Cloud Computing Adoption in Nigeria: Challenges and Benefits

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Abstract- Growing number of IT industries in the world are fast adopting cloud computing which has created the access needed by users and business organisation to have on-demand access to shared resources and applications online. The developed economies have long embraced the sturdy and cost effective cloud technology into their businesses leaving behind the developing countries who are still struggling to reap the benefits of this technology. The objective of this paper is to highlight the benefits of adopting cloud comput¬ing and highlight the challenges in adopting and utilizing services offered by cloud computing. Recommendations were also made on how ease the adoption of the emerging technology in Nigeria.

Index Terms- Cloud, Computing, Internet, IT, Adoption, Technology

I. INTRODUCTION

The advent of cloud computing has greatly assisted most businesses and organisations to deliver quality services to their customers via the internet. The National Institute of Standards and Technology 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, 2009). Similarly, Priya (2011), also defined Cloud computing as a technology which provide you a service through which you can use all the computer hardware and software sitting on your desktop, or somewhere inside your network but they are not actually installed on your computer, it is provided for you as a service by another company and accessed over the Internet. Dave Cleveland (2012), in his definition defined Cloud computing as a technology that uses the Internet alongside the central remote servers to maintain data and application. Hence, cloud computing is a fast emerging technology that permits users to store files, share files and applications on the Internet.

Slaheddine (2012), states that the remarkable development of cloud computing in recent years is increasingly sparking the interest of Internet and IT users seeking to derive the greatest benefit from the services and applications available on line via the web in service-on-demand mode with per-usage billing. Cloud computing offers a new economic model for ICTs – a model which heralds new modes of investment in, and operation of, IT resources. With cloud computing, organizations, institutions and companies no longer need to invest heavily in such resources, which are of necessity limited and require burdensome and costly internal management, having instead the option to migrate to a cloud model enabling them to purchase or lease resources on line. This model frees them from internal management costs, the IT resources being administered by the cloud computing provider.

The accessibility of services such as storage, shared files and applications on the internet through cloud computing has ease the burden of users acquiring hardware components by simply paying for the services and resources used online. Cloud computing will be particularly more useful to companies yarning to provide quality services to their customers whenever it is demanded.

Cloud computing, considered by some to be the technological revolution of the twenty-first century, could go a long way towards resolving such issues, provided the corresponding technology is implemented on solid bases that inspire confidence in users both domestic and foreign (Slaheddine, 2012).

According to Puja (2012), there are various applications of cloud computing in today's network world. Many search engines and social websites are using the concept of cloud computing like www.amazon.com, hotmail.com, facebook.com, linkedln.com etc.

Heiser et al (2008), states that for an organization to be successful at using an external service (PaaS, IaaS, SaaS), proper risk assessment must be carried out to identify the security risks, privacy and compliance risks. The following should be evaluated when carrying out the assessment: privileged user access, compliance, location of data, data segregation, and recovery.

II. LITERATURE REVIEW

It is useful to think of a cloud as a collection of hardware and software that runs in a data centre and enables the cloud computing model (Armbrust et al, 2009).

According to Youseff et al (2008), Cloud Computing can be considered a new computing paradigm that allows users to temporary utilize computing infrastructure over the network, supplied as a service by the cloud-provider at possibly one or more levels of abstraction. Armbrust et al (2009), also states that Cloud Computing refers to both the applications delivered as services over the Internet and the hardware and systems software in the datacenters that provide those services. The services themselves have long been referred to as Software as a Service (SaaS). The data center hardware and software is what we will call a Cloud. When a Cloud is made available in a pay-as-you-go manner to the general public, we call it a Public Cloud; the service being sold is Utility Computing. We use the term Private

Cloud to refer to internal data centers of a business or other organization, not made available to the general public. Thus, Cloud Computing is the sum of SaaS and Utility Computing, but does not include Private Clouds (Armbrust et al, 2009).

The idea of cloud computing is not actually new as it goes back several decades. It was pioneered by Professor John McCarthy, a well-known computer scientist who initiated time-sharing in late 1957 on modified IBM 704 and IBM 7090 computers. McCarthy expected that some corporations would be able to sell computing resources through the utility business model. Soon enough, different organizations paid for their use of computing resources (storage, processing, bulk printing, and software packages) available at service bureaus cited in Qusay (2011).

Cloud computing is simply a medium for distributing on-demand services, infrastructure, and application software using the network. The major types of cloud deployment models as seen figure 1 are:

- *Public cloud*: Cloud infrastructure shared or accessible by all, with applications and services delivered through the Internet;
- *Private cloud*: Restricted cloud infrastructure operated by or on behalf of a specific organization, available exclusively to approved users affiliated with that organization; cloud services are delivered using a private network;
- *Community cloud*: Multitenant, private cloud infrastructure that supports a specific community, consisting of two or more organizations and
- *Hybrid cloud*: Combination of two or more of the preceding cloud types.

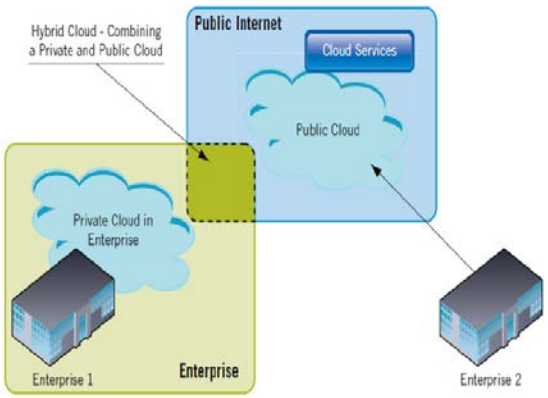


Figure 1: Cloud Computing Development Model

In the past few years there have been tremendous increases in use of cloud computing in both business, government and even educational sector, this increase was due to world wide availability of internet and high competition in the cloud market that brought about utilising computing resources at minimum cost (Rahimli, 2013).

Cloud computing is already been used by various internet users, from Yahoo mail, Google mail, Hotmail and free office applications such as Google apps, Gmail, drop box and numerous other software as a service (SaaS) (2009). Numerous organisations are now adopting cloud computing because of the cost effective on-demand services it delivers.

Buyya et al (2009) states that Cloud computing has been cited as 'the fifth utility' (along with water, electricity, gas, and telephone) whereby computing services are readily available on demand, like other utility services available in today's society. Similarly, Voas et al (2009) also identified cloud computing as the next computing paradigm that follows on from mainframes, PCs, networked computing, the internet and grid computing. These developments are likely to have similarly profound effects as the move from mainframes to PCs had on the ways in which software was developed and deployed.

In an article recently published in the journal "Les Afriques", Raphaël Nkolwoudou, Associate Counsel Azaniaway Consulting cited in Slaheddine (2012), explains that cloud computing is suited to the African continent by reason of the concentration of infrastructures, availability of IT competencies and ease of implementation. There is, however, one prerequisite, which is to speed up the development of electronic communication infrastructures. He adds that among the specific benefits of cloud computing in Africa, two in particular are liable to make a significant contribution to reducing the digital divide, namely:

i. The ability to have immediate access to the latest innovations;
ii. The possibility for an organization to do away with heavy investment in infrastructure, particularly where computation centres are concerned, given the unreliability of the electric power supply in Africa.

According to a survey carried out by Cisco and World Wide Worx (2013), the study found that 50% of South Africa's medium and large businesses were using cloud services, compared to 48% in Kenya and 36% in Nigeria. South Africa currently leads the continent in Cloud computing uptake, but appears to not be growing fast enough to retain that position in the years to come. For Kenya, in addition to the 48%, another 24% of organisations in Kenya were considering adopting within a short while.

Table 1: Cloud Service

Country	% Medium and Large businesses using Cloud Services
Kenya	48
Nigeria	36
South Africa	50

Cisco and World Wide Worx (2013) study also revealed that Private cloud was the most popular in 2013 among organizations surveyed currently deploying this compared followed by Hybrid cloud and the remaining companies opting for the Public cloud as seen in table 2. The most popular category for cloud use was storage (28% of companies). In 2014, this trend is set to continue with 32% of companies opting for the Private Cloud compared to 18% for Hybrid Cloud and 16% for Public Cloud.

Table 2: Cloud Usage

	% of Cloud usage
Hybrid	13
Private	25
Public	7

The most significant finding from the study was that, while South Africa currently leads the continent in Cloud uptake, it is about to be overtaken dramatically by Nigeria. A significant 44% of Nigerian businesses say they will embrace the Cloud in 2014, bringing the total in that country to 80% by the end of 2014. This compares to 24% of organisations in Kenya and only 16% in South Africa saying they will be taking up Cloud.

According to CompTIA 4th Annual Conference Full Report (2013), it states that as cloud components are becoming more prevalent in IT architectures, more companies are relying on cloud computing for business processes such as storage (59%), business continuity/disaster recovery (48%), and security (44%). This strong usage and strong market indicators show that cloud computing is becoming a default part of the IT landscape. Although adoption rates are high and market numbers are positive, there is still confusion related to cloud computing. This confusion will hinder end users and channel firms from fully transforming their IT practices and offerings. Only 46% of channel firms with cloud offerings described their cloud business as completely mature—an established, strategic part of business plans.

According to a white paper report from Dialogic (2010), cloud computing has a variety of characteristics, with the main ones being:

i. *Shared Infrastructure* — Uses a virtualized software model, enabling the sharing of physical services, storage, and networking capabilities. The cloud infrastructure, regardless of deployment model, seeks to make the most of the available infrastructure across a number of users.

ii. *Dynamic Provisioning* — Allows for the provision of services based on current demand requirements. This is done automatically using software automation, enabling the expansion and contraction of service capability, as needed. This dynamic scaling needs to be done while maintaining high levels of reliability and security.

iii. *Network Access* — Needs to be accessed across the internet from a broad range of devices such as PCs, laptops, and mobile devices, using standards-based APIs (for example, ones based on HTTP). Deployments of services in the cloud include everything from using business applications to the latest application on the newest smart phones.

iv. *Managed Metering* — Uses metering for managing and optimizing the service and to provide reporting and billing information. In this way, consumers are billed for services according to how much they have actually used during the billing period.

III. Architectures and Deployment Models

According to Kim-Kwang (2010), Cloud architectures can be broadly categorised into:

- *Infrastructure as a Service (IaaS)*: This is the foundation of cloud services. It provides clients with access to server hardware, storage, bandwidth and other fundamental computing resources. For example, Amazon EC2 allows individuals and businesses to rent machines preconfigured with selected operating systems on which to run their own applications.
- *Platform as a Service (PaaS)*: This is built upon IaaS and provides clients with access to the basic operating software and optional services to develop and use software applications (eg database access and payment service) without the need to buy and manage the underlying computing infrastructure. For example, Google App Engine allows clients to run their web applications (ie software that can be accessed using a web browser such as Internet Explorer over the internet) on Google's infrastructure.
- *Software as a Service (SaaS)*: This is built upon the underlying IaaS and PaaS provides clients with integrated access to software applications. For example, Oracle SaaS Platform allows independent software vendors to build, deploy and manage SaaS and cloud-based applications using a licensing economic model. Here, users purchase a license and support for components of the Oracle SaaS Platform on a monthly basis.

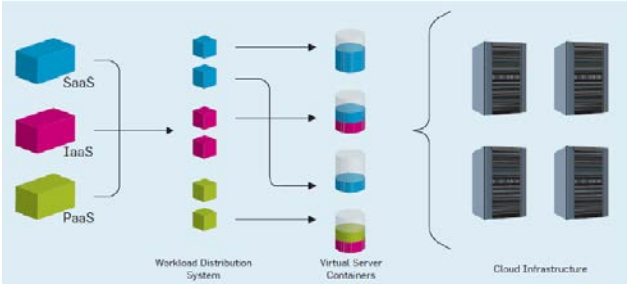


Figure 2: Service Delivery Model (Garrison et al (2012))

Table 3 below shows the different technologies used in different cloud computing service types.

Table 3: IaaS, PaaS and SaaS

Service Type	IaaS	PaaS	SaaS
Service Category	VM Rental, Online Storage	Online Operating Environment, Online Database, Online Message Queue	Application and Software Rental
Service Customization	Server Template	Logic Resource Template	Application Template
Service Provisioning	Automation	Automation	Automation
Service accessing and Using	Remote Console, Web 2.0	Online Development and Debugging, Integration of Offline Development Tools and Cloud	Web 2.0
Service monitoring	Physical Resource Monitoring	Logic Resource Monitoring	Application Monitoring
Service level Management	Dynamic Orchestration of Physical Resources	Dynamic Orchestration of Logic Resources	Dynamic Orchestration of Application
Service resource Optimization	Network Virtualization, Server Virtualization, Storage Virtualization	Large-scale Distributed File System, Database, Middleware etc	Multi-tenancy
Service measurement	Physical Resource Metering	Logic Resource Usage Metering	Business Resource Usage Metering

used in cloud computing are: automation, virtualization, dynamic orchestration, online development, large-scale distributed application operating environment, Web 2.0, Mashup, SOA and multi-tenancy etc. Most of these technologies have matured in recent years to enable the emergence of Cloud Computing in real applications (Jinzy, 2010).

In many respects cloud computing is a relatively new phenomenon, particularly in the consumer space where the small amount of storage available on mobile devices sparked a need for access to photos, music, videos and documents without necessarily storing them locally. For business, however, SaaS has been available for around 15 years in areas such as email and internet banking (Burton, 2014).

IV. Security Issues in Adopting Cloud Computing Model

Heiser et al (2008) identified seven security issues that need to be addressed before enterprises consider switching to the cloud computing model. They are as follows:

i. *Privileged user access* - Information transmitted from the client through the Internet poses a certain degree of risk, because of issues of data ownership; enterprises should spend time getting to know their providers and their regulations as much as possible before assigning some trivial applications first to test the water.

ii. *Regulatory compliance* - Clients are accountable for the security of their solution, as they can choose between providers that allow to be audited by 3rd party organizations that check levels of security and providers that don't.

iii. *Data location* – Depending on contracts, some clients might never know what country or what jurisdiction their data is located.

iv. *Data segregation* - Encrypted information from multiple companies may be stored on the same hard disk, so a mechanism to separate data should be deployed by the provider.

v. *Recovery* - Every provider should have a disaster recovery protocol to protect user data.

vi. *Investigative support* - If a client suspect's faulty activity from the provider, it may not have many legal ways pursue an investigation.

vii. *Long-term viability* - Refers to the ability to retract a contract and all data if the current provider is bought out by another firm.

V. Challenges of Cloud Computing Adoption in Nigeria

Armbrust et al (2009) highlighted some challenges in cloud computing that included technical challenges relating to the adoption of cloud computing, such as availability of service and

data lock-in. The lack of scalable storage, performance unpredictability and data transfer bottlenecks are also obstacles that could limit the growth of cloud computing.

There are numerous challenges that have hindered the acceptance and uses of cloud computing in Nigeria, prominent among them are:

i. Poor quality or unavailability of internet service can hinder prompt availability of data.
ii. Fear of hackers
iii. Companies are not contented that there records will be giving the utmost privacy.
iv. Lack of technical skills in the deployment of cloud computing service.
v. Lack of flexibility of the policy or legal framework for cloud computing is discouraging a number of companies to adopt cloud computing.
vi. Lack of detailed information and awareness of cloud computing services is hampering more clients going into cloud technologies.
vii. The need for current ICT infrastructures and social amenities needed to establish cloud computing data centres across the country.
viii. The current insecurity problem facing the nation will also hinder cloud technologies providers from investing in the country.

VI. Benefits of Cloud Computing in Nigeria

Angaye (2012) states that cloud computing services are categorized into Software service, Infrastructure service and Platform service. He further revealed that, Software service alone was estimated to generate over $21.3 billion globally by 2015, and that software developers in Nigeria could tap into it and transform the Nigerian economy, if given the right tools and the enabling environment in terms of putting the right infrastructure in place.

The developed countries now based their entire multi-billion dollar business models on putting information on the net, and storing the data in the cloud. Cloud computing offers worldwide access to virtually unlimited processing power, new storage capabilities and capabilities that are being used to create virtual web platforms, where humanity today and in the future will live out large parts of their everyday lives, educating, working, shopping and talking to private networks of friends and relatives (Uwaje, 2012).

Kuyoro et al (2012) states that cloud computing enables the measuring of used resources as is the case in utility computing which can be used to provide resources efficiency information to the cloud provider and can be used to provide the consumer a payment model based in “pay-per-use”.

Hinchcliffe (2009) states that, with Cloud computing, payment is made for only software used. Some software on the Cloud is free. For example, most SaaS solutions have a pay-as-you-go pricing model instead of a large up-front investment. Such pricing models allow end users to pay only for what they use thus freeing up resources such as time and money for other more important (core) business activities. It is obvious cloud computing has helped in reducing cost, ease IT intricacies and enhance the availability of update technology.

Cloud computing is fast having huge impact on businesses today (Sourya, 2012). According to International Data Corporation (IDC) 2012 report, by 2015 cloud computing would have created about fourteen million jobs globally. As at 2011, cloud computing generated $400 billion in revenue and created 1.5 million new jobs (IDC, 2012). From Figure 3, the proposed number of jobs by cloud computing will surpass 8.8 million.

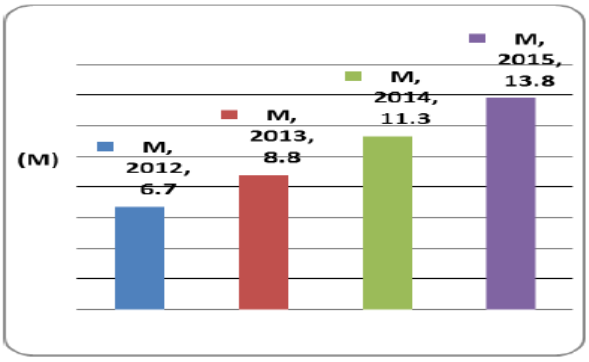
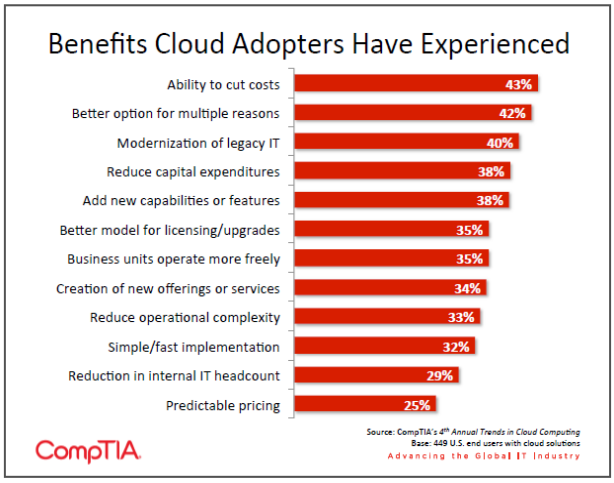


Figure 4: Projected Data for the Number of Jobs Created By Cloud Computing from 2012-2015: Source: IDC, 2012

Table 4 below reveals the result of the research conducted by CompTIA (2013) on the benefits cloud adopters have experienced after the adopting the technology.

Table 4: Benefits Cloud Adopters Have Experienced



VII. TRENDS IN CLOUD COMPUTING

According to an article in regalix.com cited in Raghavendra et al (2015), there are Five Cloud Computing Trends that will drive cloud strategies through 2015 and 2016 and they are:

i. *Hybrid Cloud Computing:* Hybrid Cloud means using a combination of public or private cloud services. As it is proved from some recent developments, hybrid cloud computing is set to become an imperative, in the form of a unified integrated cloud model, consisting both internal and external cloud platforms that can be leveraged based on specific business requirements. Data Scientists and Cloud Experts recommend that organizations should make immediate efforts on

integrating the application and dynamic data infrastructures to form a hybrid solution.

ii. *Cloud Services Brokerage:* Cloud Service Brokerage (CSB) has graduated from being an option to a key strategic factor for users and IT alike. CSB involves a service provider playing a key role in assisting the consumption of cloud computing. CSB as a trend is predicted to gather speed over the next couple of years as users choose to use cloud services, independent of IT bureaucracy.

iii. *Cloud Friendly Decision Frameworks:* Many data Scientists now agrees that Cloud Computing offers a platform of completely indispensible features and benefits, like cost-effective use-based models of IT consumption and service delivery, greater agility and lesser complexity. It also allows the IT to focus its resources on delivering new services that fuel innovation and accelerate the business.

iv. *Application Design Must Be Cloud-Optimized:* Now the way IT Sector go about cloud computing is to basically just transfer their whole organization work-loads to the cloud. This is a good technique where the workloads need a variable supply of resources. But to fully extract the potential of cloud model to deliver standard world class applications, we need to start developing applications that are cloud-optimized.

v. *Datacenters Need To Adopt Implementation Models of Cloud Service Providers:* In a cloud computing environment, the data center and other details are handled by the service provider while the organization only concerns itself with consumption of services. But as enterprises carry on building/expanding their own data centers, they will be far better served applying the cloud computing implementation models of Cloud Service Providers to increase performance, efficiency, and agility.

VIII. CONCLUSION

Cloud computing technology has no doubt changes the way both the private and public organisations deliver quality services to its teaming customers. This study revealed that the adoption of cloud computing in developing countries like Nigeria has numerous benefits which includes use of shared resources which has helped in lowering cost for most organisations using the cloud technology, provision of on-demand self-service, accessing numerous valuable applications from the cloud service provider, it is highly efficient, reliable and more secured. The major challenges in adopting this technology in the country is the problems of power supply, poor internet service, fear of hackers and the insecurity problem facing the country which has hindered cloud service providers to invest in the country and also businesses in adopting cloud computing.

IX. RECOMMENDATIONS

The following recommendations were made to enhance the adoption and growth of cloud computing usage in Nigeria:

i. Both the private and public organisations in the country should be thoroughly enlightened by the cloud service providers on advantages of cloud computing services and some of its shortcomings. This will help get rid of the fear of most organisations in adopting cloud computing.

ii. The security challenges Nigeria is currently facing should be checked to encourage more cloud service providers to invest in the country to complement the few already in place and increase competition.

iii. Better internet service and constant power supply is needed to have seamless access to the cloud service. This will also lessen the cost of services provided.

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