Problems and Prospects of Cloud Computing Adoption in the Nigerian Tertiary Institutions

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Abstract

The adoption of cloud computing in higher institutions has delivered lots of benefits to them, as it is budget friendly and gives academicians a positive experience from its use, while it also helps upsurge IT staff productivity in universities. It is against this background that this study examines the problems and prospects of cloud computing adoption in Nigerian tertiary institutions. The descriptive survey method was adopted and primary data were collected from 60 IT staff from two randomly selected higher institutions in Lagos State, Nigeria. The collected data were analyzed using mean scores and Pearson Product Moment Correlation Coefficient. The findings of the study show among others that (i) there is a significant relationship between the technological factors and the adoption of cloud computing in Nigerian higher institutions; (ii) there is a significant relationship between the organizational factors and the adoption of cloud computing in Nigerian higher institutions; and that (iii) there is a significant relationship between the environmental factors and the adoption of cloud computing in Nigerian higher institutions. The study therefore recommends that (i) the government should help in the provision of not only social amenities and infrastructural facilities but also policies that promote and enhance the adoption of cloud computing; (ii) higher institutions in Nigeria should also adopt work cultures that would enhance the adoption of cloud computing in their institutions; and that (iii) the managements of the Nigerian higher institutions should not only think about the effective and efficient adoption of cloud computing but also have a viable sustainability plan for its adoption.

Keywords: Cloud computing, higher institutions, problems, prospects, technology, organization, and environment.

Introduction

Technology is everywhere in today's life, world is changing and transform with new development and innovation of technology. Our life is used to technology to perceive new thing. There is a new technology innovation, which is going on around the world which can make changes to your life and feel comfortable with it. Among of new innovative technology that is increasing in use around the world is cloud computing. Cloud computing is a metaphor used to describe networks (Vouk 2008). The term used to explain cloud computing means host everything that relates to delivery service over the internet. It is among the future generation which categorized into three platforms they are serviced of network, software and hardware that can spread out its usefulness to the user in anywhere they demand to (Masud, Yong, & Huang 2012).

The use of cloud computing in higher educational institutions has provided them with lots of benefits. Firstly, cloud computing is cost effective therefore it is efficient where the resources are minimal. Secondly, the academicians derive a positive experience from its use. Moreover, cloud computing helps in increasing the productivity of IT staff in universities. In today's world, various applications are provided on cloud platforms by various companies especially Google and Microsoft that are providing various applications and services free of charge for use by staff and students in different learning institutions.

Cloud Computing offers On-demand network access to a shared pool of configurable computing resources like networks, servers, storage, applications, and services, rapidly provisioned with minimal management effort and provider interaction (Cachin, 2011 cited Udanor, Aneke & Obillo, 2018) and delivers infrastructure as a service (IaaS), Software as a service (SaaS), Platform as a Service (PaaS), Storage as a Service, and recently, Security as a Service (SECaaS), etc in a multi-tenant model at

relatively low cost, and high resource availability over fast Internet connectivity. Fig 1 shows how these services are layered.

Aim and objectives of study

Because of the demands of increasingly complex problems over the recent decades, developments in science and engineering have been stepped up to meet with these challenges. Scientific research today is so much based on large amount of numerical simulation, data analysis/analytics, as well as on collaborative research. Research in the 21st century is data-intensive, simulation-based, distributed across virtual communities, and collaborative. In recent years' data-intensive science has been conducted on a scale that was unimaginable a few years ago. Sensors, storage systems, computers and networks have greatly improved in capability and integration to create huge data archives that has changed the way research was conducted in the fields of medicine, physics, astronomy, biology etc.

The big question is where is Africa in the scheme of things with respect to e-science deployment and usage? These are the questions this study attempts to answer by examining the problems and prospects of cloud computing adoption in Nigerian tertiary institutions. Hence, this study seeks to answer the following research questions

Research question one. What are the challenges inhibiting the adoption of cloud computing in the Nigerian tertiary institutions?

Research question two. What are the prospects of cloud computing adoption in the Nigerian tertiary institutions?

This study therefore, tests the following hypotheses

1. **H_{01}.**There is a significant relationship between the technological factors and the adoption of cloud computing in Nigerian higher institutions;
2. **H_{02}.**There is a significant relationship between the organizational factors and the adoption of cloud computing in Nigerian higher institutions; and
3. **H_{03}.**There is a significant relationship between the environmental factors and the adoption of cloud computing in Nigerian higher institutions

Literature review

The concept of cloud computing

Cloud computing is a recent concept that is still evolving across the information technology industry and academia. Several definitions have evolved so far, the National Institute of Standards and Technology (NIST, 2009), defines cloud computing as "a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction (Mell & Tim, 2009). Olabiyisi et al. (2012) defines cloud computing as an elastic and scalable utility model that offers flexible, ubiquitous, on-demand network access to a shared pool of configurable computing resources (for example, servers, data centers, networks, applications and services) that can be rapidly provided and released with limited interaction of service provider or the management.

It provides shared infrastructure, self-service, dynamic and virtualized pay-per-use platforms which put it on high demand. Cloud computing implies a level of dynamic, flexible resource sharing and allocation of assets.

Mell and Gance (2011) defined each of the three services models thus: Software as a Service (SaaS) which allows users to use the provider's applications on a cloud through a web browser, while Platform as a Service (PaaS) allows users to deploy their own applications on the provider's cloud infrastructure under the provider's environment. Infrastructure as a Service (IaaS) allows users to control and manage computing resources.

Hurdles to cloud computing adoption in Nigeria

Below are some of the addressable hurdles to the feasibility of cloud computing in Nigeria.

Unreliable Power Supply

Unreliable power supply in this country had been a major setback to the introduction of cloud computing in Nigeria. The president of the Association of Telecommunications Companies of Nigeria (ATCON) identified inadequate power supply as the major impediment to the growth of ICT in Nigeria. According to him, "a pursuit of the liberalization agenda of the power sector as obtained in the telecommunication sector is needed to solve the protracted issue of inadequate power supply" (Omo-Ettu, 2011).

Lack of political will to the genuine growth of ICT

The Director-General of National Information Technology Development Agency (NITDA) stated that a major challenge militating against ICT development in Nigeria is lack of political will from the decision makers as he cited that the IT industries are under-funded, and reiterated the need for government to invest substantially in science and technology (Anyaye, 2010). In another development, the president of the Institute of Software Practitioners of Nigeria (ISPON) asserted that in 2012 ICT recorded growth but there was no adequate development. He stressed that we need to promote the indigenous software and infrastructure companies to ensure growth and development of ICT in the country (Uwaje, 2013).

Corruption

Experts have reasoned that Nigeria is one of the most corrupt nations in the world today. Oruame (2008) stated that "... facts are emerging on how ICT projects have merely ended up as conduit pipes with which billions of U.S. dollars have been siphoned from the public treasury into private bank accounts". Therefore, if these trends remain unchecked, it would hamper the advancement of cloud computing in Nigeria.

Persistency of poor internet services

The CEO of Main One Cable Company which has laid a 7,000km fibre optic cable linking West Africa to Europe, said that the absence of robust national backbone has led to increased cost of moving capacity around the country. Investigation reveals that to get connected from Lagos to London costs $600 per megabyte as against $1,100 between Lagos and Abuja due to governments' inability to encourage investment geared towards strengthening backbone transmission networks. According to her, $250 million had been invested so far by the company in building the underwater cables and constructing distribution networks. She opined that the federal government should conduct a review of the national backbone infrastructure, manage the country's national frequency spectrum resource as well as encourage infrastructure sharing amongst telecoms operators in order to improve internet penetration in the country (Opeke, 2011).

According to Global System for Mobile Communications Association (GSMCA), MTN, Globacom, and Airtel have only deployed 8,000km, 10,000km, and 4,600km of fibre backbone respectively making a total of 22,600km. This results to only 28.6% internet penetration across the country. Also, some of these providers offer skeletal services to the populace. This must change to enable cloud computing to work viably in Nigeria.

Need for backbone infrastructure sharing/general communication problems

Infrastructure sharing by mobile operators in Nigeria will no doubt reduce both capital expenditure (CAPEX) and operating expenditure (OPEX). Ohakwe (2011) in his blog stated that "operators need to share costs and invest in network technologies that support transmission of large quantities of data such as optical fibre and associated technologies". Furthermore, the landing of undersea cables like Main 1 and Glo 1 and the deployment of enhanced 3G (3G+) and 4G technologies will amplify the increasing demand for data services which is too expensive for individual operators to duplicate, thus requiring the need for infrastructure sharing.

Furthermore, Ikekeonwu (2011) in a paper presentation on cloud computing in Nigeria identified several communication problems which could hamper the smooth take off of cloud computing in Nigeria. Some of these problems range from broadband to backbone infrastructure. He pointed out the

lack of focus on the part of ISPs as all the ISPs (MTN, Globacom, Airtel, etc) target national coverage with none thinking of being a regional operator or provider. For instance, Visafone concentrating on eastern region, and making sure that coverage is highly optimized, steady and efficient. Being a regional operator would result to cost effectiveness and improved delivery since the cost would be less. As a result of these developments, the broadband offerings of all the service providers in Nigeria are very frustrating/unreliable due to inadequacy of infrastructure and funding. The next section discusses the feasibility of cloud computing in Nigeria.

Prospects of cloud computing

Several studies have established the benefits embedded in the adoption of cloud computing in higher institutions. Mehmet and Serhat (2011) identified some of the benefits offered by cloud computing in education to include on-demand access to online database repositories, e-learning platforms, digital archive, portals, research applications and tools, file storages, e-mails and other educational resources anywhere for faculty, administrators, staff, students and other users in university.

Gerald and Eduan (2012) conducted a survey on the adoption of cloud computing among public universities and FET colleges within South Africa. The authors argued that public universities and colleges share many similar operational processes such as course offerings, admissions, enrollments, bursaries, research and graduations that can be standardized across the higher education sector and offered as a set of services through cloud to the many colleges and universities in a more cost effective way than is currently the case. The results of the analysis shed some light on the current state of cloud computing adoption within the South African public higher education sector, the main factors that fuel its adoption, the main barriers that impede its adoption and the direction it may take in future as it matures.

Abdulsalam and Fatima (2011) argued that cloud computing is the solution to ICT in higher education in Nigeria. The authors identified scarcity of ICT infrastructure and lack of access, high cost of ownership, unsteady and inadequate electrical power supply as factors that are limiting the infusion of ICT in Nigeria higher education. They claimed that the prospect of a maturing cloud of on-demand infrastructure, application and support services is important as a possible means of driving down the capital and total costs of ICT in higher education, facilitating the transparent matching of IT demand, scaling ICT, fostering further ICT standardization and accelerating time to market by reducing ICT supply bottlenecks.

Oyeleye, Fagbola, and Daramola (2014) investigated the impact and challenges of the adoption of cloud computing in public universities in the Southwestern part of Nigeria in 2014. They selected a sample size of 100 IT staff, 50 students and 50 para-IT staff from 10 public universities in the southwestern part of Nigeria. They used stratified sampling techniques to select their same and administered 2000 questionnaires and 1724 were returned.

The findings obtained from the research showed that adoption of cloud computing has major impact on cost effectiveness, enhanced availability, reduced investment in physical assets, reduced IT complexities and increased operability. But, the major challenges affecting the adoption of cloud in theses universities are, regulatory compliance concerns, data insecurity, lock-in and privacy concerns (Raed, Fash, and Chang, 2015).

Abdulsalam and Fatima (2011) explored the applications of cloud computing in higher education in Nigeria, they identified the factors limiting the implementation of cloud computing in Nigeria's higher institutions as high cost of ownership, lack of access, unsteady and inadequate electric power supply, high cost to the consumer. They also discussed the benefits of transition to cloud computing in higher institutions.

They concluded this research by stating that cloud computing has great potentials in improving the ICT applications and infrastructure at higher levels of education in Nigeria and advised that every university that wishes to adopt this must plan the transition carefully and keep close contact with well-established organisations like NIST (National Institute of Standards and Technology) in order to ensure smooth transition (Abdulsalam and Fatima, 2011).

Theoretical framework

Technology-organizational-environment (TOE) theory

Tornatzky and Fleischer (1990) designed and introduced TOE theory which is Technology-Organizational-Environment (TOE) framework in order to expand the diffusion of innovation model further than the technological context by introducing the organizational and environmental contexts of the innovation adoption (Tornatzky & Fleischer, 1990).

Tornatzky and Fleischer (1990) is an analysis of the adoption inside organizations, to decode the choice of managing perception to move to cloud computing, the Technology, Organizational and Environmental (TEO) outline selection model is continuously considered. The model was initially created by any new product or items which is perceived as new innovation or which can be adopted to any organization as well as institutions (Tornatzky & Fleischer, 1990). Various and series of studies has been done by adopting the innovation in information technology, which has been explained by expertise, academician and professional to investigate the adoption of cloud computing in a various aspect that can be valuable to any organization system.

A percentage of the studies which has been perceived and utilized as well as advanced studies on the TOE model by Oliveira & Martin (2011). Many studies have developed change to suit the connection of the particular study to the transformation to adopt the new technology. Tomatzky and Fleischer (1990) propose that the innovation which move at the basic management level may be affected by components that relate to those connections in making decision to adopt cloud computing. As indicated by (Low & Chen, 2011; Jianyuan & Zhaofang, 2009: TOE structure has three setting gatherings on, which researches have done on cloud computing in educational institution.

The technological context identifies with the innovations on the system to be accessible to an organization. Its fundamental center shows the technology attributes and element themselves, which may have an impact on the process to adopt cloud computing (Tornatzky and Fleischer, 1990). Meanwhile, if Nigeria higher education institution can see the benefit context of technology innovation to adopt cloud computing into their system either direct or indirect can show them many ways to upgrade Nigeria education same as developed countries.

The organizational context alludes to the few develops seeing the management, for example, the firm size, scope, centralization, formalization and complexity of the administrative structure and the nature of the human resources (Kuan & Chow, 2000 cited in Jibril and Arafan, 2015). Some research has been done on how bigger organizations are regularly all the more overall outfitted with assets and framework to encourage advancement appropriation, while little firms may experience the effects of recourse on destitution.

Environmental context means the rivals and government policy on organizations, industry, institutional and firm to factors external to the organization that may present opportunities or constraints for innovations Tornatzky & Fleischer, 1990. Management controls their organizations inside an environmental context which give way to see the advantage and barriers. Despite the fact that the outside environment can furnish organization with data which relevant to them in order to make a decision on adoption of cloud, assets and innovation,

It has regulations and limitations on the stream of capital and data (Damanpour & Schneider, 2006). Plus, the business environment in which the business runs as a key value. Rivalry improves the probability of making changes to their institution by perceived innovation as an opportunity to their system. Normally, element of environment which is influencing innovation in new technology is typically seen as focused on technology adoption (Iacovou et al., 1995) which is respected one basic variable for innovation on cloud computing in many institutions.

Methodology

For the purpose of this study, the researcher adopted the descriptive survey method, while 60 IT staff from two randomly selected higher institutions in Lagos State, Nigeria. The 60 participants selected for this study were staff who have ideas of cloud computing and could say one or two things on how cloud computing affect their institutions.

The participants' demographic characteristics were presented using frequency distribution tables and the research questions were answered using mean scores, where a mean less than 3.0 implies disagree and a mean equal to or greater than 3.0 implies agree, with the aid of the Statistical Package for Social Scientists (SPSS 21.0). Figures 1-5 below show some parts of the study area.
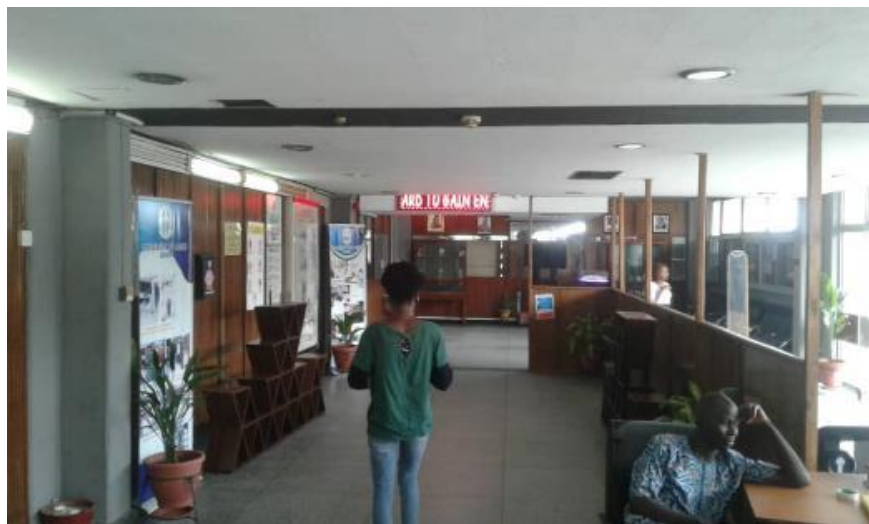

Figure 1. Outer view of a sampled university library

Figure 2. Entrance of a sampled university library

Figure 3. A section if students studying in a sampled university library

Figure 4. Reception of a sampled university library ICT centre

Figure 5. ICT center of the library

Result and discussion

Table 1. Percentage distribution of respondents' demographic data

Characteristics	Options	Frequency	Percent (%)
Sex	Male	39	65.0
	Female	21	35.0
	Total	**60**	**100.0**
Age	Below 25 years	26	43.3
	26-35 years	11	18.3
	36-45 years	12	20.0
	Above 45 years	11	18.3
	Total	**60**	**100.0**
Experience	Less than 5 years	13	21.7
	5-10 years	32	53.3
	11-15 years	10	16.7
	Above 15 years	5	8.3
	Total	**60**	**100.0**

Source. Field survey, 2019

Table 1 above shows that the majority (65.0%) of the participants were male, while the remaining 35.5% of them were female. This is presented with the chart below:
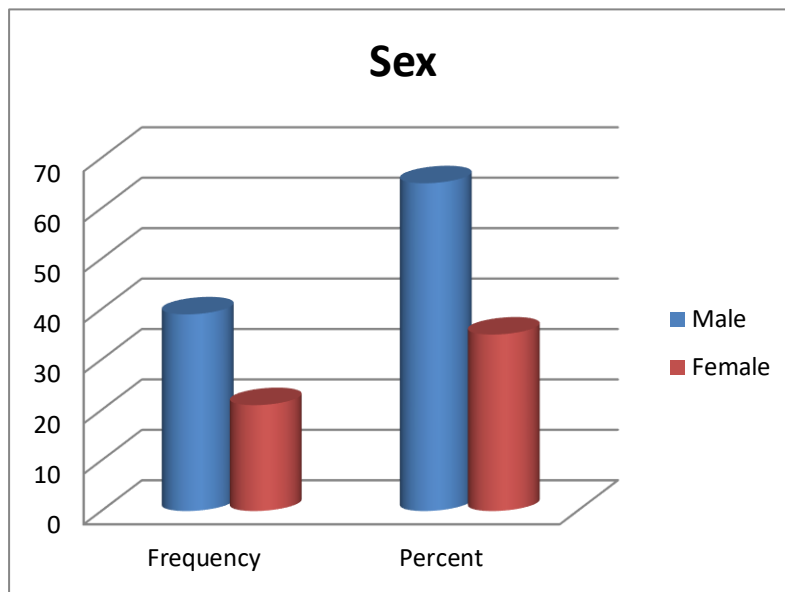

Figure 6. Participants' sex

Concerning the ages of the participants, the table shows that much (43.3%) of the participants were below 25 years of age, 18.3% of them were between 26-35 years, 20.0% of them were 36-45 years, while the remaining 18.3% of them were above 45 years. This is presented with the chart below:
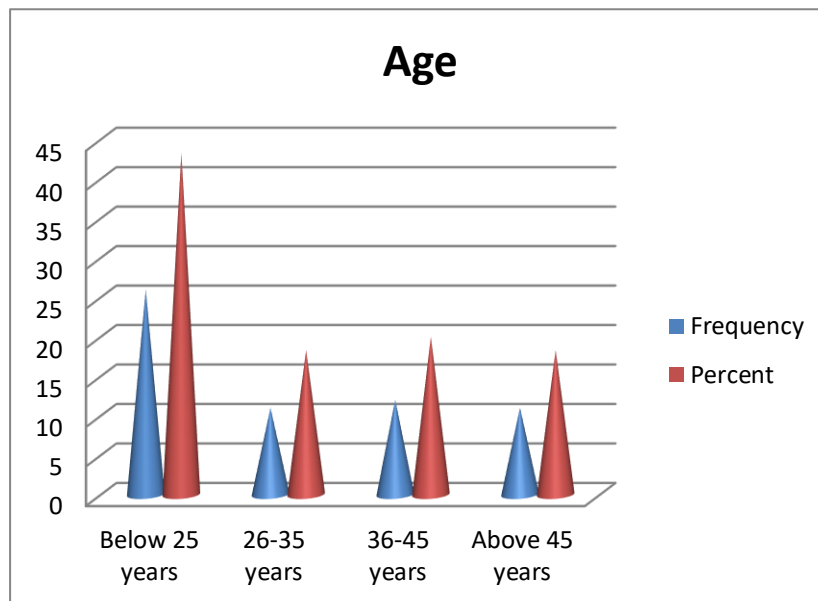

Figure 7. Participants' age

The table also captured the work experience of the participants, 21.7% of them had less than 5 years' work experience, most (53.3%) of them had between 5-10 years' work experience, 16.7% of them had 11-15 years' work experience, while the remaining 8.3% of them had above 15 years work experience. These are graphically presented with the charts below:
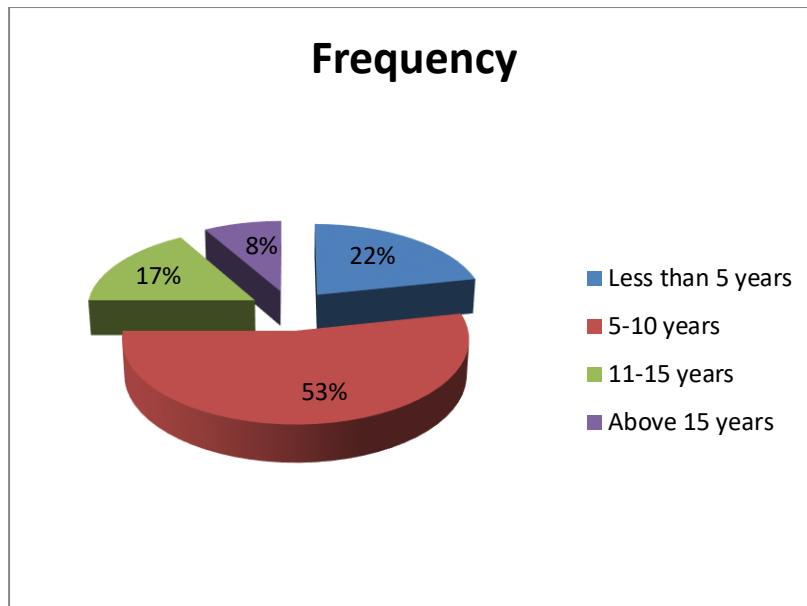
Figure 8. Participants' work experience

Research question one

What are the challenges inhibiting the adoption of cloud computing in the Nigerian tertiary institutions?

Table 2. Challenges of cloud computing adoption in Nigerian tertiary institutions

S/N	ITEM	(N =60)	
		Mean	**STD**
1	Data insecurity	3.63	1.138
2	Unsolicited advertisement	3.73	1.050
3	Lock-in	2.58	871
4	Reluctance to eliminate staff positions	3.29	977
5	Privacy concerns	4.29	776
6	Reliability challenge	3.12	855
7	Regulatory compliance concerns/user control	3.31	805
8	Institutional culture / resistance to change in technology	3.90	934
9	lack of focus on the part of Internet Service Providers	3.15	1.178
10	Need for Backbone Infrastructure Sharing/General Communication Problems	3.42	801
11	Persistency of Poor Internet Services	3.51	356

Source. Researchers field survey, 2019

Table 2 shows that most of the mean scores of the items 1-11 above are greater than $3.0(\bar{x} > 3.0)$, while the remaining 1 items is less than. It could therefore be inferred that most of the participants agreed with the items answering research question one. Hence, the challenges inhibiting the adoption of cloud computing include data insecurity, unsolicited advertisement, reluctance to eliminate staff positions, privacy concerns, reliability challenge, regulatory compliance concerns/user control, institutional culture/resistance to change in technology, lack of focus on the part of internet service providers, need for backbone infrastructure sharing/general communication problems, and the persistency of poor internet services. This result is in consonance with the findings of Opeke (2011); Ohakwe (2011); and Ikekeonwu (2011).

Research question two

What are the prospects of cloud computing adoption in the Nigerian tertiary institutions?

Table 3. Prospects of cloud computing adoption in Nigerian tertiary institutions

S/N	ITEM	(N =60)	
		Mean	STD
1	Enhanced Availability	3.77	783
2	Cost effectiveness /Affordability	3.77	807
3	Elasticity/Scalability	3.75	789
4	Lower environmental impact	3.65	1.008
5	End-User Satisfaction	4.08	926
6	Mobility	4.37	817
7	Reduction in IT Complexities	3.42	305
8	Less investment in physical assets	3.98	534
9	Increased Interoperability between disjointed technologies	4.01	178

Source: Researchers field survey, 2018

Table 3 shows that all the mean scores of the items 1-9 above are greater than $3.0(\bar{x} > 3.0)$. It could therefore be inferred that most of the participants agreed with the items answering research question two. Hence, the prospects of cloud computing adoption in Nigerian tertiary institutions include enhanced availability, cost effectiveness/affordability, elasticity/scalability, lower environmental impact, end-user satisfaction, mobility, reduction in it complexities, less investment in physical assets, and increased interoperability between disjointed technologies. This result is in consonance with the findings of Mehmet and Serhat (2011); Gerald and Eduan (2012); Abdulsalam and Fatima (2011); and Oyeleye, Fagbola, and Daramola (2014).

Test of hypotheses

Hypothesis one

There is no significant relationship between the technological factors and the adoption of cloud computing in Nigerian higher institutions;

Table 4. Correlation statistics

		Cloud Computing Adoption
Technological Factors	Pearson Correlation	721[*]
	Sig. (2-tailed)	001
	N	60

*. Correlation is significant at the 0.1 level (2-tailed).

Table 4 shows *r=.721*, indicating a very strong and direct relationship between technological factor and adoption of cloud computing, while *p=.001* indicates a significant relationship between the two variables. Hence, we reject the null hypothesis and concludes that there is a significant relationship between the technological factors and the adoption of cloud computing in Nigerian higher institutions.

Hypothesis two

There is no significant relationship between the organizational factors and the adoption of cloud computing in Nigerian higher institutions; and that

Table 5. Correlation statistics

		Cloud Computing Adoption
Organizational Factors	Pearson Correlation	748[*]
	Sig. (2-tailed)	004
	N	60

*. Correlation is significant at the 0.1 level (2-tailed).

Table 5 shows *r=.748*, indicating a very strong and direct relationship between organizational factor and adoption of cloud computing, while *p=.004* indicates a significant relationship between the two variables. Hence, the null hypothesis is rejected and its alternative is accepted, therefore, there is a significant relationship between the organisational factors and the adoption of cloud computing in Nigerian higher institutions.

Hypothesis three

There is no significant relationship between the environmental factors and the adoption of cloud computing in Nigerian higher institutions

Table 6. Correlation statistics

		Cloud Computing Adoption
Environmental Factors	Pearson Correlation	805[*]
	Sig. (2-tailed)	000
	N	60

*. Correlation is significant at the 0.1 level (2-tailed).

Table 5 shows *r=.805*, indicating a very strong and direct relationship between environmental factors and cloud computing adoption in the Nigerian higher institutions, while *p=.000* indicates a significant relationship between the two variables. Hence, the null hypothesis that states "there is no significant relationship between the environmental factors and the adoption of cloud computing in Nigerian higher institutions "is rejected, while its alternative is accepted.

Conclusion and recommendations

The findings of this study show that though there are several hurdles against the adoption of cloud computing in tertiary institutions in Nigeria, but the adoption of cloud computing comes with several benefits that are believed to outweigh the hurdles. This study also found that there is significant relationship between the adoption of cloud computing in Nigerian higher institutions and technological, organizational, and environmental factors. Hence, this study recommends that the government should help in the provision of not only social amenities and infrastructural facilities but also policies that promote and enhance the adoption of cloud computing in the tertiary institution and the Nigerian society at large. More so, higher institutions in Nigeria should also imbibe work cultures that would enhance the adoption of cloud computing in their institutions. And on the final note, the managements of the Nigerian higher institutions should not only think about the effective and efficient adoption of cloud computing but also have a viable sustainability plan for its adoption.

Suggestion for further studies

As this work examines the problems and prospects of cloud computing adoption in the Nigerian higher institutions, it is recommended that future researchers should work on

1. An evaluation of the technological, organizational, and environmental factors impeding the adoption of cloud computing in the Nigerian higher institutions;
2. A comparative analysis of the adoption of cloud computing in public and private higher institutions in Nigerian; and
3. An evaluation of the problems and prospects of cloud computing adoption in the Nigerian public sector.

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