SHORT COMMUNICATION

# A Survey of Cloud Computing Awareness, Security Implication and Adoption in Nigeria IT Based Enterprises

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**Abstract**
*The advancement in information technology (IT) infrastructures and the overwhelming pervasive Internet accessibility has tremendously change the way computing is done in IT based enterprises. The recent hype of Cloud Computing that utilizes the existing Internet infrastructure to provide pay-as-you-go services to diverse community of businesses has emerged to alleviate and reduce the cost of computing tremendously. This paper examined the awareness of the Nigerian business enterprisesand their readiness in adopting cloud computing. It was found that the trend of awareness and adoption were very minimal with many being sceptical although few businesses were aware of the cloud technology. The survey also revealed that the stakeholders were precarious of the security-level of the cloud-based computing.*

**Keywords:** Cloud-Based Computing, Security Implications, Cloud Awareness, Cloud Adoption, Enterprises, Technology.

## Introduction

Modern day businesses enterprises are more dependent on information technology infrastructure to conduct their businesses at a more convenient and consistent manner than before. They are able to gain new ground and provide new goods and services at a faster rate than before with culminating effect of more customer base and huge profit. All the benefits derivable form IT based services are not without hitch due to cost implications of acquisition, set-up and day-to-day running of the IT facility. A huge investment is also   required in software acquisition and maintenance owing to licensing fees or hiring of in-house developers. In addition to these cost, companies in Nigeria face an enormous challenge of inadequate power supply from the public power source and had to depend mostly on internally generated power sources either by running electricity power generating sets that consume fuel round the clock to avoid interrupted service or total service failure.

The recent development and paradigm shift in IT infrastructure provisioning where users access services based on their requirements without regard to where the services are hosted is referred

to as utility computing or more recently as cloud computing (Buyya et.al. 2009). The basic idea behind this technology is that the hardware and software infrastructures are provided as a service made available on subscription bases via pay-as-you- go model to companies who subscribed to it. Companies deployed their application on the remote infrastructure without concern on how the underlying infrastructures will be sourced or provisioned in case of expansion. Cloud provider in turn operates by providing infrastructure; platform and software application supported by state of the art data centres.

When IT needs of companies are no more of a concern to them, it afford them the opportunity to concentrate on their area of expertise and reduce their investments on IT infrastructures and manpower considerably, thereby gaining adequate and huge returns on their investments and improve on their corporate culture and improved service delivery and expertise. How much are the business enterprises in Nigeria aware of this promising technology and how prepared are they in adopting it? These are the major research questions that we addressed in this paper. It is worth noting that average Companies in Nigeria spend substantial amount of money on fuel to power their electricity generating set in other to keep their IT infrastructure running and a huge amount keeping IT personnel and other nontechnical staff in charge of IT. By moving to cloud computing they tend to reduce this cost considerably.

The rest of the paper is structured as follow; section 2 discusses the related works to the research. In section 3, we provided an expanded review of cloud computing itself identifying the deployment and service models and the state of cloud computing in Nigeria. Section 4 presented survey methodology and the key findings and discussions were followed in section 5 where we also look at the security implication of the cloud services. The challenges facing Cloud Technology were highlighted in section 6. Recommendations to improve discussed technology enterprise were discussed in section 7 while the conclusion of the research work is given section 8.

**Related works**
Several works have been conducted to look into the challenges and prospects of cloud computing to enterprises business computing. In (Asad, 2009) the challenges facing adoption of cloud computing were identified to include traditional challenges, security challenges and technical challenges. He also highlighted that reduced cost in IT infrastructure investments as the most important benefit of cloud computing. In ( Erdogmus, 2009) other benefits of cloud computing were identified to include "scalability, reliability, security, ease of deployment, and ease of management for customers, traded off against worries of trust, privacy, availability, performance, ownership, and supplier persistence".

In addition, Motahari-Nezhad et.al (2009 ) briefly discussed the benefits and risks of using cloud computing from a business perspective. They highlighted the lack of environments for helping businesses migrate their legacy applications to the cloud. In addition, they pointed out the difficulties of finding and integrating different cloud services for a given set of business requirements. They also proposed a conceptual architecture for a virtual business environment where individuals and SMEs can start and operate a virtual business using cloud-based services.

Other works have also survey the  of some market research firms have also published the business potential of cloud computing, IDC a market research and analysis firm reported that the worldwide spending on Cloud services to be $16 million in 2008 and projected an increase to $42 billion by 2012. All these points to the importance that research community are directed toward the benefits of cloud computing. This study is unique in this direction as itexamines how companies and organizations in Nigeria are able to identify the benefits this potential technology portends as a catalyst to business development and their preparedness to adopt this technology.

## Cloud Computing

There are many definitions of cloud computing in the research community. However most of these definitions fell short of full description of Cloud Computing paradigm and are usually given from the perspectives of individual technology provider in their whitepapers. A more encompassing working definition was given in a document by the United State National Institute of Standards and Technology (NIST) which encompass the consensus areas of cloud computing attributes (Mell and Gance, 2009). NIST definition of cloud is given as follows:

Cloud computing is 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 and Gance , 2009).. This definition highlights the basic features of cloud computing and it's widely acceptability in most US government documents. The definition also highlights five basic characteristics of cloud computing to include the following essential attributes:

   i.   On-demand self-service: Computing resources such as server, network storage etc can be provisioned to consumer without any interaction with the service provider.
   ii.  Broad Network Access: cloud service is heterogeneously available over the network to wide diverse user platforms such PDAs, cell phones, laptops etc.
   iii. Resource Pooling: the resources (storage, network bandwidth, etc) provisioned to the user are heterogeneously, transparently and dynamically pooled by the providers to the consumers irrespective of their location.
   iv.  Rapid elasticity: the provided resource can be dynamically scaled-up or scaled-down according to consumer needs.
   v.   Measured Service: all the service rendered is utility based and are appropriately and transparently measured to bill the consumer based on the consumption rate.

## Cloud Service and Deployment Models

Different providers such Amazon EC2, Microsoft Azure, Google App Engine to mention but a few provides diverse cloud service models. The cloud computing service models currently in vogue include the following.

## Cloud Software as a Service (SaaS)

This service model has the capability to provide provider's applications running on a cloud infrastructure to the consumer through various client devices in a thin client interface such as a web browser (e.g., web-based email). The underlying cloud infrastructures including network,

servers, operating systems, storage, or even individual application capabilities are under the full control of the service provider. Only the user specific configuration settings may be required.

**Cloud Platform as a Service (PaaS)**
The capability provided to the consumer is to deploy onto the cloud infrastructure consumer-created or acquired applications created using programming languages and tools supported by the provider. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, or storage, but has control over the deployed applications and possibly application hosting environment configurations.

**Cloud Infrastructure as a Service (IaaS)**.
The capability provided to the consumer is to provision processing, storage, networks, and other fundamental computing resources where the consumer is able to deploy and run arbitrary software, which can include operating systems and applications. The consumer does not manage or control the underlying cloud infrastructure but has control over operating systems; storage, deployed applications, and possibly limited control of select networking components (for instance, host firewalls).

**Cloud Deployment Models:**
**Private cloud:**
The cloud infrastructure is operated solely for an organization. It may be managed by the organization or a third party and may exist on premise or off premise.

**Community cloud:**
The cloud infrastructure is shared by several organizations and supports a specific community that has shared concerns (for instance, mission, security requirements, policy, and compliance considerations). It may be managed by the organizations or a third party and may exist on premise or off premise.

**Public cloud:**
The cloud infrastructure is made available to the general public or a large industry group and is owned by an organization selling cloud services.

**Hybrid cloud:**
The cloud infrastructure is a composition of two or more clouds (private, community, or public) that remain unique entities but are bound together by standardized or proprietary technology that enables data and application portability (e.g., cloud bursting for load-balancing between clouds).

**Cloud Computing in Nigeria**
Nigeria as one of the developing nations is growing faster in information technology from analogue to digital and from standalone to distributed computing. However, the awareness of cloud computing potentiality is still very low in the country. Cloud computing services and its

applications has a huge amount of benefit and opportunity in Nigeria considering the large number of growing communication and networking companies operating in the country. Additionally, consider the large number of growing Small and Medium Scale Enterprises in Nigeria, there is need for the awareness and application of cloud computing in their businesses in order to assist them economically, in term of flexibility, effectiveness, Consistency in service delivery, energy efficiency and security consciousness.

**Cloud Security Implications**

There are several security challenges arise from the emergence of cloud computing technology, which require urgent and critical attention in order to facilitate the effectiveness of the technology and remove fear of its adoption. The security component could be added to the security layer and be delivered as Security as a Service (Sloan, 2009). He explored and solved the cloud computing technologies and discusses about the challenges posed in security of technology.

Stringent access controls and data backup schedule (Kaufman, 2009) including tested encryption schema must be included in the package of cloud computing provider, in order to ensure maximum Confidentiality, Integrity and Availability. Various cloud technology available in the market today are not using the same clouds for their operation, which according to Kim (2009) could eventually result to a situation whereby cloud integration services will require different approach of security implication. In another perspective, presently, the cloud computing technology has no any single regulatory body charge with the duty of regulating the standard of cloud computing security. There is need for the provision of security requirement parallel to the requirement of business activities.
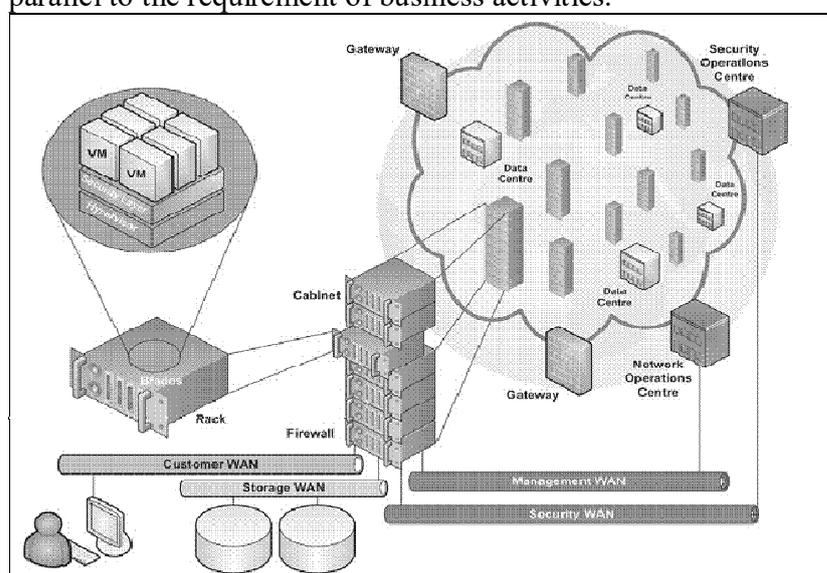


Figure 3.4.1.:   Cloud Computing Security Architecture.
Source: (Sloan, K. 2009)

**Security Components in Cloud Computing**

Authentication and Identification mechanisms are varies for different services in cloud computing. The most commonly adopted security mechanisms in cloud computing are What User know (i.e password, token), What User have (i.e Smartcard), and Who User is (i.e biometric test). The combination of these mechanisms is highly secured than any other type except for its cumbersomeness. For example Google and Yahoo employ Request Token mechanism for authentication while Amazon AWS employs a custom mechanism which mirrors the identification and authentication.

Secure Socket Layer (SSL) technology is a secure web based technology to enhance the security of communication between the cloud services and consumer activities in order to prevent all form of foresee Security Threat. All various forms of cloud computing attacks including XSS, CSRF flaw in indexing design of Zoho have been successful on cloud and makes it highly vulnerable to attacks (Mansfield-Devine, 2008). Viega, (2009) propounded that there should always be a verification mechanism in Security as a Service model (SaaS) to verify client requests before execution in order to prevent an intruders who may also have access to code binaries.

In order to guarantee the privacy of information hosted on the server in cloud technology, Data Encryption and Validation is another security component where information in cloud is encrypted, and can only be decrypted at the client level with a key. However, it is recommended that data be quickly decrypted at the client level as it might need high processing power. It is also highly recommended that the cloud services be runs using https which is a Socket Secure Layer.

The client of cloud technology should maintain their own data backups in order to provide a continuous access to their data even at the extreme situations such as data providers going bankruptcy or disaster at data center etc. (Viega, 2009). Combination of security mechanisms should also be used to provide a granular security in a cloud environment. Intrusion Detection is another security panacea for vulnerability detection in cloud as proposed by Vieira et al. (2009)

Antivirus is another type security mechanisms on the cloud to reduce the threat of malware. It is however recommended that the antivirus be updated regularly in order to be up-to-date with the database of the provider. In order to detect various forms of intrusion within the cloud and prevent them from entering the cloud, Firewalls could be implemented as software or at the hardware level at each gateway.

The security components in cloud environment is incomplete without relating the Legal Issues as applicable to the sourcing arrangements of Data Protection Act 1998 (DPA), confidentiality and Integrity. The intricacies over confidentiality and integrity as well as database (server) maintainer or owner should be resolved in order to enhance the security of the cloud. A specific contract should also be made between the service providers in order to prevent data search and seizure by as proposed by the UK government as published in the news article Computer Fraud & Security (August, 2009).

## Methodology

### The Survey Design

A questionnaire was prepared for some staff of Small and Medium Businesses (SMBs) and Small and Medium Enterprises Development Agency (SMEDAN) of Nigeria, to find out the adoption, security implication and eventual usage of cloud computing in their various sectors. The next is finding out whether the claims of the stakeholder on the existence and exploration of cloud computing are genuine. Personal interview was also used in order to gather the response of some staff of Small and Medium Businesses in Nigeria. Finally, the collation of the available data for presentation and analysis is done. Some of the existence Small and Medium Businesses consulted for the research are in Communication Sector like MTN Nigeria, Globalcom Nigeria, Multilink Nigeria, Starcom Nigeria, Education, industry and Banking sector of the economy.

### Interviews and Questionnaire

The interview was conducted for the staff of some selected economy sectors to find the cloud computing existence, cost implication and its security challenges within their organization. The aim is to evaluate the proliferation of cloud computing and examine its cost and security implication on the Small and Medium Businesses in the country, which is one of the determinant of country economy's growth index. Ten (10) staff each were interview in five sectors of the economy i.e Communication, Education, Industry and Banking. Online questionnaire were also set and dispatched for the general response.

The result of the interview was tabulated and analyzed below:

### Table 1: Presentation of the Questionnaire

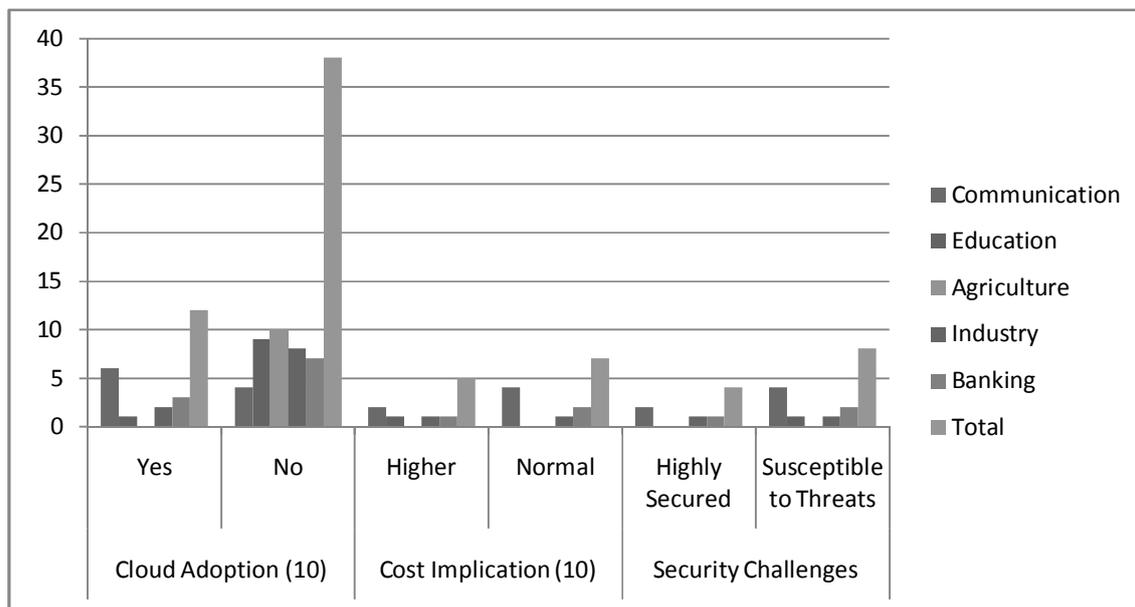| Economy Sectors | Staff Cloud Adoption (10) | | Cost Implication (10) | | Security Challenges | |
|---|---|---|---|---|---|---|
| | Yes | No | Higher | Normal | Highly Secured | Susceptible to Threats |
| Communication | 6 | 4 | 2 | 4 | 2 | 4 |
| Education | 1 | 9 | 1 | 0 | 0 | 1 |
| Agriculture | 0 | 10 | 0 | 0 | 0 | 0 |
| Industry | 2 | 8 | 1 | 1 | 1 | 1 |
| Banking | 3 | 7 | 1 | 2 | 1 | 2 |
| **Total** | **12** | **38** | **5** | **7** | **4** | **8** |

**Fig. 4.1:** **Bar chart of the result of questionnaire in various sector of economic**

## Analysis and Discussion of the Results

From the table 4.1 above, it was observed that out of 50 interviewed staff, only 12 staff attested to the adoption of cloud computing in their organization while the remaining 38 staff confirmed the non-availability of cloud computing infrastructures. It was also observed that the cost implication of cloud computing as attest by 7 staff out of 12 staff is normal, considering various factors and cost benefits of the technology, which outweigh its cost implications. The table finally shows that 8 staff out of 12 staff that attested to the adoption of cloud computing in their organization declined the low level of security of the technology, while only 4 agree that the security level of the technology is alright. The deduction from the table was that the awareness of the cloud computing technology is still very low in Nigeria and those that are aware are afraid of cost implication in order to subscribe. Also, because of the network oriented nature of the cloud computing technology, there are lot of security issues that still has to be patched in order to avoid various vulnerabilities posed by the network.

## Challenges of Cloud Computing

The under listed are some of the identified challenges associated with the Cloud Technology and its deployment.
  i.    Free service from Provider
  ii.   Malware Infection (Zero day vulnerability allows USB malware to run automatically)
  iii.  Network Intrusions

iv.  Online fraud
v.   Unauthorized information revealed like patient records
vi.  Denial of service attack

## Recommendations

The following are the recommendations based on the finding and analysis of the research work:
1. The Cloud Service Providers should enhance efforts in order to create awareness on the benefits of cloud computing most especially in the developing nation.
2. The cloud service providers should make an appropriate consideration for the small scale business to encourage their participation.
3. The cloud computing security should be enhanced to facilitate participation.

## Conclusion

It is worthwhile to note that the cloud computing activities and subscriptions in the developing nation like Nigeria is still very low. The researchers discovered that the level of awareness among the stakeholders and enterprises is low due to several factors. Those already engaged in the system is being afraid of the security implication, and those intend to engage is being scare of cost implication due to the nature of economy of the country. The cloud computing service providers like Google, Amazon among other need to double their efforts in creating awareness on the benefits of the system to encourage those that need the system. Furthermore, the deployment of the system should be considerate so as not to scare away the interested enterprises.

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**SHORT COMMUNICATION**

## Design of a Web Based mathematical Application for High School

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## Abstract

*Mathematics is a subject in high school that students have found so tasking and challenging. There is an increase in failure in mathematics as recorded for students who sat for WAEC and JAMB in Nigeria in the last two years. This study therefore designed a mathematics web based application using the Javaserver Faces (JSF) technology framework, Glassfish server and Prime Faces technology to help students improve and develop their abilities in assignments solution, summations, and mathematics projects and increase their reasoning. The results shows that the application designed makes students to grab the understanding of mathematics concepts better help the students solve problems faster and easier and also increase their performance in mathematics.*

*Keywords: Design, Web Based Application, High School.*

## Introduction

The universe cannot be read until we have learnt the language and become familiar with the characteristics in which it is written in mathematical language, and the letters are triangles, circles and other geometrical figures, without which means, it is humanly impossible to comprehend a single word without mathematics Galileo Galilee (1564-1642)

Mathematics provides a language for quantifying, measuring, comparing, and reasoning, identifying patterns and communicating precisely. It is a language children can bring into the world they create (Kleiman, 1991, p51). Mathematics is a subject in high school that students have found so tasking and challenging. In the last two years, SSCE records show that the number of students that failed mathematics in WAEC and JAMB is approximately 51% of the entire population of student that sat for the examination. The failure could be due to one or many factors (Salman, Mohammed, Ogunlade, Ayinlaa, 2012) : Lack of frequent practice by students, Poor mathematical background, Laziness on the part of students and teachers, More Unqualified teachers or few number of professional math's teachers. Majority of after school educational programs or school lessons are funded by private organizations primarily to check the increasing number of mathematics failure in Nigeria. Many more of these programs (online and offline) are designed to support the academic growth of students in several levels especially in secondary schools. Several techniques have been employed to help students improve in