

Feasibility Analysis of Critical Factors Affecting Cloud Computing in Nigeria

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ABSTRACT

Cloud computing is an evolving and new way of delivering computing services and resources over the internet which are managed by third parties at remote sites. Currently, Cloud computing is enjoying a lot of buzz in Nigeria due to its perceived economic and operational benefits and stakeholders believe that it will transform the IT industry in Nigeria. Despite all its promises there still exist so many challenges before Cloud computing is fully adopted in the Nigerian ICT sector. This paper delivers an overview of Cloud computing together with its advantages and disadvantages. Thereafter, the challenges affecting the adoption of Cloud computing and drivers of opportunities that will favour and nurture the adoption of Cloud computing by organisations in Nigeria are outlined. Finally, recommendations for the adoption of Cloud computing technology by stakeholders in Nigeria are discussed.

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1. INTRODUCTION

Cloud computing is an evolving concept and is based on existing technologies like web services, Service Oriented Architecture (SOA), web3.0, grid computing and virtualization, etc. Computing services includes data storage, processing and software. As the demands on data centres keeps growing in terms of energy consumption, cooling system, infrastructure, space, qualified IT professionals and day-to-day running costs, cloud computing is evolving as an important transition and a paradigm shift on how services are been delivered in IT because of its economic and operational benefits to organizations. This was echoed by Omobola Johnson the Nigeria Minister of Communication in a speech at the annual Institute of Software Professionals of Nigeria (ISPON) conference held in Cross River State in Nigeria, "Given our plans for e-Government and the increased use of ICT by government Ministries, Departments and Agencies (MDAs), this is an unsustainable practice that must be managed. A Government cloud will provide some economic savings" [1] While cloud computing brings with it promising economic and operational benefits; security, privacy, trust and data integrity remains the major concerns slowing down its adoption by governments, financial institutions, ICT firms, industry and researchers in Nigeria. This is verified in Figure 1, which shows 34% respondent citing security as the highest concern slowing a movement to cloud largely due to the sensitivity and critical data deployed in the cloud by entities who have outsourced their data owing to its vulnerability to attack as a result of the multi-tenant nature of cloud computing [2], also coupled with the fact that new technologies and services which are been deployed on cloud computing infrastructure have not been adequately tested and evaluated in terms of security. The result on Figure 1 though carried out in Canada,

also stand true for Nigeria as security remains the major stakeholders concerns about adopting Cloud computing in Nigeria.

Data integrity, trust, privacy, expectations, control, regulations, intellectual property management, audit trails, service-metering and performance are some of the critical concerns associated with cloud computing. Security concerns in Cloud computing varies depending on the area of adoption, for example security concerns in social networks will vary from that of Banking and Finance, Telecommunication, eGovernment and in the Health care system because valuable data of people is at stake if compromised.



Figure 1: Cloud Computing Concerns (Source: PricewaterhouseCoopers, Toronto May 2010) [3]

Therefore, organizations need to weigh the cost, benefits and risks of cloud computing in determining its adoption into its IT strategy. The main aim of the paper is to examine issues slowing the adoption of cloud computing in Nigeria as well as key drivers in support of making decisions about its adoption. In this paper we shall also discuss the types of cloud computing and deployment models, thereafter discuss recommendations for the adoption of cloud computing in Nigeria and conclude by outlining areas for further research.

2. RELATED WORK

This section reviews the related research on factors affecting cloud computing adoption in different organizations and businesses [4], In the past few years there have been tremendous increase 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 [5]. 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) [6], Nowadays organisations are increasingly looking to adopt robust and cost effective technology that allow them focus on their core business rather than maintaining a large IT infrastructures that are expensive to acquire and maintain [7].

A research by Gartner on cloud market in 2009 shows that as at 2009, the cloud service market was \$46.4 billion and estimated to reach \$150.1 billion by 2013 [8] p.1 and similarly Forrester recent research in 2011 forecasts \$241 billion by 2020 [9]. Reference [10] offers a strong argument, maintaining that cloud computing has disrupted the IT industry using the pay as you use business model which shift IT expense from Capital Expenditure (CAPEX) to Operational Expenditure (OPEX) in business terms. It basically transform the IT sector from been a CAPEX to an OPEX lowering cost of purchase and maintenance of expensive hardware devices. New technology need time to mature as most organisations adopt new technology in stages; this depends largely on organisations as some adopt new technology earlier than others [5]. Cloud Computing and its increasing dominance in the IT industry and business alike have established itself as a discontinuous innovation [11], one that establishes new ways of computing, software development, application delivery and resource allocation.

Cloud technology possess distinct characteristics that differentiate it from traditional datacentre environment, [12] identified on-demand sale normally by minutes or hours; elasticity for user to demand much or little service at any given time; and service been wholly managed and administered by the service provider as the main characteristics of cloud computing. In the past few years there have been tremendous increase in use of cloud computing as such ESG (Enterprise Strategy Group) report on 2012 to 2013 IT

spending shows an increase of 60% on Cloud computing services in 2013 [13] p.12. Cloud Computing will soon be a notion that will move from “*may have!*” to a “*must have!*” [14] p.9. Technology and organizations that adopt cloud technology will have a competitive edge in the business world. In reference [15], John Brownlee quoted late Apple CEO Steve Jobs in WWDC (World Wide Developer Conference) 2011 saying “*Keeping these devices in sync is driving us crazy! We’ve got a solution for this problem. We’re going to demote the PC and Mac to just be a device. We’re going to move your hub, the centre of your digital life, into the cloud.*” Cost savings and efficiency is driving the rate at which organizations adopt cloud technology [16] with ESG (Enterprise Strategy Group) report 2013 showing cost reduction initiatives ranking top business initiative impacting on IT spending largely due to the 2008 global financial crises with 44% cost reduction initiatives within IT strategy [13] p.5. Organizations turn to adopt cloud computing in different perspectives based on their business requirements, both SMEs and large organizations are adopting cloud computing [16]. Recent [16] report on overall cloud adoption and services shows that about 61% of 1500 IT professionals admitted to using the cloud while 39% did not use cloud within the enterprise as shown on Figure 2 below.

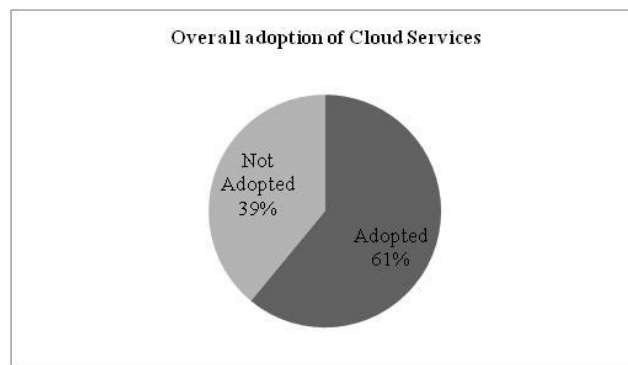


Figure 2: Over all adoption of Cloud Services (source – TechTarget, 2012) [16]

In today’s competitive world, organizations are encountering difficult economic times following the global financial crisis and global climatic change which compels businesses both local and international to review their strategy [17]. With Cloud computing, organizations are bound to save hardware and maintenance cost, reduce CO2 emission and promote Green IT for a smarter business and smarter planet, [17] view on the use of PESTEL framework, a framework used in strategic management to analyse macro environmental factors affecting organizations is well argued and convincing with political, economic, social, technological, environment, and legal factors affecting adoption of cloud computing. Cloud Computing comes with huge benefit to organizations and business, which has been extensively reported in details from conferences, journals, and industrial reports. Reduction in infrastructure cost, agility in development and deployment of applications, focus on core competencies of organizations rather than underlying IT infrastructure were identified as the basics of adopting cloud computing [18] p.1, [19] stressed application roll out time and speed is increased if cloud computing is adopted in software firms. Reference [20] argued that cloud computing provides SMEs with low cost access to web based tools as resources using a pay as you go model of utility services like Electricity and Telephone.

The benefits of cloud technology are unavoidable in most organizations however there are possible risks and barriers that can also lead to rejection of the fast growing technology, [19] argued that security and privacy are the most challenges facing cloud adoption. Adopting cloud computing in any organization means placing critical data in the hands of a third party [21], which calls for challenges in terms of security when data is at rest or on transit. Data confidentiality, availability, privacy and accessibility need to be ensured and rightly addressed before adopting cloud technology [21]. In [20] is argued that public access to organizations data pose a severe security risk in cloud environment, with these challenges, [22] argued that though the risks are much but the benefits of cloud computing outnumber the challenges and thus excellent approach to cloud adoption is required in organizations and governments. In Nigeria, only few organizations and businesses are willing to outsource their less sensitive data to a cloud provider, [23] reported a survey of over fifty Chief executives and IT managers of ten Nigerian companies that shows they still prefer and trust their current in-house datacenters over the cloud-based datacenters due to fears of loss of control and complex business processes. On the other hand, Chief executives that are willing to migrate to cloud-based systems are only ready to do so, on experimental bases with few less sensitive business processes.

3. OVERVIEW OF CLOUD COMPUTING

Cloud computing is a new computing paradigm, and it is increasingly gaining ground as the fifth utility apart from electricity, water, gas and telephony utility services currently in existence [24]. It allows a third party cloud service provider (CSP) to provide a centralized pool of configurable computing resources to Cloud end-users (CEU) over the internet. The CEUs (individuals and organizations) could make on-demand accesses to these resources and use them to implement their services according to their dynamic business requirements. Consequently, the CEUs do not need to deploy and manage their own computing services thus enabling fast deployment and minimum operational and management overheads.

Variant of cloud computing definitions exist, but the one with fairly broad acceptance among many IT and research agencies like the Cloud Security Alliance (CSA), International Telecommunication Union (ITU) focus group on Cloud computing and the European Network and Information Security Agency (ENISA) among others is the one proposed by the US National Institute of Standards and Technology (NIST 800- 145) which states that: “*Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to shared pool of configurable computing resource (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction*”.

In the NIST definition of cloud computing, five key characteristics are outlined, namely: on-demand self-service, ubiquitous network access, location independent resource pooling, rapid elasticity, and measured service with pay-per-use. On-demand self service customers can request and manage their own computing resources, ubiquitous network access allow services to be offered over the internet or private networks independent of location, location independent resource pooling means customers draw from a pool of computing resources in a remote data centre, rapid elasticity means services can be scaled large or smaller and measured service with pay-per-use means service is measured and customer billed. Additional characteristics not specified in NIST definition, but captured in ENISA (2009 p.14) report titled “*Cloud Computing: benefits, risks and recommendations for information security*” is virtualization and multi-tenancy. Virtualization allows a single physical server to be logically separated and compute many task simultaneously, which gives rise to multi-tenancy where resources can be shared by multiple users concurrently.

Cloud computing is still an evolving technology [25] as depicted on Figure 3, which has lots of potential like providing access to new technologies to a customer, without the need of procurement of hardware and software, but lack of standards is a major challenge, therefore cloud security is a combined and joint responsibility of all stakeholders from the CSPs to the CEUs. The signing of a Service Level Agreement (SLA) between the CSP and CEU does mean that a CEU does have a responsibility in ensuring that his data in the cloud is properly secured according to International best practice and standards. Cloud computing enables users to store files and software remotely, rather than on a hard drive or server at their office, the fact is that many people may already be using cloud computing without realizing it, whether through work or personal use. Examples include web-based email like Gmail, Yahoo and Hotmail, communication tools like Skype, video sites like YouTube and Vimeo and music-sharing sites such as SoundCloud.

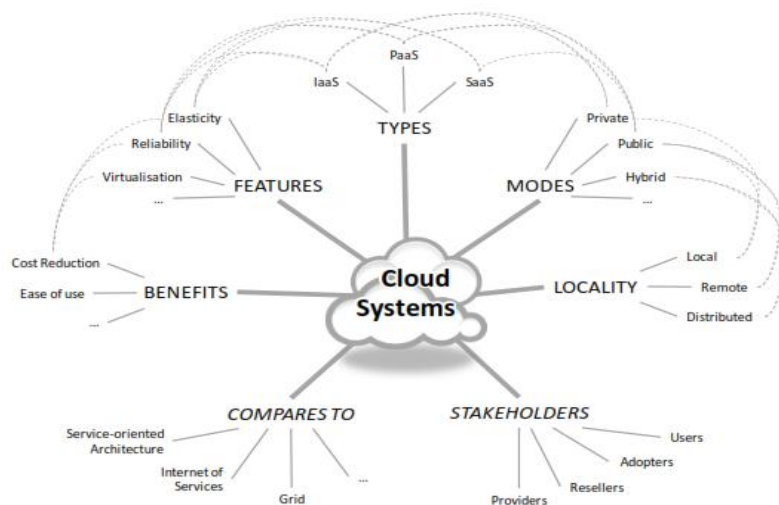


Figure 3: Non- exhaustive and evolving view of cloud computing system [25]

3.1. Cloud Computing Implementation Models

There are different kind of cloud a CEU can subscribe to depending on needs and requirements, below is the cloud deployment models currently in existence as outline in NIST definition of cloud computing.

- **Private** – The cloud is specifically established, managed and to be used internally by an enterprise for a specific group or organization and access is limited to that group or organization.
- **Community** – This is a shared cloud among two or more organizations with similar cloud requirements.
- **Public** – This is an open cloud which can be accessed by multiple CEU, provided there is access to internet connection and access to the cloud space
- **Hybrid** – This is a combination of at least two clouds, where the cloud is a mixture of private, community or public.

3.2. Cloud Computing Service delivery Models

There exist three Cloud computing service delivery models namely:

- **Infrastructure as a Service (IaaS)** – It is having your servers located with the CSP, while remaining in control and responsible for your software and data. It is delivery of virtual CPUs, disk space and datacase services. Sub-types of IaaS are: Database management system as a service (DBaaS), Data storage as a service (STaaS), and On-demand usage of computing capacity (CPUs) as a virtual service.
- **Platform as a Service (PaaS)** – It is having your servers and operating system located with the CSP, while remaining in control and responsible for your data. Sub-types of PaaS are: Desktop as a service (DTaaS), Testing solution as a service (TaaS).
- **Software as a Service (SaaS)** – It is having the application you run, data and server located with the CSP. The responsibility of control and management is entirely the CSP’s. Sub-types of SaaS are: Communication as a service (CaaS), Security as a service (SECaaS) and Integration as a service (INTaaS).

The cloud services, sub-types and established world’s big players is summarised in Figure 4.

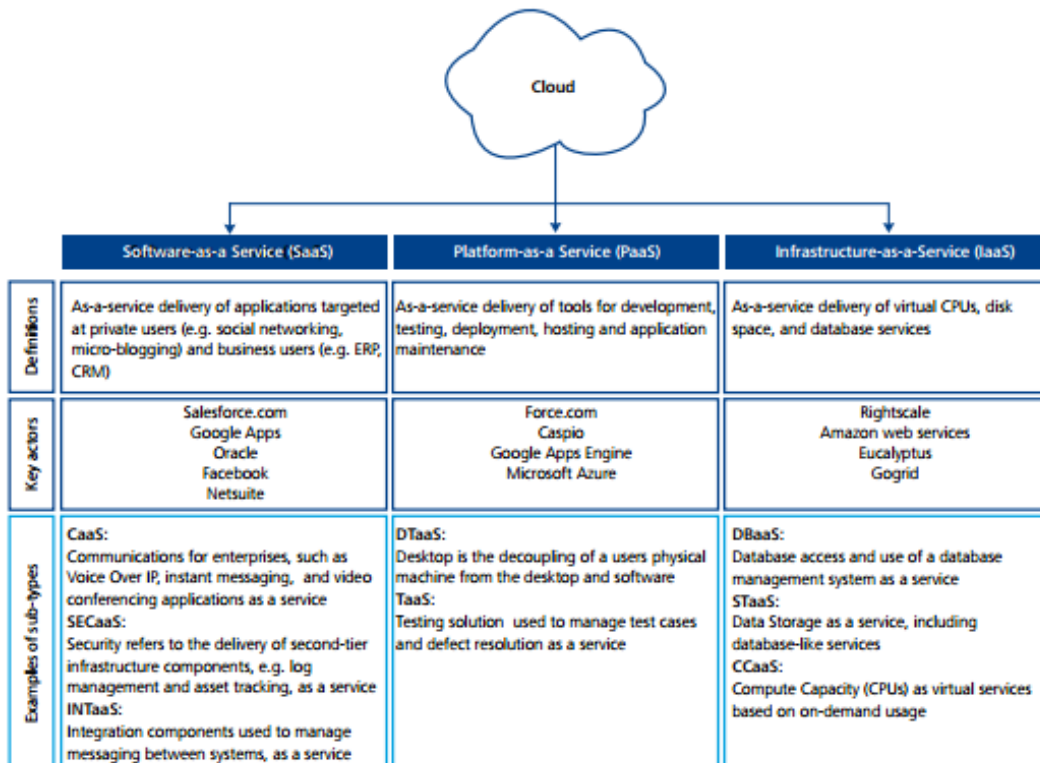


Figure 4: Cloud Services, sub-types and key players [26]

3.3. Cloud Computing Players

There exist four main cloud computing players namely Cloud Service Providers, Cloud End-Users, Cloud Enablers and Cloud Regulators. The CSP often also render Cloud consultation service to it clients, while the Cloud Enablers can further be divided into Cloud resellers, Cloud adopters and Cloud tool providers [27].

- **Cloud Service Providers** – Own and operate cloud computing systems used to render services to third parties cloud end-users. They are responsible for providing general maintenance and upgrade of of the system, data security, cloud computing service pricing and for majority of CSP often have competency in different cloud deployment models (IaaS, PaaS, SaaS) as well as provide consultancy service to CEUs.
- **Cloud End-Users (CEUs)** – These are the consumers that subscribe to Cloud computing service that is offered by the CSPs. The consumer could be private or corporate users.
- **Cloud Enablers** – They are organization that will sell specialized products and services to enhance and make easy the delivery and adoption of cloud computing. They could be Cloud Resellers, Cloud Adopters or Cloud tool Providers.
- **Cloud Regulators** – They are national governments and international bodies that harmonise and regulate the activities of CSPs, CEUs and Cloud enablers through laws and best practices.

4. ADVANTAGES AND DISADVANTAGES OF CLOUD COMPUTING

It is important to understand the potential advantages and disadvantages before deciding to adopt a cloud computing, on Table 1 is summarised advantages and disadvantages of cloud computing.

Advantages	Disadvantages
Limitless flexibility to different databases	Security and privacy
Better reliability & physical security	Control of data
Enhanced collaboration enabling users to work together	Data mining
Accessibility of data anywhere/Redundancy	Data storage location/legislation
Simpler device Interface to the cloud	Unavailability of certain functionality
Unlimited data storage	Likelihood of Hacking
Faster access and processing power	Compatibility of Infrastructure
Reduced IT maintenance complexity & cost	Integration with other systems
Business continuity and Disaster Recovery	Lack of knowledge of CSP
Automatic software upgrade in the cloud	Moving between CSP &
Quicker deployment	Password security over the internet
Reduce cost (hardware, software, electricity investment)	Quality of CSP
Scalability	Quality and speed of internet access
Improved security offered by reputable CSP	Software licensing
Future proofing your business	Software pricing
Easier and improved back-up and recovery	Technical issues

5. CLOUD COMPUTING ADOPTION CHALLENGES IN NIGERIA

There is currently a high degree of enthusiasm of cloud computing in Nigeria among IT professionals, organizations and government agencies as the next big revolution to happen in Nigeria, after the telecommunication industry stormed the country in the early 2000. But, there still remains challenges to its full adoption in Nigeria which ranges from ownership and security of data and information on the cloud, internet availability, unstable power supply, policy implications arising from implementing cloud services, litigations and legislation on data ownership in the cloud and infringement rights, interoperability and international legislation.

5.1 Security, Privacy and Trust

While Cloud computing continues to remain one of the most captivating technological innovations across the globe, it is still the most feared in Nigeria. In fact, presently many individuals, institutions and organizations in Nigeria still withhold their reservations about this novel technological approach. The reason for this is that there are threatening and crucial issues pertinent to confidentiality, security, privacy and trust whenever and wherever Cloud computing is implemented and utilized. In addition to this, there is a strong

likelihood that the companies (CSPs) charged with the responsibility of keeping customer's vital data and personal information will have undue and constant access to them and can intentionally or inadvertently disclose it or use it for unauthorized and/or illicit purposes. Therefore, this loss of data control and the issue of dependence on the CSPs are one of the major challenges impeding the adoption of Cloud computing in Nigeria.

5.2 Good Internet Connectivity

As the highest ranking internet country in Africa according to internet world stats as at June 30, 2012, with 48.4million internet users in Nigeria as shown on Figure 5, one naturally expect any newly introduced computing technology to meet considerably high data availability requirements in order for the technology to adapt and thrive in the Nigerian IT market.

This is because nowadays, customers in Nigeria prefer to move around with their information and data. In most cases, vital and confidential data like pictures of certificates are stored by some people in Nigeria on eight or sixteen gigabytes of memory chip for easy portability. In such situations, if there is a need to print or submit the certificates, they can easily plug the memory chip into a computer or any other computing device in order to print them as hardcopies or send them for submission/application as softcopies. However, in the big cities of Nigeria, a serious challenge facing Cloud computing is that, when there is no network connectivity or internet access due to high cost of subscription of broadband internet, there is a higher vulnerability for denial of service attack. Therefore, vital data may not be readily available in the case of Nigeria and this will make end users to be at a disadvantage due to the poor, uncertain and erratic nature of the network connection.

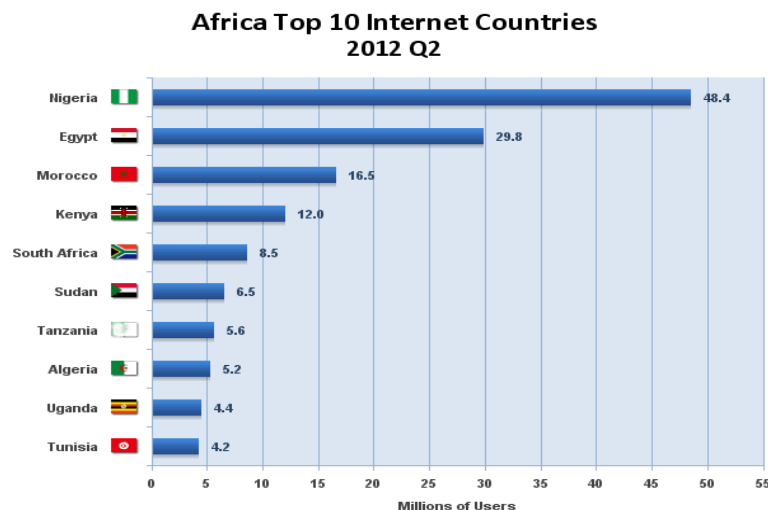


Figure 5: Source - Internet World Stats (www.worldinternetstats.com/stats1.htm)

5.3 Infrastructure and Social Amenities

A cogent reason inhibiting the influxes of the established global data players into Nigeria are the obvious inadequacy of basic amenities and infrastructures. In order for Cloud computing to be firmly established for sustainable development, there is need for water to cool the constantly active servers and stable electric power supply. Unfortunately, these two basic amenities are inadequate, unguaranteed and erratic in Nigeria. This lack of growth in basic infrastructures and social amenities is a major inhibitor for the establishment of Cloud computing data centres in Nigeria. Therefore, there is a need for significant infrastructural development and rejuvenation in the management of resources in Nigeria before the big global players in Cloud computing can fully partner with the Nigerian business community for any substantial investment in Nigeria.

5.4 Institutional Environment

In Nigeria, the cloud service providers and cloud end users face an additional greater challenge in the form of unfavourable institutional environment. Detrimental factors such as the lack of transparency in governance, widespread corruption and weak legal system often exacerbate the global perception about Nigeria of market insecurity and economic instability. In addition to this, when these adverse factors are combined with perennial issues like political upheaval, civil strife, food scarcity and natural disasters, it

makes the global players and investors in Cloud computing to be even more reluctant to move into the Nigerian IT market. The reason for this is that these cloud service providers have studied the Nigerian institutional environment and projected that business continuity is considerably unguaranteed and there is a strong possibility for little or no return on investment.

5.5 Legal and Regulatory Framework

The legal agreements written by cloud service providers are expressed in very complicated statements and hence, customers find it extremely difficult to interpret and understand legal and regulatory implications of such agreements. As a result of this, customers in Nigeria are bored away by the complex legal terminologies, hesitant to agree to the agreement terms of cloud service and bear a latent feeling that the complexity of the agreement is meant to cover up an ulterior and exploitative motive. In terms of connectivity to the international telecommunication network, Nigeria is installing many international cables and establishing shared data processing centres. However, confidence in the prevailing regulatory measures and perception of the legal framework for Cloud computing still remain at an unsatisfactory level in Nigeria.

6 DRIVERS IN SUPPORT OF MAKING DECISIONS ABOUT ADOPTING CLOUD COMPUTING IN NIGERIA

The plethora of challenges facing the adoption of Cloud computing in Nigeria cannot be viewed as major problems or inhibitors when there are many opportunities on ground that will favor the adoption, nurturing and sustainable growth of Cloud computing in Nigeria. In fact, foreign-based and local data players view these challenges as latent opportunities which must be exploited, transformed and utilized together with the existing supporting drivers of Cloud computing for the common benefit. There are many existing factors that will support the adoption of Cloud computing in Nigeria but the major ones are, namely; recent revolution in mobile technology, availability of skilled manpower, high volume of research in this novel area, government's venture into renewable energy, and the sudden influx of multinational data players in Nigeria seeking to invest due to the huge opportunities on ground.

6.1 Mobile Phone Revolution

The influx of inexpensive netbooks and smartphones with mobile data capabilities in Nigeria has opened the way to establish and have access to competitive IT infrastructures that can match those of developed nations. In addition to this, the recent mobile phone revolution in Nigeria has tremendously transformed how Nigerians exchange information in domestic, official and corporate scenarios. Presently, some people in Nigeria do not have access to landline phones and electricity supply. Therefore, the easiest way employed by these deprived people is the use of mobile phones and in order to solve the problem of inadequate electric supply, they simply charge their phones using a charger that generates electricity from a car or motorbike. As cellular networks become increasingly mature and reliable, Nigerian consumers are having faster and better access to the internet using their mobile phones without the need for a broadband or computer at home. This positive development will undoubtedly be a key driver for a range of applications that will support Cloud computing.

6.2 Skilled Manpower

One of the major drivers in support of adopting Cloud computing is that Nigeria has highly skilled, well-trained and seasoned IT professionals working in developed nations. These foreign-based Nigerian experts have the required technical know-how and skill to design and develop new software that will trigger and sustain the growth of Cloud computing in Nigeria. In fact, Cloud computing has offered a wide range of beneficial opportunities and potentials which is currently leading to a reverse migration trend among foreign-based Nigerian IT specialists who are gradually returning back to Nigeria to pursue and utilize such existing opportunities. In addition to this, these foreign-based Nigerian IT experts will bring in their wealth of experience from developed countries to create a generation of innovative tools, applications and techniques that will accelerate Nigeria's growth on the track of adopting Cloud computing.

6.3 Heightened Research Interest

Presently in Nigeria, it is encouraging to observe that the amount of research on Cloud computing from the academic and industrial sector is increasing. The interest of these researchers are focused on how to harness the limitless potentials of Cloud computing within the scope of existing Internet and cellular technology infrastructures for the purpose of positively transforming the computing landscape in Nigeria. These research efforts are engineered towards offering more opportunities to Nigeria by making individuals, small businesses, big corporate organizations and the government realize the tremendous benefits of Cloud computing enabled applications. Moreover, one of the key benefits of these efforts is that Nigerians will

understand the issues and challenges of using Cloud computing and effective means of overcoming them. This will provide the necessary drive and required support for the adoption and sustainable development of Cloud computing in Nigeria.

6.4 Energy Renewability and Sustainability

Current technological advancements in Nigeria in the area of renewable energy can be harnessed and leveraged in order to make the challenge of powering the servers surmountable. In order to actualize this goal, the mindset of Nigerians must be realigned to discover the hidden potentials lying in constrained circumstances and exploit the resources in their environment for better alternative solutions. In addition to this, government policy will also be a major catalyst as long-term commitment on the part of the Nigerian government to any project promoting renewable energy will significantly boost the growth of alternative and sustainable energy for Cloud computing. Therefore, with more efforts from the public and private sector on how to harness ultra energy efficient technologies for powering Cloud computing servers with renewable energy, there will be larger influx of big global data players in Cloud computing willing to fully invest in Nigeria.

6.5 Multinationals' Search for Opportunities

The recent interest and activities of several multinational companies has triggered the evolution of Cloud computing in Nigeria. Inlaks Computers is one of the active IT firms in Nigeria which has been in operation for over 30 years. The firm offers innovative ICT solutions for the oil and gas, financial and industrial sectors of the Nigerian economy. Inlaks recently partnered with Ramco, one of the big global data players, to offer Cloud computing solutions in Nigeria by leveraging on Ramco's existing infrastructure which has been proved to be secure. In addition to this, such a partnership will further improve the level of awareness of Nigerians on Cloud computing which will help in alleviating the concerns of various stakeholders.

Apart from Ramco, there is the case of Business Connexion Limited (BCX), one of the leading providers of Cloud computing solutions and data centre in Africa, which has officially launched its cloud computing services in Nigeria. By partnering with approved Nigerian firms to develop regular releases of software applications that are highly demanded by Nigerian SMEs, BCX's data centre in Nigeria, offers IT Messaging-as-a-Service, Infrastructure-as-a-Service, SharePoint-as-a-Service and private cloud to Nigerian enterprises and government. The Government of Nigeria is also weighing in with with an injection of \$100million out of the \$1.1billion loan agreement signed by the Federal Government with China Exim bank for financing high priority public projects to Galaxy Backbone that provides ICT services MDAs to build a government cloud infrastructure which is projected to be completed by 2015. The main aim is to reduce the cost of running the federal government as well as improving efficiency and productivity across all its MDAs [1]. Other players that are already in the Nigerian cloud computing market offering various cloud services are: Dimension Data, MTN Nigeria, EMC Corporation, and Signal Alliance. It is therefore, not suprising when at the launch of multi-tenant cloud and dynamic scalable business solution by Business Connexion in Lagos early this year, when the outgoing Director General of National Information Technology Development Agency (NITDA) Professor Cleopas Angaye concluded that Nigeria is a honeypot for cloud computing and it has the prospect of becoming the African hub of Cloud computing.

7 RECOMMENDATIONS FOR THE ADOPTION OF CLOUD COMPUTING IN NIGERIA

In the light of the above-mentioned challenges and existing opportunities for Cloud computing in Nigeria, there are some pragmatic steps that need to be taken in order to successfully surmount these challenges and at the same time, maximize these existing opportunities. These practical recommendations are highly important because they are blueprints and guidelines that will easily shape the decisions of all stakeholders in their effort to promote the adoption and growth of Cloud computing in Nigeria. Among the innovative solutions proffered in this research are namely: the implementation of effective regulatory procedures, maintaining a regular watch on the recent global trends in Cloud computing, meticulous preparation of Cloud computing contracts, conformity with existing provisions, establishment of quality data centres, launch of training programmes, and cross-border standardization and regulation.

7.1 Effective Regulatory Process

It is recommended that the Nigerian government should expeditiously adopt a new regulatory approach that will nurture, sustain and promote the emerging technology of Cloud computing and its impact on personal data protection, data confidentiality and security. This will help in ensuring the development of effective regulatory process favourable to the adoption of Cloud computing in Nigeria.

7.2 Maintaining a Regular Watch

In a country like Nigeria, where it is easy to introduce a new technology but quite difficult to keep that technology abreast with new global trends, it is vital for the local data players to be fully prepared to adopt and implement new requirements pertinent to governance of Cloud computing services. The local data players in Nigeria are expected to establish a regulatory and legal watch body performing the following activities:

- Systematic gathering and monitoring of standards, laws and regulatory codes pertinent to Cloud computing
- Holistic analysis of the effect of regulatory obligations on individuals, corporate bodies and the government of Nigeria
- Strategic updating of protocols for monitoring risks resulting from non-conformity to Cloud computing regulations
- Elaboration of policies for managing situations of non-conformity to Cloud computing regulations
- Examination, investigative review and recording of incident management operations
- Provision for corrective and control measures whenever the need arises.

7.3 Careful Preparation of Cloud Computing Outsourcing Contracts

In order to tackle data security and availability challenges, the local data players and the government in Nigeria should ensure that contracts written for Cloud computing projects have robust clauses that will lead to the development of technologies that are capable of performing without failure under a wide range of conditions. In addition to this, the following considerations need to be meticulously taken care of:

- Adequate security should be provided for the network connection
- Individuals, organizations or government bodies should be properly authenticated before accessing data
- Personal data should be well encrypted
- Access to data should be granted to the rightful owner based on well-established privileges
- Data backup should be periodically done
- Data operations and access should be traceable
- CEUs should be certified and CSP's security procedures should be unambiguous and easy to follow
- CSPs should be willing to frequently meet the requirement of local firms by providing helpful information on security incidents
- Regular testing of data recovery procedures should be provided
- Frequent checking of fallback procedures in case of service interruption should be provided

7.4 Conformity with Existing Provisions

In order to protect the interest of Nigerians, the government should lay special emphasis on and enforce the following rules in the regulatory texts and standards governing Cloud computing in Nigeria:

- Mandatory terms and conditions should be strictly stipulated for outsourcing contracts.
- Quality control obligations should be laid down and implemented for continuity of service, quality of service provided, data security and availability and personal data protection.
- Rules governing keeping of records and data access should be effectively established and monitored
- General obligations pertinent to the maintenance of emergency plans and processes should be strictly laid down and followed in order to ensure the optimum management of service interruptions and security incidents
- Rules and regulations governing ownership of data, data's geographic location (inside or outside Nigeria), level of availability of data to authorities and disclosure of data should be well established and implemented.

7.5 Establishment of Quality Data Centres

It is highly recommended to establish quality data centres in Nigeria in order to quickly, smoothly and easily adopt Cloud computing. In addition to this, this will significantly improve the access speed to Cloud computing resources and reduce bandwidth costs. With the establishment of data centres in Nigeria, there will be improvement in quality of Cloud computing services and the costs of access to these services will be reduced. Preferential tariffs within Nigeria could also be implemented for the storage and retrieval of data in these local data centres which will be a source of revenue. In order to have the ability of hosting increasingly diversified ranges of services and products while meeting all technical, commercial and regulatory requirements, local data centres in Nigeria should be:

- Service-oriented: ability to provide required Cloud computing services to data players in a timely manner and at an affordable price
- Agile: ability to swiftly respond and adapt to any variations or changes in CEU's requirements
- Automated: ability to handle processes of Cloud computing operations with less technical staff while honouring service level agreements and adhering to international best practices
- Well protected: ability to guarantee data security and availability. Data in this context covers the broad range of active, archived, static or in transit data.
- Ecologically sound: ability to minimize energy consumption and environmental pollution that comes from non-renewable natural resources

7.6 Launch of Training Programmes

In order to fully grasp the various challenges arising from adopting Cloud computing and identify innovative and effective solutions to all these issues in this Cloud computing environment, new training programmes need to be conducted for all the stakeholders in Nigeria.

7.7 Cross-border Standardization and Regulation

Taking into consideration the high number of global data players working on standardizing Cloud computing, it is recommended that Nigeria actively collaborate and participate with International Telecommunication Union (ITU) standardization sector in the field of Cloud computing. In addition to this, it is also recommended that foreign-based and Nigerian standardization bodies work in a cooperative way to avoid significant disparity among the Cloud computing standards adopted. In line with these recommendations, the role and functions of ITU are essential to Nigeria in order to achieve standardization on a broader scale.

8 CONCLUSION AND FUTURE WORK

This paper has presented the basic features of Cloud computing with advantages and disadvantages associated with Cloud computing which will give a new entry into the cloud world an insight before taking the next step. Challenges in the adoption of Cloud computing as well as the drivers in support of making decision for the adoption of Cloud computing in Nigeria, has been highlighted. We also proposed a number of recommendations which will enhance and fasttrack the adoption of Cloud computing in Nigeria. If Nigeria really wants a maximum benefit from the cloud services it is important to strategically consider where it wants to play either as services providers, implementers or on content creators levels. There is also a need to launch a national consciousness awareness initiative on Cloud computing as a new and innovative concept in Information Technology with a clear strategic vision which is capable of transforming Nigeria to a Cloud computing hub in African in the nearest future. It is our opinion that careful adherences to our stated recommendations will fasttrack the adoption of Cloud computing in Nigeria. In the future, further research would be carried out to evaluate the feasibility of adoption of cloud computing for a specific company, specific cloud based application, and a comparison of strategies adopted by different CSPs which influence the CEUs adoption of Cloud Computing in Nigeria.

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