), 147-147.
- [22] Nwabuonu, O. G., and Nwachukwu N J (2013). Cloud Computing: Key to IT Development in West Africa. West African Journal of Industrial and Academic Research, 9(1), 115-130
- [23] Otuka, R., Preston, D., and Pimenidis, E. (2014). The Use and Challenges of Cloud Computing Services in SMEs in Nigeria. In proceedings of the European Conference on Information Management and Evaluation 43 (10), 47-55.
- [24] Chinedu, P. U (2014). Survey of Cloud services in Nigeria: Assessing Adoption and Deployment. NCS Owerri 2014 International Conference on Computational Sciences & I.T.for National economic Sustainability-CoSITNES, pp 107-122
- [25] Oguntala, G. A., Abd-Alhameed, P., Raed, A., Odeyemi, D., and Janet, O. (2017). Systematic Analysis of Enterprise Perception towards Cloud Adoption in the African States: The Nigerian Perspective. The African Journal of Information Systems, 9(4), 1-21.
- [26] Oyoyo J. Y. and Baguma R. (2019). Adoption of Cloud Computing in Government Institutions in Nigeria. International Journal of Scientific and Research Publications, 9(8), 709-744
- [27] Mallo N S and Ogwueleka F N (2019). Impacts and Challenges of Cloud Computing for Small and Medium Scale Businesses in Nigeria. Computer Networks and Distributed Systems, 53(3), 169-180.
- [28] Saidu A. and Kwadan M. S. (2020).Factors Challenging the Adoption of Cloud Computing Application in E-Learning among Polytechnics in NorthEastern Nigeria. European Journal of Computer Science and Information Technology, 8(2), 38-49
- [29] Osuolale A. F., Akanle J., A., and Lawal F., L., (2020).Comparative Analysis of Indigenous Cloud Computing Providers in Nigeria. International Journal of Computer Applications, 176(24), 0975 – 8887
- [30] Bakare A. A. (2020). The Challenges of Adopting Cloud Computing in Nigerian Government Organizations (Doctoral Thesis), Walden University, College of Management and Technology.
- [31] Microsoft (2020). Core Cloud Services - Introduction to Azure. Retrieved 14 June 2020, from <https://docs.microsoft.com/en-us/learn/modules/welcome-to-azure/4-exercise-create-website>
- [32] Nunez S. (2020). 6 ways Alibaba Cloud challenges AWS, Azure, and GCP. InfoWorld. Retrieved 14 June 2020, from https://itpulse.com.ng/2020/07/20/cloud-computing-will-enable-growth-of-smes-and-governance-experts/file:///C:/Users/Emos/Documents/Cloud%20Computing/6%20ways%20Alibaba%20Cloud%20challenges%20AWS,%20Azure,%20and%20GCP%20_%20InfoWorld.html

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