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Engineering Sustainability and Cloud Computing in Higher Education - a case study Model in Nigeria

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Abstract: The cloud computing can be seen as change and innovative technology that has leveraged the Internet world and its application to business enterprise and education. In developed nations cloud computing and virtualisation may be used interchangeably but its professional contributions and benefit in to education requires strategic applications especially within the HEI sectors. But this approach remains a reverse model in the developing economies due to the various challenges such as lack of power supply and Internet access and bandwidth capabilities, especially in Nigeria. It is obvious that the effective application of cloud computing in Nigeria will transform the traditional education model to computer based virtual applications with a focus on e-pedagogy. The knowledge domain and competencies required in the HEIs continues to act as draw backs in terms of skill acquisition and the development of sustainable innovative technological practices.

Keywords: Cloud Computing, Engineering Sustainability, Higher Education, Competencies Model, Nigeria.

A. Introduction

Cloud computing in the Educational sector has immensely enhanced academic performance in the developed nations and the professional contributions may benefit the education strategy of Nigeria particularly in transforming the traditional education model to computer based virtual applications with a focus on e-pedagogy. Shamsul et. al (2013), argued that the new education paradigm cannot be transformed without cloud computing as key driver providing relevant infrastructure for teaching and learning. Similarly, Ambrust et. al (2010), clarifies that a lot of research studies have shown that effective utilization of cloud computing will provide a competitive advantage to institutions through cost savings, performance improvement and optimal resources deployment with usage flexibility. Furthermore, a review from Wheeler and Waggener, (2009) reveals that cloud computing may have initially been in existence since 1961 after John McCarthy, an illustrious computer analyst, envisaged and predicted computing becoming a public utility.

Cloud computing remains a paradox and open to academic debate with respect to business adoption of its utility, and studies Shamsul et. al, (2013) depict that cloud computing to an extent is still at its early incubation in institutions of higher learning; Chen and Chen (2011) also affirms the infancy of cloud computing in academia, and this has caused the dearth of a unified definition and understanding of cloud computing. However, this study will develop academic definition and meaning of cloud computing with reference to institutional applications This study will also explore the benefits of cloud computing in learning, and focus on the development of relevant models for resource usage in higher education institutions.

Sule (2011) shows that successful adoption of cloud computing by various educational institutions in Nigeria depends on their transition strategies in terms of resource acquisition and deployment. These strategies could form barriers in delivering effective teaching learning, and assessment of instruments encountered through migrating to the cloud. Hence this study is geared towards bridging the gap between the usage of cloud computing in education and effective delivery of educational services via the 'cloud' in Higher Education Institutions (HEIs) in Nigeria.

Finally, a proposed conceptual model will be developed to address the digital migration gaps and adoption of the implementation of cloud computing in (HEIs) in Nigeria

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B. Significance of the study

Cloud computing seems to be largely gaining popularity both in the community and in the educational sector, but the impact it has created on HEIs has largely been unexplored especially in Nigeria one of the developing nations (Sule, 2011). This study will explore the impact of cloud computing in HEIs, the challenges users encounter in adopting the technology, and a proposed model to address the barriers encountered in the implementation of cloud computing. The successful and unsuccessful HEIs that adopt cloud services will be assessed and analysed by the use of Likert scale and statistical measurement. Despite the hype for cloud computing, so many people including academics especially in developing countries, are still unfamiliar with its features, although they unintentionally adopt cloud computing in various ways. This study will also be an exploratory study to expose those features to the knowledge of the users.

It has been noted by Abidi and Abidi (2012) that libraries worldwide are deficient in data flexibility, resource efficiency in information delivery, inter collaboration between libraries, and invariably expensive in management. In this view, digital Cloud computing is developed on libraries and can be regarded as 'location independent computing'. This is a widely assessed resource pool, which enhances massive file storage, file sharing and easy accessibility of information. Cloud computing is regarded as an emergent form of technology inculcated in the educational sector of higher learning which includes the universities especially in developing countries like Nigeria. In this regard, cloud-computing services are considered as influential factors and of immense value to educators in teaching-learning sector. Matthew (2010) in his observation, observes that the trend of migrating to the cloud system has been extended to developing countries like Nigeria in recent times by most top cloud storage providers such as IBM, Microsoft, MTN. HEIs in Nigeria would be examined by carrying out an in-depth investigation and exploration of the barriers against the adoption of cloud based services by these institutions.

C. Research Aims

The aim of this research is to explore the usage of Cloud computing and develop a conceptual model that addresses its impact in HEIs

Research Objectives

1. To explore the benefits of cloud services in HEIs in Nigeria
2. To assess the challenges in adopting cloud computing in HEIs Nigeria
3. To evaluate the impact of cloud computing usage in HEIs in Nigeria
4. To develop strategic model for effective adoption of cloud computing in HEIs in Nigeria
5. To develop benchmarking standard for cloud computing in Nigeria

D. Proposed contribution

This research is aimed at assessing the way cloud computing is being used in HEI in Nigeria, with the view to identifying the benefits, current usability scenarios and proposing a model for good practice and successful adoption of cloud computing to enhance teaching-learning in Nigeria as it affects HEI in Nigeria.

There are three basic contributions for this research

1. This research will provide a model to bridge the ‘gap’ in cloud computing implementations and devise the strategy for the deployment of cloud services in HEIs (Manousakis, et al 2013)
2. The research will provide benchmarking standards for effective measurement index of cloud computing in HEIs in Nigeria (Bennett, C. et al 2010, Ghazal, A. et al., 2013)
3. The research would develop conceptual models for effective adoption of cloud computing (Katzan, H., 2010)
4.

E. 1.5 Conceptual model

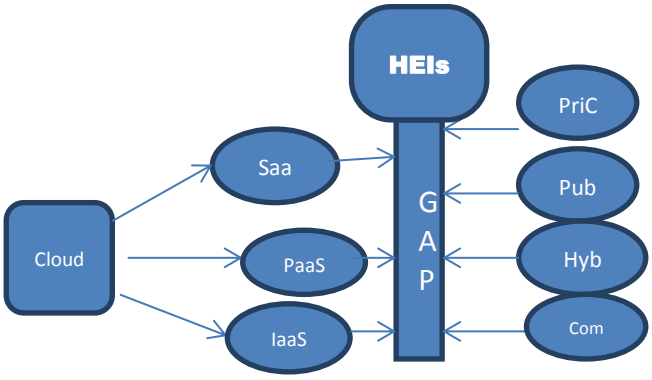

Fig 1 Conceptual model

- PriC: Private Cloud, PubC: Public cloud
- HybC: Hybrid Cloud, ComC: Community Cloud
- SaaS: Software as a Service
- PaaS: Platform as a Service
- IaaS: Infrastructure as a Service
- HEIs: Higher Education Institutions
- Fig: Figure

Research Literature Review

1) Cloud computing developmental architecture

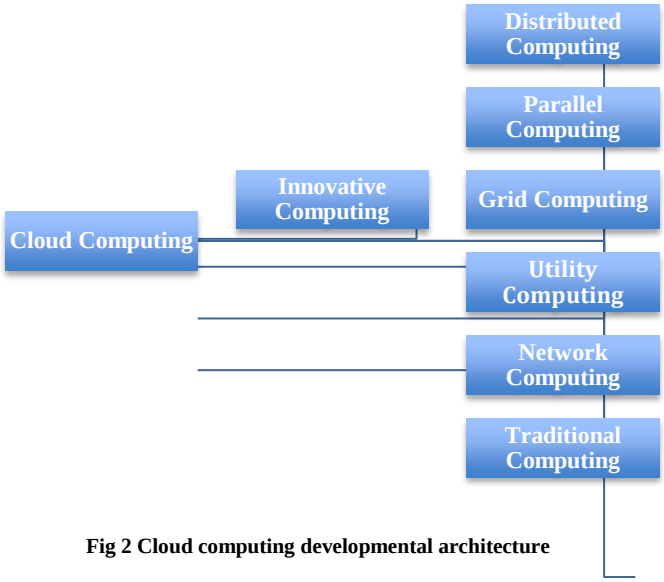

Fig 2 Cloud computing developmental architecture

The above cloud computing development architecture was based on the examination of the various literatures (Mollah and Islam (2012), Harry and Andreas (2013))

Originally, academics have been adopting cloud computing in different transformational forms of computing such as distributed computing, parallel computing, grid computing, utility computing, network storage mechanism, as well as the traditional computing, either through the Internet or intranet, but now digital cloud computing virtualization is the key advancement in technology. The reason for these systems of computing is generally to deliver to the system user an integrated and distributed on-demand computing capability as web-based infrastructure.

F. Cloud Computing - Historical Perspective

Cloud computing has improved educational provisions in Nigeria using the e-learning programmes tailored towards virtual applications. There is research evidence that Nigeria lacks adequate infrastructures to facilitate effective cloud services at HEIs (Ogbu and Lawal, 2013). The main problems were that of lack of energy management strategy, poor power supply and inefficient data storage facilities. Cloud computing provides platforms to bridge the gaps and improve the deficiencies of traditional ICT provisions through effective management of educational resources such as e-library, e-administration, e-management, e-portfolio and virtual e-driven support programmes.

Cloud Computing is defined as "an emerging computer paradigm where data and services reside in massively scalable data centers in the cloud and be accessed from any connected devices over the internet (Ogbu and Lawal, 2013, p. 476). There is a gap in this definition as it fails to consider the personalization of cloud computing within the organizational intranet or private virtual domain. On the other hand, Vaquero, L.M. et al (2008) in their view defined cloud computing as the process of providing computing infrastructure on the network by delivering application software over the Internet down to the user, irrespective of the user's location. From this definition, cloud computing is limited to a 'process' not considered as an application that renders services to the user, it also does not capture the enhanced storage capacity of cloud which provides a medium of massive data storage as defined by Aziz et al (2012) that cloud computing is an enabler of a location where computing infrastructure, data, software and application is stored.

Mell and Grance (2009) in The NIST and ITU Focus Group defined cloud computing as "a model for enabling network users' on-demand access to a shared pool of configured resources that can be rapidly provisioned and released to the client without direct service provider instruction." National Institute of Standards and Technology (NIST) and the ITU Focus Group, 2012, p. 3. Cloud Computing provides opportunities for organizations to realize return-on-investment (ROI) through quality service delivery, infrastructure acquisition and improvement in the training of professional employees Creeger (2009) cited. (Ogbu and Lawal, 2013, p. 479) statedthat cloud computing will reduce cost and adoption of better IT capabilities in enterprise, industries, universities as well as other tertiary institutions in the country.

G. Research definition of Cloud computing

The researcher defined cloud computing as an application that virtually deploys and manages services through the Internet or intranet to the end

user. It is service-paying application that companies invest in due to cost reduction and effective service delivery to the users. The cloud services deployment is functionally measured by: efficiency in service delivery, effectiveness of platform and flexibility in the performance of infrastructure and cost benefit in service deployment. This concept of cloud computing can be represented using the Mathematical representations shown below:

Key representations: Cloud in HEIs (CHE)**,** Public cloud (Pb)**,** Private cloud (Pr)**,** Hybrid cloud (Hb)**,** Community cloud (Cm)**,** Software (s)**,** Infrastructure (i)**,** Platform (p)

Assumptions

CHE = Pb + Pr + Hb + Cm .....(1)

Similarly,

CHE = Pb = s+i+p ..... (2)

Where s, i, and p are represented as HEIs requirements

Alternatively,

Pb = f(s+i+p) .....(3)

if CHE = Pb and f(s+i+p) = functions

Pb=f[s+ (i_0) + (p_0)] .....(4)

Where (i_0) and (p_0) = 0

This implies that HEIs only considered Service (s) as the cost effective requirement for the organisation otherwise, the loop may be applied to Hybrid as well as excluded if not viable

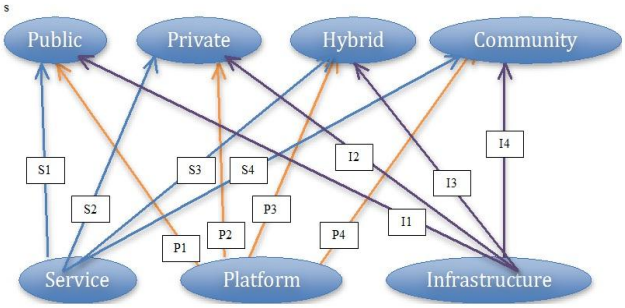

Fig 3 Cloud computing definition representation

Blue Line: measure the benefit of cloud services based on SaaS using indicator 1

Yellow lines: measure the benefit of cloud services based on PaaS using indicator 2

Purple lines: measures the benefit of cloud services based on IaaS using indicator 3

1) Research questions strategy

Indicators such as Cost savings, efficiency in service delivery, and effectiveness of software deployment, storage capacity, performance and standards will be used to measure the first objective (RQ1s)

To measure the second objective, the PEST analysis will be employed, as indicators for identifying the challenges of cloud computing in HEIs

To evaluate the impact of cloud computing in HEIs, the indicators to be used are the SWOT analysis metric

To develop strategic models for cloud computing implementation in HEIs.

H. Benefit of cloud computing

The literature have shown that the basic benefit of Cloud computing is cost savings in terms of deployment and management of services (Menon and Anala (2012) but lack evidence of benchmarking index and standardization (Hayes, 2008). There is no evidence of professionalism within the cloud computing subject area, as it seems to include other specialist disciplines such as integration of ICT, Engineering and Applied Management Sciences with different background and professional expectations.

The cost reduction and a pay as you use strategy has given cloud computing a competitive edge above other provisions. In-house data centers and provision pay as you go synergy and the concept of renting IT infrastructures, services and platforms are used applied in order to achieve the maximum benefits of Cloud Computing using other ICT innovative strategy to create values and best practice. The financial reward to organizations cannot be over emphasized as most researchers focus on the acquisition of reduced rate of cost of installation, maintenance, training, software and hardware. Cloud being a visualized system of computing, it can be regarded as resource bank holding various huge information, applications, services, IT infrastructure, which can be easily accessible as online-real-time via the web services and outsourced to the user on-demand. Therefore cloud computing plays a significant role in information service deployment and such facility provision is to a large extent essentially recommended to the educational sector as it enhances learning through its visualization system, scalability, flexibility, and portability nature as academics access the information bank

conveniently based on their demand (Chen, 2011). These computing resources are simply used on the Internet other than on various personal computers, yet all needed facilities are available.

With the evolution of cloud service, it is obvious that many organisations and countries migrate to the cloud efficiently because of its beneficial conceptual, economical, and technical benefit, which enhances business; an evident from 'Energy Saving Trust' employs analytics and cloud computing from IBM to help reduce domestic carbon footprints across the nation.

1) Conceptual efficiency of cloud service usage

The above entails the theoretical framework on cloud computing and how it supports efficiency in terms of cloud service provision and delivery while the key parameters to be considered will be in three areas regarded as the features of cloud computing; the Software as a Service (SaaS), Infrastructure as a Service (IaaS), and Platform as a Service (PaaS).

a) Infrastructure as a service (IaaS)

This service is commonly known to render the virtual machines, all the instances to the subscribed clients. Hence, IaaS is mostly concerned with carrying out mathematical calculations of data, managing and storing unencrypted data and this is specifically a function of a computer server Fershtman and Neil (2012). It is regarded as a service from a sphere of low-level operations, which gives access to elasticity of IT resources. This means that service users have the capacity to increase or reduce the volume of service they need, therefore it reduces the cost of usage. Also the computing resources offered at this level are on the basis of 'pay per use'. According to Ciuffoletti (2010), one of the products delivered by the IaaS includes; 'load balancing'. Load balancing means equal allocation of processed information to the clients over the computer network to avoid overflowing of information on a single client. An example of company adopting the IaaS is Amazon EC2.

b) Platform as a service (PaaS)

PaaS is solely concerned with constructing and developing programming and code testing software in the form of custom application and deployment of these services to the service users. It is a middle form between the IaaS (low-level functionality) and the SaaS (High level functionality). This makes PaaS to be seen as a unique type of SaaS as it could be combined to provide application software to host the server over the cloud. In the same vein, it can be seen as a special type of IaaS being that IaaS combines with PaaS to design and develop hosting infrastructure and make the design available to the service user. As such the service user can design the application (using it as a template) uniformly either for his employees or for his clients to suit his desire. An example of a PaaS is Windows Azure.

c) Software as a Service (SaaS):

The SaaS is fondly seen to be a type of cloud service with the highest functionality (Hon, et al., 2011) because it provides the end product usage to the end user. SaaS supports application of the end-user's modified application for instance the use of 'Drop-Box' SaaS enables the end user to store their downloaded applications, in the Drop box. The Drop box simply means where a service user stores his downloaded files or application. Also, SaaS as supports the social network sites like Twitter, Facebook, web pages, Google applications etc. In recent times, the conceptual benefit of Cloud computing has attracted variety of meanings in the IT sector by various authors and is evidently shown in this thesis. As at 2009, a report from McKinsey & Co. disclosed as much as twenty-two different definitions of cloud computing including the typology of SaaS that describes;
Delivery stage: cloud computing has been defined as a platform which collaborates with the provider to manage and host IT infrastructure, and by the use of on-demand services and deploys these infrastructures to the required applications. The platform through which cloud runs include; the public cloud, private cloud, hybrid cloud, and community cloud.

i. Private cloud plan: this is a model exclusively owned by just one company or by a business unit, like Amazon VPC. The private cloud is more securely controlled, more expensive to manage and processed within the company. Information does not go beyond the cloud providers managing the service.
ii. Community cloud plan: is a model owned and provided for a group of people with similar vision, mission and goal, usually managed by one or more organisation in the community. The cloud service is usually open and membership is required.
iii. **Public cloud plan:** this is an open cloud platform for public use with the benefit of no initial capital investment as argued by Astrova, I. et al., (2012). An example of public cloud is Google AppEng.

iv. **Hybrid cloud plan:** is a cloud platform that comprises all the cloud models, or two cloud models, (private, public, community). They share the same synchronised services.
Development stage: at this stage, cloud computing provides programming language such as Bungee Labs for general purpose using on-demand service.

Application-led stage: by the use of Software as a Service (SaaS) applications is developed and deployed through cloud computing. This definition could be seen as an ill defined concept of cloud computing as it is centred solely on Software as a Service, whereas other platforms; IaaS and PaaS still exist and will be captured in this study.

2) Economical efficiency of cloud service usage

Further explanation from Vaquero, L.M. et al, (2008) shows that the reason for the provision of the computing infrastructure on the network is to reduce the cost of hardware management as well as the cost of software resources. Similarly, cloud computing usage scales up moderate infrastructure for short periods of time and at a very moderate cost (Owens, 2010). This as well depicts the elasticity of the cloud.

3) Technical efficiency of cloud service usage:

People adopt the file storage system as a form of cloud service usage in the cloud to maximize space, yet the majority are left in ignorance of a comprehensive meaning of cloud computing, as evidently shown by Audrey and Uwe (2013) who define cloud computing as a central hub that allocates computing infrastructure and services to data centres, an enhancement of scalability, cost efficiency and the elasticity of computing. These three factors represent the technical benefit of cloud computing to the users. They also emphasised the vital role of cloud computing on the fast growing IT generation, but argued the need for user awareness on the concept of cloud computing including data privacy of user's data on the cloud.

The technical architecture of cloud is based on; the design of server (hardware) and the size of the infrastructure. Exploring the design of the server, the storage capacity is widely considered, the reduction in IT cost of running the server is effective and because cloud computing suffers on from data explosion since organisations try to track information hence it requires data harmonisation which looks at data migration from old to new platform and data transformation which is based on content (distinctiveness of data) management strategy. Cloud computing exerts a high performance of distributed computing. All the system software required by an organisation to host their application software can be configured in a Virtual Machine or made available by the organisations' cloud Platform as a service provider (PaaS). Therefore the technicality of cloud service brings about its flexibility to the users especially who depend on their cloud providers' infrastructure and hardware to execute the needed software application. Lin and Chen, (2013) explain technically that in the cloud exists multi cloud configurations by the use of various models. Although this explanation of technical efficiency of cloud services captures the configurations of the technical model, It fails to identify the aspects of a technical architecture of the cloud.

I. Cloud Computing Standardization and Benchmarking Index

There are different agencies working on the standardization of cloud computing and benchmarking but there is no conclusive key attributes demonstrating indicators for measurement within the discipline. It is necessary to mirror across relevant associated discipline for appropriate indicators to enable researchers to develop conclusive good practice models for the growth of the cloud-computing professionals. The Cloud computing activities lack unique standardization and professional measuring attributes, as it has a complex relational trade mark based on the innovative computing concepts which was based on cost benefits, efficiency and performance. The various models of cloud computing were misplaced as either Grid Computing, Parallel Computing and Distributed Computing, that does not make it easy to professionalize the discipline. According to Uzunboylu, and Ercan, (2010) emphasized on the heterogeneous resource cloud as the focus of cloud in HEIs based on the reduction of configured scale, cluster systems and consolidation of workloads and external supportive platforms.

1) Benchmarking

The need for business and industrial sectors to work towards standards and quality has dominated the production processes in design engineering education for years but HEIs realised the importance of strategic delivery based on quality and standardization of educational services as demand from students and quality assurance agencies increased in various countries, Nigeria included dues international academic admission requirements. Moriarty (2011), argued that benchmarking development focused on tool for continuous improvement for the achievement of excellent quality and service integration. In a developing economy, benchmarking quality assurance remain key problems affecting quality of services in education, especially with respect to challenges created by low government investment in HEIs and continuous strike due to poor employment benefits to both academics and teachers in the tertiary education sectors. It is obvious that in Nigeria the Universities were closed for one year academic session in 2007 due to strike action based on lack of compliance by the

government in paying academics an agreed fridge benefits and allocation for resources and infrastructures for quality teaching provisions Nworah (2007). Similarly in 2013, universities in Nigeria and Uganda were closed for several months also due to strike action and non-payment of academics salaries by the government (Akinfolarin, 2013). It may be argued that benchmarking and quality provisions may be affected due to ineffective engagement of teaching and learning mechanisms and lack of measurable yardsticks.

Definition of Benchmarking

Dattakumar and Jagadeesh (2003) definition of benchmarking focused on the standardization with reference to collection and reporting of critical operational data, such that it provided platform for comparisons wiht the establishment and a achievement good practice. This definition identifies the importance of diagnosis, problem solving, and identification of service levels for performance, improvement. The Hefce Website Glossary (2011) defined benchmarking using 4-points indicators for raising service levels and performance namely: Process, Analysis Standard, and Effective (PASE).

The reflection on the above definitions does exclude HEIs; it is obvious that benchmarking originated from the technical and management disciplines, until recent times that HEIs executives became responsible for accountability according to the requirements of the United Nations and UNESCO for transparency and audit trail. The concept of benchmarking adopted by Hefec focused on the process while UNESCO focused on standards but they lack knowledge based applications especially with respect to resources and infrastructures, which are fundamental for the achievement of excellence in teaching and learning.

The researcher defined benchmarking as a measurement of quality and standards of educational provisions in HEIs and related resources and infrastructures that support effective delivery of teaching and learning. It must provide a platform for best practice and performance improvement.

J. Integration of cloud computing in Education

Cloud computing in Education enhances teaching and learning outcomes by providing avenue for simulation, interaction and collaboration lesson sessions, problem solving as a technological tool for advancement of learning instruction. In recent times, cloud computing in the various forms, has been adopted in education to improve the educational delivery patterns Masud, Yong and Huang (2012). The need for integration of student record into a basic storage or synchronising more records in a specific application through a cloud type enhances time and cost management. Cloud type (Saas, Paas, Iaas) is very essential and inculcating cloud computing in to educational curriculam basically does this.

K. Applications of cloud services

1) Applications of Cloud Services in developing countries

For the sake of this study, the application of cloud computing in developing countries will generally explore the Educational sector.

Cloud Services, with its economical and technical traits, which promote business, is highly adopted by institutions of higher learning. With the knowledge of the infrastructures of cloud computing, requires immediate access to data anywhere and at anytime by the use of available gadgets over a substantial Internet service. In developed countries like the Western Europe, there is a greater number of individuals and organisations who access the internet through their personal or organisational broadband, satellite, cable and or mobile (Kloch, 2011), and this yields a distinctive rating of how cloud based services can be implemented in businesses. Developing countries are not left behind though as (Agbaje, 2013) in his view explains that having access to cloud computing in developing nation like Nigeria makes it simple for companies to tackle their cost expenses and enjoy the benefits of accessing secured data over private, public or hybrid hosted cloud services in Nigeria. In the same vein, (Sule, 2011) points out the efficacy of implementing cloud services by organisations, as it improves the productivity of such organisation. This is to say that the adoption of cloud services by small and medium Enterprises is cost beneficial to enterprises as it aids its client users.

L. Adoption of Cloud computing in developing countries

Although cloud computing in developing countries is still at its early stage it makes has made in-road into some of these minor economies. In this vein, some international bodies have expedited the use and application of Cloud-based services in some of these developing countries. According to Kshetri (2010) Hewlett Packard (HP) and UNESCO as a team have introduced in Arabic and African countries an inaugural way of applying the use of cloud computing right from the grid generation. International Business Machines (IBM) is one of the international agencies which ensure is determined to insure consistent progres of cloud computing in Africa, hence has introduced in Africa

(of which Nigeria is one of them) a new dynamic cloud computing technology termed; 'Baby-cloud'. This cloud service is uniquely an IBM technology, which runs on a 220v (standard) electrical output. It bears the form of a box, has a six blade chassis with a storage (SAN) and modified Cloudburst 2.1 software but must be executed on IBM 's Technical Accelerators (TAs). It is an independent first mobile cloud to be sold over the world.

M. Adoption of cloud services in Education

In the Education Sector, the application of cloud computing in education enhances file storage, by the provision of massive storage space to accommodate presentation slides, lecture resources, research materials, students' records, etc., this makes it valuable and is easily accessible on an internet-based system. It also enables file synchronization, such that educators could create a local folder to hold the synchronised file so that learners can conveniently and automatically download materials from the folder to their computer without navigating to the resource website to download the file needed. Users can as also create documents on the cloud for study efficiency. Academicians are uniquely identified with their information seeking skills, which enable them update, their knowledge regularly. Cloud computing invariably provides this information to Educators through the Internet and aids in academic excellence by deploying cloud services through various mediums. These could be in the form of Creating Records and files, storing these created files and sharing the information and or created files amongst educators or learners. Hence the application of Cloud computing is widely spread across all levels of learning. Alam (2013) has it that teaching materials can be made available by the Cloud Service Providers to educate the client users on the available risk management issues as it relates to cloud usage. This indicates how crucial it is for educators who are cloud service users to understand how to manage their information usage in the cloud.

To the students, it enhances their involvement in studies, increases their enthusiasm and motivation, hence the time at which they study is increases while the cost is reduced. The students gain limitless access to web based teaching-learning resources needing little or no effort of the teacher. Learning is gradually made virtual as educational institutions move their resources, Students Information System, Learning Management systems, Knowledge management systems to the cloud, with this, students are able to access the needed resources from anywhere in a flexible way (Thomas 2012). There is as well some web-based software hosted in the cloud and deployed as cloud service rendering to Educators which were generally analysed by Aaron and Roche (2012) for academic improvement. With the flexibible nature of cloud computing, academic professionals and or learners can always prepare their proposals, write-ups, conference papers etc., store them on the cloud, and easily retrieve them as and when needed. In a more advanced area, the importance of implementing cloud computing in Libraries is heightene (Cloud Library) as a link which connects the Libraries with the IT sector thereby enabling readers to share educational resources amongst different libraries (online) as such increasing the effectiveness of the us of Libraries, while cost of materials is reduced, Abidi and (Abidi, 2012).

N. Challenges of Cloud Computing in HEIs

Information Communication Technology (ICT) has been an essential aspect of learning in various forms as e-learning, e-libraries and e-assessment by enhancing teaching-learning through service delivery, therefore ICT can be seen as an enabler for the provision of IT services, which cloud with its functionalities form part of ICT that provides services and infrastructure which through its cost savings has made part of ICT values and services affordable. This is in contrast with Enuku and Ojogwu (2013) view that the value of ICT is unaffordable in HEIs due to the limitations foreseen in Nigeria.

1) Cloud computing challenges in Developing Economy

Cloud computing in Nigeria dates back to 2011 (Matthew 2010) (compared with developed nations) and it continues to face drawbacks due to lack of adequate infrastructures, electricity, renewable energy and problems of internet access in less strategic areas and HEIs inclusive.

The assurance of data security is seen as the greatest deterrent to the adoption of cloud computing in all spheres. However, security measures such as (IDS) Intrusion detection system, encryption are put in place to checkmate activities performed on data stored in the cloud. To ensure Security, confidentiality, integrity, and availability are terms, which must be well explained and adhered to in every establishment over their data (Kshetri 2013) When an establishment encrypts its data, it is expected to be in charge of the encryption keys which are unique to every encrypted document, This is likened to confidentiality, the encrypted key should be confidential to the establishment. The integrity of an enterprise is portrayed when it maintains the stipulated policy including its security laid down rules such as

uniqueness of password. There is every need for availability of data at any time and easy access from any where over the Internet to be ensured in every company. In this view, (Gartner in Gartner, 2008) listed various issues to be understood by establishments before they venture into cloud computing, these includes; location of data, segregation of data, regulatory compliance, recovery of data, supportive investigation, durable viability, and privilege user access. The listed when put into consideration would yield effective data security. MCP is one of the cloud-based services seen to provide various levels of data security, which enhance the managerial capability in developing nation.

Irregular power supply is a factor that generally but negatively affects business sectors as seen in developing countries like Nigeria (Anumaka, 2012) This could be a great challenge to the adoption of cloud service as it denies the client-user Instant access to stored data and inconsistency in internet access. On the other hand enterprises could face excessive reliance on the use of generators, which is not cost effective to business, as more expenses would be incurred.

Internet bandwidth: Bandwidth is a concept used to explain the amount of data transferred over a medium; Internet or network, therefore bandwidth describes network speeds. For instance, 1 Gigabit connection of Ethernet possesses a bandwidth of 1,000 Mbps, which is 125megabytes per second. Internet bandwidth is said to mean an electronic process that connects a user's PC to the Internet. When the bandwidth connection is more, the speed of the Internet will be faster; hence the information loads easily, and in a short time. In recent times, bandwidth limitations are a major challenge to Internet surfing. Meanwhile, according to Lori (2011) 10mbps is the benchmark for cloud and video related activities. However, Bankole (2013) has shown the lowest average Internet connection speed as declined to 2.8 mbps in Nigeria. This inhibits the bandwidth-efficiency, thereby taking a longer time to connect to the cloud on the Internet.

References:

[1] Aaron, L.S. & Roche, C.M., 2012. Teaching, Learning, and Collaborating in the Cloud: Applications of Cloud Computing for Educators in Post-Secondary Institutions. *Journal of Educational Technology Systems*, 40(2), p.95-111

[2] Abidi, F., Abidi, H.J. & Armani, S., 2012. Cloud libraries: A novel application of cloud computing. *International Conference on Education and e-Learning Innovations*, 1(3), p.79-83

[3] Agbaje, J., 2013. Dimension Data launches cloud services in Nigeria. [Online Vanguard Newspaper 23/02/2013] [Accessed April 4th 2013]

[4] Akinfolarin, A., 2013. ASUU and Federal Government: A negative impact on Nigeria's Education. Available at http://www.africanspotlight.com/2013/08/26/asuu-and-f-g-a-negative-impact-on-nigerias-education/ [online] [assessed on 4th February 2014]

[5] Alam, M.T., 2013. Cloud computing in education. *IEEE Potentials*, 32(4), p.20-21.

[6] Aliyu, A. S., Ramli, A.T. & Saleh, M.A., 2013. Nigeria electricity crisis: Power generation capacity expansion and environmental ramifications. *Energy*, 61, p.354-367.

[7] Anumaka, M.C., 2012. Scenario of Electricity in Nigeria. *International Journal of Engineering and Innovative Technology (IJEIT)*, 1(6), p.176-183.

[8] Armbrust, M. et al., 2010. A view of cloud computing. *Communications of the ACM*, 53(4), p.50

[9] Astrova, I. et al., 2012. Security of a Public Cloud. *Innovative Mobile and Internet Services in Ubiquitous Computing (IMIS), 2012 Sixth International Conference on*, p.564-569.

[10] Audrey, M., & Uwe R., 2013. User Awareness and Policy Compliance of Data Privacy in Cloud Computing *ACM Digital Library*, [e-journal] 144 3-12

[11] Axinn, W.G. & Pearce, L.D., 2006. Mixed Method Data Collection Strategies A. Tashakkori & C. Teddlie, Eds. *Methods*, 87(1), p.1-415

[12] Aziz, N.A.A. et al., 2012. Providing augmented reality based education for students with attention deficit hyperactive disorder via cloud computing: Its advantages. *Public Policy*, p.577-581

[13] Bankole, O.M., 2013. The use of Internet services and resources by scientists at Olabisi Onabanjo University, Ago Iwoye, Nigeria. *Program: electronic library and information systems*, 47(1), p.15-33

[14] Bryman, A. & Bell, E., 2007. *Business Research Methods* Anonymous, eds. Oxford University Press.

[15] Chen, Y. & Chen, F., 2011. Overview and Analysis of Cloud Computing Research and Application. In *2011 International Conference on EBusiness and EGovernment ICEE (2011)*. IEEE, pp. 1-4

[16] Ciuffoletti, A., 2010. Monitoring a virtual network infrastructure An IaaS perspective. *Computer Communication Review*, 40(5), p.47-52.

[17] Creeger, M., 2009. Cloud Computing: An Overview. *Queue*, 7(5), p.3

[18] Creswell, J. W., 2012. *Educational research. Planning, conducting and evaluating qualitative and quantitative research*. 4th ed. New York: Pearson.

[19] Dattakumar, R. & Jagadeesh, R., 2003. A review of literature on benchmarking. *Benchmarking: An International Journal*, 10(3), p.176-209.

[20] Enuku, U.E. & Ojogwu, C.N., 2006. Information and communication technology (ict) in the service of the national open university of Nigeria. *Education*, 127, p.187-195.

[21] Fershtman, C., & Neil G. N., 2012**.** Migration to the Cloud Ecosystem: Ushering in a New Generation of Platform Competition**.** *Social science research network.*

[22] Flowers, P., 2009.***Research for Masters in science 1***. England: Cranfield Press.

[23] Gartner, 2008. Gartner Identifies the Top 10 Strategic Technologies for 2009.

[24] Ghazal, A. et al., 2013. Big Bench: towards an industry standard benchmark for big data analytics. In *Proceedings of the 2013 international conference on Management of data - SIGMOD '13*. ACM Press, pp. 1197-1208.

[25] Global, M., 2011. McKinsey on Business Technology. *New York*, 19(22), p.4-11

[26] Golafshani, N., 2003. Understanding Reliability and Validity in Qualitative Research. *The Qualitative Report*, 8(4), p.597-607.

[27] Harry E J., &Andreas T., 2013. Evaluating the Applicability of Cloud Computing Enterprises in Support of the Next Generation of Modelling and Simulation Architectures. *Society for Computer Simulation International*. [E-journal] 4 pp. 17-20

[28] Hayes, B., 2008. Cloud computing. *Communications of the ACM*, 51(7), p.9.

[29] Heit, E. & Rotello, C.M., 2010. Relations between inductive reasoning and deductive reasoning. *Journal of experimental psychology. Learning, memory, and cognition*, 36(3), p.805-812.

[30] Higher education council for England Glossary, 2011. [Online] [Assessed on 5th March]

[31] Hon, K.W., Millard, C. and Walden, I., 2011. ***The problem of personal data in cloud computing.*** London: University of London Press. United Kingdom.

[32] Jebreen, I., 2012. Using Inductive Approach as Research Strategy in Requirements Engineering. *International Journal of Computer and Information Technology*, 01(02), p.162-173.

[33] Katzan Jr, H., 2010. The Education Value Of Cloud Computing. *Contemporary Issues in Education Research*, 3(7), p.37-42.

[34] Kelloway, E.K. et al., 2008. Third-party support for strike action. *The Journal of applied psychology*, 93(4), p.806-817

[35] Kloch, C., Petersen, E.B. & Madsen, O.B., 2011. Cloud Based Infrastructure, the New Business Possibilities and Barriers. *Wireless Personal Communications*, 58(1), p.17-30.

[36] Kshetri, N., 2010 Cloud computing in developing economies: drivers, effects and policy measures; IEEE proceedings.

[37] Kshetri, N., 2013. Privacy and security issues in cloud computing: The role of institutions and institutional evolution. *Telecommunications Policy*, 37(4-5), p.372-386.

[38] Lin, A. & Chen, N.C., 2012. Cloud computing as an innovation: Perception, attitude, and adoption. *International Journal of Information Management*, 32(6), p.533-540

[39] Lori Makvite (2011) the cloud and the consumer: The impact on bandwidth and broadband. https://devcentral.f5.com/articles/ (Accessed on 2nd June 2013)

[40] Manousakis, V. et al., 2013. Privacy in the Cloud: Bridging the Gap between Design and Implementation. In *Proceedings of the Advanced Information Systems Engineering Workshops*. pp. 455-465.

[41] Masud, M.A.H., Yong, J. & Huang, X., 2012. Cloud Computing for Higher Education: A roadmap. *Proceedings of the 2012 IEEE 16th International Conference on Computer Supported Cooperative Work in Design CSCWD*, p.552-557.

[42] Matthew, O., 2010. Software Piracy: Microsoft to deploy Cloud service in Nigeria. Available through http://www.nigerianbestforum.com. [Accessed 12th August 2013].

[43] Mell, P. & Grance, T., 2009. The NIST Definition of Cloud Computing. *National Institute of Standards and Technology*, 53(6), p.50.

[44] Menon, K. et al., 2012. Cloud computing: Applications in biological research and future prospects. *Cloud Computing Technologies, Applications and Management (ICCCTAM), 2012 International Conference on*, p.102-107.

[45] Merriam, S.B., 2001. Case Study Applications in Education Revised and Expanded from Case. In *Qualitative Research and Case Study Applications in Education*. pp. 26-43.

[46] Mollah, M.B., & Islam, K.R.. 2012. Next generation of computing through cloud computing technology. *Digital Library*, [e-journal] 25 pp.1-6

[47] Moriarty, J.P., 2011. A theory of benchmarking. *Benchmarking: An International Journal*, 18(4), p.588-611.

[48] Nworah, U., 2007. "Nigeria And The World University Rankings." *The Global Politician*. Available at: http://www.globalpolitician.com/22935-nigeria.

[49] Ogbu, R. C., & Lawal, A 2013. Cloud Computing and Its Applications in e-Library Services: Nigeria in Focus. *International Journal of Innovation, Management and Technology*, 4. p.470-476

[50] Owens, D., 2010. Securing Elasticity in the Cloud. *Queue*, 8(5), p.10.

[51] Quinton, C. et al., 2013. Towards multi-cloud configurations using feature models and ontologies. *Proceedings of the 2013 international workshop on Multi-cloud applications and federated clouds - MultiCloud '13*, p.21.

[52] Saunders, M., Lewis P. and Thornhill, A., 2009. *Research methods for business students*. 5th ed. Pearson.

[53] Schechter, J., 2010. The Reliability Challenge and the Epistemology of Logic. *Nous-Supplement: Philosophical Perspectives*, 24(1520-8583, 1520-8583), p.437-464.

[54] Shamsul Anuar M., et. al., (2013) Cloud computing in academic institutions New York, NY, USA Sule, M. -J., 2011. A Conceptual Framework of Deploying Cloud IaaS in Higher Educational Institutions. *2011 IEEE Third International Conference on Cloud Computing Technology and Science*, p.489-493.

[55] Thomas, P.Y (2012) Cloud Computing: New opportunities and challenges for Education. 5.pp.95-106

[56] Turney, L., 2009. Semi-Structured Interview. *Qualitative Research*, 23(1999), p.1-2.

[57] Uzunboylu, H. & Ercan, T., 2010. Effective use of cloud computing in educational institutions. In *Procedia - Social and Behavioral Sciences*. pp. 938-942.

[58] Vaquero, L.M. et al., 2008. A break in the clouds. *ACM SIGCOMM Computer Communication Review*, 39(1), p.50.

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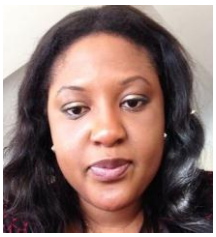
[59] Wainer, J. & Barsottini, C., 2007. Empirical research in CSCW — a review of the ACM/CSCW conferences from 1998 to 2004. *Journal of the Brazilian Computer Society*, 13(3), p.27-35.

[60] Wheeler, B. & Waggener, S., 2009. Above-Campus Services: Shaping the Promise of Cloud Computing for Higher Education. *Educause Review*, 44(December 2009), p.10

[61] Yin, Robert K., 2012 Case Study Research. Design and Methods. *Zeitschrift Für Personalforschung*, 26(1), p. 93-96.

[62] Yin, Robert (2013). Case Study Research: Design and Methods. Fifth Edition. Sage Publishers: Thousand Oaks, CA.

[63] Zhaojun Li & Kailash C. Kapur (2013). Some Perspectives to Define and Model Reliability Using Fuzzy Sets. Quality Engineering, Volume 25, Issue 2, 2013, pages 136-150



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