CLOUD COMPUTING ADOPTION IN NIGERIAN UNIVERSITIES: A CONCEPTUALIZED MODEL BASED ON STAKEHOLDER PERCEPTIONS

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CERTIFICATION

This is to certify that the thesis titled

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Hajara Umar Ibrahim.

SIGNATURE PAGE

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ABSTRACT

Cloud computing is a technology that represents a shift from traditional ownership of infrastructure and other resources to a more scalable pattern in which computing resources are leased online to businesses on a pay-as-you-go or subscription basis. Virtual resources' increased scalability and reliability offer several advantages when handling software services and hardware infrastructure. This study aimed to discover the adoption of cloud computing in Nigerian universities, the expected benefits, the challenges in implementing the technology, and the solutions to these problems. Cloud

ACKNOWLEDGEMENTS

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LIST OF ABBREVIATIONS

ICT- Information and Communication Technology

IT- Information TECHNOLOGY

NNCP- Nigerian Cloud Computing Policy

NITDA-National Information Technology Development

NIST- National Institute of Standard and Technology

CHAPTER ONE: INTRODUCTION

1.1 BACKGROUND

Cloud computing is changing the way organizations work together to support related elements. It is the leading technology in data processing and is considered a solution for different types of organizations. In education, we provide lucrative opportunities for administrators, educators, and students with technology-based devices, needs, and desires to consider. Cloud computing transforms how educational institutions conduct activities, adding value to computing services and operations management while providing cheaper, more flexible, and more available computing resources. The National Institute of Standards and Technology defines cloud computing as convenient, on-demand network access to a shared pool of configurable computing resources (networks, servers, storage, applications, services, etc.) that are rapidly provisioned and deployed. defined as a model that enables Can be published with minimal administration or interaction with a service provider. However, integrating cloud computing into education is relatively new and is expected to impact the learning process significantly. Numerous studies have demonstrated that cloud computing has dramatically changed how activities are performed, increasing organizational scalability and making virtualizing resources on the Internet more viable. Cloud computing is highly integrated into various industries, including education. According to Anjali and Pandey (2013), cloud computing is practical. By enabling educational institutions to access global resources and analyze and store data over the Internet for data analysis and storage. Instructors should focus on creating content so students can understand and share their ideas. Cloud computing can improve student academic performance by providing access to various resources. Cloud computing also improves productivity as employees can work from anywhere over the internet using internet-enabled computing devices confined to the office. Plus, you can access

your organization's services anytime, anywhere, rather than having infrastructure on-premises that limits employee access after business hours. Cloud computing costs less than traditional environments (The Punch, 2013).

1.2. PROBLEM DEFINITION

It is observed that tertiary institutions in Nigeria still use the traditional method of teaching and learning. Given the vast benefits of the technology, there is a need for creating awareness and guidance on how to systematically increase the implementation of cloud computing in tertiary institutions in Nigeria. According to Linthicum (2013), cloud computing is growing day by day at the expense of traditional IT. service provider.

The need for more adoption and usage of technological innovation, such as cloud computing, could be one reason for retaining tertiary institutions from providing effective and efficient means of teaching and learning. Only a little has been studied about solutions for these challenges and, more importantly, how to adopt cloud computing in developing countries. The adoption of a framework for cloud computing adoption would help tertiary institutions adopt this technology as one of the potential solutions to improve the quality of teaching and learning.

1.3 SCOPE OF STUDY

1. This research focuses on I.C.T. Adoption in general and the adoption of cloud computing in particular.

2. The research background is on Nigerian universities, including public and private universities.

3. This research focuses on adopting a framework that considers the factors affecting the adoption of cloud computing technologies in Nigerian universities.

1.4 AIM AND OBJECTIVES

This study focuses on cloud computing technology that can be used in Nigerian universities as one of the potential solutions to improve the accessibility and quality of education. Based on the previous sections above, the aim of the study is to explore ways to improve the implementation of cloud computing in higher education in Nigeria. The objective of this research is to:

1. Design a model to guide how to improve the adoption of cloud computing in developing countries, especially Nigeria.

2. Examine stakeholder perceptions of factors affecting cloud computing adoption

3. Adopt a framework for cloud computing technologies into higher education in Nigeria.

1.5 RESEARCH QUESTIONS

Research questions for this study include:

1. What are the key factors influencing the adoption of cloud computing in Nigerian universities?

2. To what level do these factors influence the adoption?

3. How do we minimize the effects of these factors?

1.6 RESEARCH JUSTIFICATION

The widespread new technologies in education such as Cloud computing encourages universities to use new technologies to find better solutions. The adoption can improve the quality of educational processes and outcomes. The study will provide a better understanding of the advantages and benefits of adopting cloud computing in tertiary institutions in Nigeria. Such adoption can improve the accessibility and quality of educational processes and outcomes. The study will also benefit cloud computing service providers, consumers, the IT department, and the research community.

1.7 SUMMARY OF THE STUDY

The study focuses on "Cloud Computing adoption in Nigerian Universities: A Conceptualized Model Based on Stakeholder Perception." The study is organized into five chapters.

Chapter one provides a general overview of the subject matter. It highlights the statement problem relating to the current situation and the strategies adopted, research questions, objectives of the study significance, study scope, limitations encountered in conducting this research work, and conceptual definition terms used in the study.

Chapter two examines the review of the related literature and the contribution of various scholars on cloud computing.

Chapter three deals with the methodology adopted for this study, the study's research design, the study's area, the study, the population of the study, the instrument for data collection, the procedure for data collection, and the procedure for data analysis. The results were used to design a conceptualized model based on stakeholder perceptions.

Chapter four deals with data display and analysis. Data collected in Chapter 3 were analyzed using frequency and simple percentages. With this in mind, a conceptualized model was designed based on stakeholder perceptions

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 EVOLUTION OF CLOUD COMPUTING

Cloud computing is evolving rapidly, with individuals, governments, and businesses of all sizes embracing the technology. According to Seasia Infotech, the evolution of cloud computing can be divided into three main phases:

- **The Idea Phase:** this phase was conceived in the early 1960s with the advent of utility and grid computing and continued into the pre-Internet bubble era. In the 1960s, John McCarthy pioneered cloud computing by enabling businesses to use mainframe computers and introducing the concept of time sharing. In 1969, J.C.R. introduced the concepts of "Galactic Network" and "Intergalactic Computer Network" and also developed the Advanced Research Projects Agency Network (ARPANET). By 1970, it was possible to run multiple operating systems in an isolated environment. In 1997, Professor Ramnath Chellappa introduced the concept of "cloud computing" in Dallas.

- **The Pre-Cloud Phase:** The pre-cloud phase started in 1999 and lasted until 2006. During this phase, the Internet served as a mechanism for delivering applications as services. In 1999, Salesforce.com launched the concept of an enterprise application through a simple website. In addition, the service included the possibility of supporting professionals who deliver applications via the Internet. In 2003, the Virtual Machine Monitor (V.M.M.), which allowed running multiple virtual guest operating systems on a single device, paved the way for other great inventions.

- **The Cloud Phase:** The much-discussed absolute cloud phase began in 2006 when the taxonomy of IaaS, PaaS, and SaaS development was formalized. The history of cloud computing has seen several groundbreaking breakthroughs pioneered by the world's

leading computer/web organizations. Amazon began expanding into cloud services in 2006. From EC2 to Simple Storage Service S3, we introduced a pay-as-you-go mode that has become standard today.

Another way of looking at the cloud is that it is a form of computing in which elastic and scalable IT-enabled capabilities are provided to customers as a service. Cloud computing moves data and computers from desktops and portable computers to large data centers. Applications can be delivered over the internet from within the cloud infrastructure. A user can access this service or the user's data and files from the cloud service provider's server using a web browser (Kim, 2009). Some immediate benefits include allowing students to quickly share their information and experience the educational system in new ways. However, this comes with other challenges, such as Security and Privacy and configuring resources in shared Environments. Proposing appropriate innovations, such as cloud computing, to be adopted by Nigerian universities is essential to this research. Additionally, cloud computing technologies can improve limited computing power and physical data storage. Additionally, cloud computing deployments and service models offer many options for Nigerian universities to choose from according to their current and future needs.

2.2 DEFINITION OF CLOUD COMPUTING

Cloud computing has many definitions, and different academics and organizations define the technology in their way. Below are some of these different definitions. The National Institute of Standards and Technology (NIST) defines cloud computing as: "Cloud computing is a model for enabling ubiquitous, 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."

Cloud computing is considered an umbrella term for sophisticated on-demand computing services offered initially by commercial providers such as Amazon, Google, and Microsoft (Voorsluys, Broberg, and Buyya, 2011).

Gartner defines it as: "Cloud computing is a style of computing in which scalable, elastic, IT-enabled capabilities are delivered as a service using Internet technologies" (Gartner.com, 2009).

The evolution of cloud computing is seen as a critical component of computing technology that will incrementally improve the services of information systems by responding to user requests in real-time (Kim, 2009). Cloud computing service providers offer pay-as-you-go options. This is seen as a new business model where customers only pay for the exact amount of resources they need. Cloud computing promises significant benefits, including reduced initial service costs and near-unlimited availability of resources (Staten, Yates, Rymer, & Nelson, 2009). Cloud computing offers flexible on-demand capabilities such as scalability and elasticity. Cloud computing can be classified according to service and delivery models. These classifications are based on the customer's computational requirements. The cloud computing service model consist of three main types: Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS). Cloud computing deployment models, on the other hand, are categorized as follows: Public, Private, Hybrid and Community Clouds (Mell & Grance, 2011).

2.4 CLOUD COMPUTING SERVICE MODELS

Cloud computing has three primary service models based on available resources, each meeting specific needs. The key to adopting cloud technologies is understanding the commonly available resources, the solutions cloud providers can offer, and how those solutions

meet the institution's needs. Therefore, it is essential to understand the institution's options for adopting the best available cloud scenarios (Mahmoud Odeh, 2017). The service models are:

2.4.1 Software as a Service (SaaS)

Consumers use the provider's applications running cloud infrastructure in these cloud computing service models. Applications can be accessed from various client devices through thin client interfaces such as web browsers (web-based email) and programmatic interfaces. Consumers do not manage or control the underlying cloud infrastructure, such as networks, servers, operating systems, storage, or individual application functions, except for limited user-specific application configuration settings (Mell & Grance,2011).

It represents the top tier of the cloud and provides services in a software model of web-based applications, serving many users. All your application users need is a connection to the Internet. With SaaS, users don't have to install or run applications on their devices or worry about maintenance, upgrades, and support. Applications such as e-learning systems, admissions procedures, research, faculty and student corners, administration, digital libraries, e-mail, account and financial processes, student lifecycle and information systems, classroom management systems, and other administrative processes at the SaaS layer can be hosted at Make it easily accessible and convenient for college students, faculty, and government workers. Cloud providers such as Salesforce.com, Google, and SkyDrive offer SaaS services. Using SaaS helps overcome the problems of limited modern teaching and learning resources and the lack of scalability of e-learning (S Okai et al., 2014).

2.4.2 Platform as a Service (PaaS)

PaaS sits between software as a service (SaaS) and infrastructure as a service (IaaS). PaaS is a cloud-delivered service that provides customers with the resources they need to build and

develop web applications (Velte et al., 2009). PaaS gives cloud clients control over software applications. However, it is also vital that application developers know how to use vendor-provided programming languages (Chou, 2015). Consumers control deployed applications and have limited control over some network components, but the cloud does not control or manage the infrastructure.

2.4.3 Infrastructure as a Service (Iaas)

This concept emerged under the umbrella of Hardware-as-a-Service and became IaaS (Aumüller, 2010). In this service model, the provider guarantees the number of resources and their availability, and the customer does not have to manage the infrastructure. IaaS can be deployed in universities to meet the specific needs of students and researchers, such as simulation in engineering projects that require highly specialized hardware(Pardeshi, 2014). The IaaS service is hosted on a remote network, giving customers access to off-site resources anytime, anywhere. IaaS provides resource flexibility and scalability. Such features allow cloud customers to upgrade resources according to their needs by adding more CPU cycles or memory (Velte et al., 2009). This level of simplicity for infrastructure resources is nearly impossible with traditional hardware resources. Examples of IaaS services are Amazon EC2 and Google Cloud Platform.

2.5 CLOUD COMPUTING DEPLOYMENT MODELS

The deployment identifies environment types based on ownership, scope, access, cloud type, and purpose. A deployment model also specifies the servers' locations and who controls them and defines the relationship between users and infrastructure. According to (Chang, 2015), cloud deployment is classified according to the type of service provided by the cloud provider: Public, private, hybrid, or community cloud.

2.5.1 Public Cloud

Public clouds are open to everyone which makes them less secure, as anyone can access systems and services. In public clouds, the infrastructure is open to the public and used by individuals, organizations, and governments. It is owned, managed, and controlled by a service provider and located on its premises (Mell & Grant, 2011). Cloud infrastructures are available to the general public or large industry groups over the Internet. The public nature of this service, which allows resources to be shared among multiple organizations, can result in lower security and privacy than other delivery models (Hamdaqa & Tahvildari, 2012). Examples of this model are Amazon, Google, and Microsoft. It is a cost-effective solution for institutions due to its many possible uses.

2.5.2 Private Cloud

A private cloud is the opposite of a public cloud. Cloud infrastructure works exclusively within a single organization and provides more control and management capabilities. A private cloud is an internal data center of a company or other organization that is not publicly available (Armbrust et al., 2010).

Organizations can adopt their own Security and privacy policies, which gives them greater flexibility in control over cloud resources. It is more expensive than the other deployment models. However, it is suitable for organizations that want a high level of Security and full control of their data which can be accessed by authorized staff.

2.5.3 Community Cloud

The cloud infrastructure is offered to organizations with similar/common concerns (policies, considerations, security needs, compliance, etc.). It may be owned, managed, and controlled by one or more organizations or third parties and may be local or remote. The community cloud

delivery model allows one or more parties (cloud community members or third-party service providers) to share cloud infrastructure hosting. Community clouds are seen as a good option for large institutions with many chapters in distributed locations and sharing the same policies and rules (Nwobodo, 2016). It is a distributed system created by integrating services from different clouds to meet the specific needs of a community, industry, or enterprise.

2.5.4 Hybrid Cloud

According to Mell and Grance (2011), a hybrid cloud infrastructure combines two or more different cloud infrastructures (private, public, or community) that remain separate entities but can share data and applications connected by standardized or proprietary technologies combined with portability. Hybrid clouds are considered more complex in composition than other deployment models that require advanced technical skills to implement and manage (Rountree & Castrillo, 2013).

2.6 CHARACTERISTICS OF CLOUD COMPUTING

There are many characteristics of cloud computing, but five essential characteristics of cloud computing are described by Mell and Grance (2011). Naveen et al. (2016); Diaby and Rad (2017):

- **Broad network access:** Cloud computing services are available across various networks and accessible to various clients through different cloud platforms.

- **Rapid elasticity:** It refers to "virtualization," where data can be quickly processed and stored. Storage capacity can be increased or decreased according to the needs of cloud users.

- **Measured service:** Cloud computing provides users and customers with a fully structured cloud system. Such systems have a cost-saving approach, requiring users to pay only for their cloud services.

- **On-demand self-service:** The cloud model is easy to use, and the user cannot rely on his provider for services. Must be familiar with digital devices and technology.

- **Resource pooling:** Cloud computing uses different computing resources, such as network and storage platforms, to provide the best model for customers.

According to the National Institute of Standards and Technology (NIST), these five characteristics broadly define "cloud computing".

2.7 BENEFITS OF CLOUD COMPUTING
2.7.1 Scalability
Scalability is a built-in feature of cloud deployments. Cloud instances are provisioned on demand, so you only pay for the application and data storage you need and use. Cloud-based software helps reduce costs associated with expanding facilities compared to scaling on-premises data centers. No matter how many students you have or how many colleges you manage, your cloud system can scale as your users grow. It's also elastic because the cloud can rise to adapt to IT changes. system request.

2.7.2 Cost Effectiveness
This is one of the most important advantages of cloud computing. Cloud computing eliminates the cost of owning the infrastructure needed to run an organization. Data storage costs, data center maintenance costs, Licensing fees, software updates, etc., are reduced, enhancing the learning environment and creating new educational opportunities. It is better and cheaper than

traditional approaches. It is easily scalable and allows companies to focus on core business functions and add value (Ilias, 2013).

2.7.3 Convenience and Continuous Availability

Cloud-based education systems improve physical and digital access to resources. For example, public clouds provide services to end users wherever they are. This allows students to easily access information and learning resources to meet their needs in different locations.

2.7.4 Better Collaboration

Collaboration is vital in cloud-based education because accessing, viewing, and modifying shared documents and files is more accessible. The cloud creates many new collaboration opportunities that can help improve remote virtual classrooms, support student communication, create teacher management portals, and more. . It also creates an environment where students and lecturers can collaborate easily.

2.7.5 Backup and Recovery

Data backup and recovery are simplified because data resides in the cloud instead of on physical devices. Various cloud providers offer reliable and flexible backup and recovery solutions. Sometimes, the cloud can only be used as backup storage for data residing on your local computer (Ilias, 2013).

2.7.6 Modernizing Learning Environment

Cloud-based technology makes educational institutions attractive and desirable for new students. It also allows you to offer students a higher standard of learning.

2.7.7 Quick Deployment and Ease of Integration

Cloud systems can be up and running quickly, so rapid deployment is a crucial advantage. Onboarding new users to the system is immediate, eliminating wait times. (Ilias, 2003), software integration happens automatically and organically in cloud installations. Businesses can choose the services and applications that best suit their preferences, with minimal effort to customize and integrate these applications.

2.8 CHALLENGES OF CLOUD COMPUTING

2.8.1 Limited control

One of the advantages of cloud computing is accessibility, but cloud applications and services run in third-party virtual environments. Organizations and users have less control over the software and hardware's functionality and operation, such as updates and other features. The cloud service provider manages the infrastructure, so you have limited control.

2.8.2 Security and Privacy

Security and privacy are among the top concerns for any organization using cloud computing. Universities hold a lot of confidential information. Institutions typically utilize remote, cloud-based infrastructures to share private data and information. A cloud service provider manages, protects, and stores them. Therefore, provider reliability is critical. Similarly, data protection in the cloud is also a big issue. Businesses and users should trust cloud service providers to protect their data from unauthorized users. Various stories of password leak and data loss in the media do not reassure some of the most concerned users (Ilias, 2013).

2.8.3 Dependency and Vendor Commitment

One of the challenges of cloud computing is the difficulty of switching between service providers and the dependence on a single provider. Also known as vendor lock-in, it makes migrating from your cloud provider challenging once you're on the hook. Therefore,

choosing the right provider is critical when migrating to the cloud. A good provider listens to you, understands and manages the associated risks end to end and eliminates surprises.

2.8.4 Up-Front Expenses

Cost efficiency is an advantage of cloud computing, especially in higher education institutions, but the upfront costs can be increased. Moving to the cloud can be expensive, depending on the number of applications and services you are migrating. There is also an opportunity cost in the time it takes to prepare and train employees on new systems and security best practices.

2.8.5 Internet Dependency

Cloud computing services rely entirely on the Internet's availability, speed, quality, and performance, as it acts as a conduit between consumers and service providers (Jangra & Bala, 2011).

2.9 CLOUD COMPUTING IN AFRICA

Cloud computing is one of the most exciting technologies today but also one of the most alarming. Despite the apparent benefits of cloud computing, many individuals and businesses have questions and concerns about this form of computing. A further question to cloud computing is the question of security (Ume and Bassey et al., 2012). Cloud computing can solve Africa's IT shortage. Solve infrastructure that can meet the needs of the population. Cloud computing technology is suitable for the continent because there is no infrastructure to own, manage, or maintain. You can rent it as a service. While this can be easily achieved, two issues that have hindered the growth of cloud computing across the continent must be addressed. The two main concerns are inadequate electronic communication infrastructure (network coverage) and lack of stable electricity supply (State and Perspectives of Cloud Computing in Africa, 2012).

A Hedera Technology Consultancy report on the Internet in Africa identified a lack of necessary investment in telecommunications networks as the main reason for poor network quality in Africa. Complying with terms guaranteeing cloud service quality levels and access speeds can be difficult. I.C.T. usage is increasing across the continent, supporting economic growth. Therefore, the necessary investments are made to ensure that the sector delivers the benefits it offers (State and Prospects for Cloud Computing in Africa, 2012).

2.9.1 Cloud Computing in Nigeria

Nigeria is the most populous country in Africa. There are some challenges when using IT. Infrastructure can be solved by cloud computing, according to the Nigerian Cloud Computing Policy 2020. According to the Nigerian government, adopting cloud computing will reduce capital costs, better respond to the needs of citizens and customers, increase transparency, and improve public service delivery. Implementing this policy requires a proactive strategy to enable government agencies to integrate cloud functions quickly and efficiently. This policy aims to promote adopting cloud services in the public sector by introducing the principle of "cloud first," which encourages a better approach to infrastructure investment and efficient IT, representing an essential step for use in public services.

As such, the Nigeria Cloud Computing Policy (NCCP) has made provision for Federal Public Institutions (F.P.I.) and S.M.E. "Cloud First" (National Information Technology Development). Agency (NITDA), 2019).

In (Businessdayonline, 2012), the Nigerian federal government spent N19.4 billion (US$ 121.25 million) on data centers in 2011 alone, says Omobola Johnson, Nigeria's former Minister of Communications and Technology. She said it was unsustainable, and given the increasing use of information and communication technology, we must find ways to reduce and better manage

it. It plans to introduce cloud computing services to reduce its I.C.T. costs. infrastructure. The government's development of cloud infrastructure departments, Departments, and Agencies (M.D.A.) aims to save costs and improve the efficiency and productivity of all her M.D.A.

However, a recent survey of more than 50 business leaders and IT directors from 10 companies conducted in the major capitals of Nigeria showed that most of them are not willing to outsource even applications that bring them to the market. less sensitive information. Most of them still prefer their internal infrastructure for fear of not having control over their data and systems. The few who agreed said they would only review it after a thorough analysis of the risks of dealing with a third party and would also do so in phases with one or two applications or processes to initiate the transaction. head. All agree that fear and the fact that people don't know what technology is; are major barriers to technology growth and adoption (Ume and Bassey et al., 2012). Therefore, it is necessary to sensitize the organizations and individuals that can benefit from the use of cloud computing about what it is, its potential advantages, disadvantages, and solutions and how to use it. use it.

A critical analysis of the benefits and challenges of cloud computing adoption and usage in Nigeria was conducted. The study presented the relationship between the key stakeholders in Nigeria's cloud ecosystem and suggested approaches to maximize the benefits of cloud computing while reducing the inherent adoption challenges. However, this study focuses on businesses and enterprises as consumers of cloud technology and not on educational institutions (Dahunsi & Owoseni, 2015). A study conducted by Ofemile to evaluate the capabilities of selected cloud computing tools for language teachers in Nigeria found that participants could perceive the opportunities inherent in using cloud computing for classroom learning and unforeseen possibilities.

2.9.2. Adoption of Cloud Computing in Tertiary Institutions

The education sector is also unaffected by the constant proliferation of cloud computing. Many educational institutions also join the effort to incorporate cloud technologies into their operations. The use and adoption of cloud-delivered services are spreading everywhere, and the education sector is no exception. However, rates and magnitudes vary by region and regional currency positions (Muriithi G and Kotze, 2012). In an educational environment, cloud computing offers many benefits for teachers and students.

Whether in education or research, storing big data, collaborating on projects, and sharing documents is a compelling proposition (Alajmi, Q., Sadiq, A.S., Kamaludin, A., & Al- Sharaf, M.A., 2017). According to (Gital & Zambuk, 2011), cloud computing is the answer to some of the problems higher education in Africa and other developing countries are facing when integrating IT into their educational modules.

Cloud computing can also be used remotely, where users can access these documents on any device, from anywhere, anytime. Recently, universities have chosen to ignore obsolete computers. configuring software and systems and moving to the cloud due to fast, efficient deployment, scalability, and more. According to (Pocatilu, Alecu, and Vetrici, M, 2009), cloud computing also facilitates online learning in human-computer interaction because they can use facilities such as monitoring and saving stores access data through the cloud platform, which also provides the infrastructure for it. And it also offers a collaborative approach to learning, making it an ideal choice for organizations looking for computer technology to enhance a more social and collaborative learning style. Cloud computing is becoming an increasingly essential part of the education industry, and this is due to increasing competition in the higher education market and pressure on performance, student success, and revenue. Sasikala & Prema, 2011).

Large companies like Microsoft offer free cloud services to universities. And its services are document hosting, email, training, report sharing, and the ability to create websites. In higher education institutions, cloud applications have been adopted in various forms and used for different tasks.

2.9.3. Challenges Facing Adoption of Cloud Computing in Nigerian Tertiary Institutions.

Despite the immense benefits of cloud computing, the uncertainty about the security and privacy of information stored in the cloud, the location of the data, privacy and regulatory compliance, Vendor lockout, vendor reliability, and cloud legal jurisdiction are barriers to the adoption of cloud computing in higher education institutions. The key infrastructures supporting cloud services such as electricity; fast, reliable, and affordable Internet connection; network availability, etc., are minimal and unreliable in Nigeria. The power shortage in Nigeria is not financially beneficial for data center providers who want to partner with or set up their data centers abroad. Privately supplying electricity through generators will cost them less than at a significant cost. And many consumers and third-party providers in Nigeria feel more comfortable purchasing data center services from overseas providers in countries with reliable infrastructure. more reliable with backups of an overseas data center. The few data centers available in the country are mainly located in Lagos, which means that most of the states in Nigeria do not have data centers. This lack of home network infrastructure is the main problem holding back broadband growth. Some states, including the Federal Capital Territory, have fiber networks within the state, but there are minimal connections between fiber networks from one state to another. And where there is connectivity between states, it is only between state capitals. In summary, there is no national long-distance backbone to transport and distribute the

capabilities the submarine cable tousers offer at inland offices, schools, and homes across Nigeria (Olusola & Olaojoyetan, 2013).

Armbrust et al. (2009) highlighted several challenges of cloud computing, including technical challenges such as service availability and data locking in cloud adoption. Furthermore, unpredictable performance, lack of scalable storage, and other barriers could limit the growth of cloud computing in Nigeria. There are numerous challenging factors hindering the adoption of cloud computing in Nigeria and some of them are:

- **Unreliable Internet:** Poor quality of service or unavailability of internet service is one of the principal challenges that hinder prompt availability and widespread adoption of cloud in Nigeria. For cloud services to be effective, the internet must be reliable, as the cloud requires fast and reliable internet. In addition, the lack of reliable Internet access has prevented most developing countries from adopting cloud computing.

- **Lack of awareness:** This is confirmed by the general public's lack of insight and awareness of the potential benefits and capabilities of the cloud. Such a large-scale ignorance is a contributing factor to the region's low cloud adoption rate.

- **High Cost of I.C.T.:** The cost of acquiring, setting up, and maintaining an I.C.T. framework and equipment are exorbitant; many people cannot afford personal computers, laptops, mobile phones and some I.C.T hardware because it is unreasonably expensive for most people in developing countries. This limits the population of people who can purchase an I.C.T. material.

- **Poor Network Infrastructure:** Lack of adequate network infrastructure is a notable barrier to ICT use in many developing countries. Most regions of the country are still in

the process of developing in many areas of their economy. The telecommunications networks in most of the developing countries and the cost are enormous. And the limited accessible framework is mainly found in large urban areas, thereby pushing aside and depriving rural communities of good networks.

- Lack of technical skills in deploying cloud computing services

- The lack of flexibility in the cloud computing policy or regulatory framework discourages many businesses or organizations from adopting cloud computing.

- **Insecurity:** The country's current insecurity problem also hinders cloud providers from investing.

2.9.4 Reasons for Low Rate of Adoption of Cloud Computing by Universities

Cost savings are the main reason for adopting cloud computing in most colleges and universities. Concerns about the security and privacy of data stored in the cloud, privacy and regulatory compliance, vendor lock-in, data location, legal authority, and vendor reliability of cloud service delivery has been identified as barriers to cloud adoption in higher education despite the great advantages of cloud computing, by Low, Chen and Wu (2011) and Mircea and Andreescu (2011). The survey also revealed that for higher education institutions, the challenges of cloud adoption are not limited to the risks listed above. However, the relative novelty and underdevelopment of cloud services is also a major concern for cloud adoption. According to Rittinghouse and Ransome (2010), non-compliance with S.L.A. (Service Level Agreements) of cloud providers is another reason for slow adoption, because if cloud providers fail to meet S.L.A. and attend downtime, fast performance will be greatly affected. Legal and jurisdiction issues also pose concerns because legal issues can bind an institution into unwanted or unsatisfactory conditions, thereby leading to legal disputes that can run into years due to laws

regarding the location of the data. Once the services of cloud vendors are employed, the institutions no longer have control over the physical infrastructure where they store their data; the average user may not be concerned with where their data are sitting, but universities hold very vital information of thousands of people and processes such as research results and findings that require high levels of confidentiality and privacy (Cegielski, Jones-Farmer, Wu, & Hazen, 2012). Also, Security and privacy are major concerns for cloud adopters because valuable data reside outside the institution's firewalls. Therefore any hacking or other forms of attack on the cloud vendor's infrastructure will affect all clients whose data are stored on the infrastructure. However, the rate of adoption of cloud computing technology is still quite low in developing countries; universities in this part of the world will mostly work with copyright laws of the cloud vendors chosen and that of the location where the vendors' infrastructures are located; therefore, one of the yardsticks of choosing vendors will be based on how favorable the copyright laws are to the universities.

2.9.5. Cloud Computing Adoption Strategies

The capabilities and practices that can help with the adoption of cloud computing in higher education are yet to be identified (Nasir & Niazi, 2011). It should be noted that cloud adoption has an impact on accounting, security, compliance, project management, system support, end-user work, I.C.T. department, I.C.T. management, I.C.T procurement,I.C.T. provisioning and I.C.T. policy (Khajeh-hosseini, Greenwood and Sommerville, 2010). Therefore, institutions should develop a strategy to smoothly move blended learning services to the cloud. We have applied and proposed the five-step strategy of Mircea and Andreescu (2011). The description of each step is explained below.

1. Developing the Knowledge Base about Cloud Computing: The first step is to ensure that everyone involved in a cloud deployment is fully informed about the technology's benefits and risks, policies, and best practices. Knowledge of cloud computing can be gained by attending seminars, and workshops, talking with vendors, and reviewing the latest research in the field.

2. Institutional I.C.T. Assessment: The cloud computing strategy should take into account the needs of the organization and its overall strategy. As a result, the need for assessment, structure, and use of IT service tools varies. This will help the organization understand which data, services, processes, and applications can be moved or need to be retained.

3. Experimenting with Cloud Computing Solutions: The third step is to test the selected cloud computing solutions. This can be done gradually as pilot test projects and extended to all users in the organization.

4. Choosing the Cloud Computing Solution: At this stage, organizations should implement In-depth assessment to compare the capabilities, licensing mechanisms, and pricing models of cloud service providers to make a sustainable choice. The choice will also depend on the cloud deployment options discussed in section 6.

5. Implementation and Management: This step involves migrating IT services and data to the selected cloud solution. Mircea and Andreescu (2011) suggest that data migration should be done while maintaining a balance between data accuracy, migration speed, downtime, and minimal cost.

2.9.6 Requirements for Uptake of Cloud Computing

Dahunsi and Owoseni (2015) argue that active stakeholder engagement and providing basic infrastructure, such as efficient power supply, are fundamental requirements for cloud computing

deployment in Nigeria. These will spur institutions and investors to invest in cloud computing facilities as well as I.C.T. infrastructure such as data centers, thus reducing the cost of accessing cloud services. In addition, promoting the establishment of a more comprehensive and robust network infrastructure will increase the use of broadband services and improve Internet security.

Yusuf and Rehema (2019) argue that enforcing data protection laws and other intellectual property protection measures will help users confidently accept cloud computing services. They say that a robust management system that ensures service providers stay true to their agreements and deliver consistent services with minimal downtime would encourage organizations to adopt cloud computing services. In addition, more research should be focused on improving cloud computing services through research and funding from private institutions. Dahunsi and Owoseni (2015) support this view, arguing that universities should set up cloud computing services to teach their students and meet the needs of institutions that may decide to send their staff to learn cloud computing.

2.10 BRIEF REVIEW OF RELATED PAST LITERATURE

Akin et al. (2014) studied the impact and challenges of cloud computing on public universities in southwestern Nigeria. The study involved 2,000 people, including staff and students from 10 universities, for a total response rate of 87.1%. The results show that privacy and data security issues are the biggest challenges affecting cloud computing adoption. At the same time, cloud computing has been shown to have an impact on profitability and increase the operability of schools in research.

Dahunsi and Owoseni (2015) critically analyzed the challenges and benefits of cloud computing in Nigeria, proposing methods of optimizing the benefits and reducing the challenges. Through a robust literature review, the authors concluded that the electricity and I.C.T. infrastructure of the

country should be well established to support the sustainability of cloud computing in Nigeria. Furthermore, government policies should create a favorable environment for foreign investments in cloud computing and enforce compliance with regulations and data protection laws.

Adeleke et al. (2020) examine how cloud computing technologies can improve university management in Nigeria. The study results also demonstrate that university academic and non-academic workforces will benefit from free or low-cost use of cloud computing. The supporting document validates research on the availability, benefits, and challenges of implementing cloud computing technology for effective university management. According to the observations, SaaS continues to be the most popular cloud service. Similar to how it has revolutionized other industries, the introduction of cloud computing has dramatically changed university management with regard to accessibility, storage, and administration without sacrificing over issues like security and threats.

Mathew et al. (2021) investigated managerial performance enhancement in the context of investments in electronic learning by including context-aware and self-reconfiguration adaptable systems. It also examined manageability difficulties in electronic learning environments. A survey of four higher institutions in southeastern Nigeria justified the adoption of cloud computing technology as the best alternative strategy for organizational data warehousing in the current society automation. The paper's conclusion that using technology in schools is essential to student's academic success made it clear that teachers in the twenty-first century must adapt digitally and technologically and set students up for success in the rapidly developing digital new world.

Although some works identifying the challenges and benefits of cloud computing, such as the brief review above, have been done by different researchers, there is little literature providing a

framework for cloud computing adoption in universities. This work will contribute to this knowledge gap and attempt to create a framework upon which cloud computing services can be built for universities in Nigeria.

CHAPTER THREE

3.0 METHODOLOGY

This study will use qualitative and quantitative methods to determine the level of cloud computing implementation in Nigerian universities and develop a cloud computing adoption framework based on the obtained data. in the first step.

3.1 QUANTITATIVE APPROACH

Data on the current level of adoption as well as factors affecting cloud computing in Nigerian tertiary institutions, will be obtained via google Forms and delivered to students. The data will then be analyzed using IBM SPSS (Descriptive statistics).

3.1.1 Purpose of the Google Form

The purpose of the Google form is to collect data regarding students' views on cloud computing in Nigerian universities. Perspectives include current levels of awareness, acceptance, and perceived challenges. Additionally, google forms aim to answer the following questions:

1. What is the current level of cloud computing adoption in Nigerian universities?

2. Is it time for Nigerian tertiary institutions to fully adopt cloud computing solutions?

3. Should Nigerian University Management come together to develop and manage cloud computing solutions for their respective institutions?

3.1.2 Structure and Design of the Google Form

The form will be structured to obtain data regarding the following;

1. Background information of Respondents

2. Level of awareness.

3. Respondents' perceptions of the factors affecting cloud computing adoption in Nigerian universities. Factors to consider are taken from Dogo et al. (2013), including security and

privacy, infrastructure (electricity and internet connectivity), institutional environment, and regulatory framework.

3.1.3 Google Form Questions

All information provided in this form is treated confidentially and used only for educational purposes.

1. Current Qualification (in View)

NCE () OND () HND () BSc () MSc () Ph.D. ()

2. How often do you use the Computer?

Rarely () Sometimes () Always ()

3. Have you ever used free cloud computing services like google Docs or google drive?

Yes () No ()

4. Which cloud computing service have you worked with?

Messaging () Storage () File sharing and Collaboration ()

5. What is your single most important concern in the use of cloud computing?

Data security () Slow network services () Complicated legal framework () Ease of use ()

6. On a scale of 1 – 5, what is the level of your institution's adoption of cloud computing?

7. In your opinion, why are your institution's use of cloud computing limited or non-existent?

Cost () Lack of Infrastructure () Lack of Technical know-how ()

8. Do you think your institution is ready to collaborate with another organization to develop a cloud computing platform specifically for the education sector in Nigeria?

Yes ()   Maybe ()   No ()

9. On what level should institutions in Nigeria collaborate over the cloud?

Department ()   Faculty ()

3.3 QUALITATIVE APPROACH

Using the information obtained from 3.1 as a guide, appropriate cloud service and deployment models discussed in the literature review will be used to develop a cloud adoption framework in universities in Nigeria.

3.3.1 Proposed model

The proposed model will be based on the framework Alkindi et al. proposed (2014). The framework comprises four layers: Authentication layer, Software as a Service layer, Infrastructure as a Service layer, and Platform as a Service layer. The framework will be remodeled to suit the needs of the Nigerian education system using the data obtained from the questionnaire as a guide. The basic requirement of the proposed framework is to allow Collaboration between higher institutions and grant computing power to institutions lacking the capacity.

CHAPTER FOUR

4.0 DATA PRESENTATION AND ANALYSIS

4.1 INTRODUCTION

This chapter is intended to analyze and present the data collected for this study; it is organized into other research questions.

4.2 RESPONSE RATE

One hundred google forms were submitted to respondents, and 80 (80%) complete answers were received.

4.3 DATA ANALYSIS

4.3.1 Current Qualification (In view)

Table 4.1

Item	Frequency	Percentage
NCE	00	00.0%
OND	00	00.0%
HND	00	00.0%
BSc	80	100%
MSc	00	00.0%
PhD	00	00.0%
TOTAL	80	100%

Source: Field Survey, 2022

Table 4.1 presents the results on the education level of the respondents. The table implies that all respondents currently enrolled are university students.

4.3.2 Computer Usage

The chart below depicts the results on the computer usage of respondents. The result implies that 73.0% of respondents always use computers, 16% attested that they sometimes use computers,

and 11% rarely use computers. As such, the researcher concludes that many undergraduate students of the institution use computers.
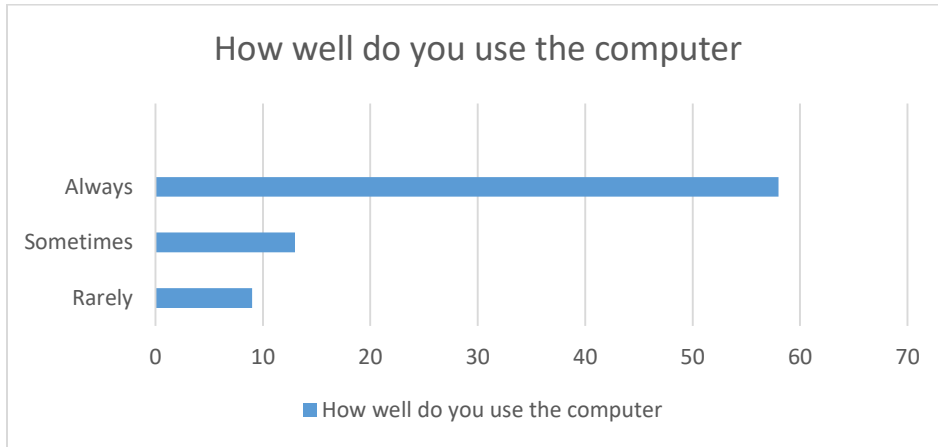

Figure 4.1 Respondents' level of computer usage

4.3.3 Use of Cloud Computing Services
Table 4.2

Item	Frequency	Percentage
Yes	80	100%
No	00	00.0%
TOTAL	80	100%

Source: Field Survey, 2022

Table 4.2 presents the results of respondents' use of cloud computing services. The results imply that all respondents use cloud computing services. Thus, the researcher concludes that the respondents have the right to access and use cloud computing services such as google docs, google drive, etc.

4.3.4 Cloud Computing Services Used

The result implies that 97.5% of respondents have worked with cloud computing messaging services, 66.3% have worked with cloud computing storage services, and all respondents attested to having worked with cloud computing file sharing and collaboration services.
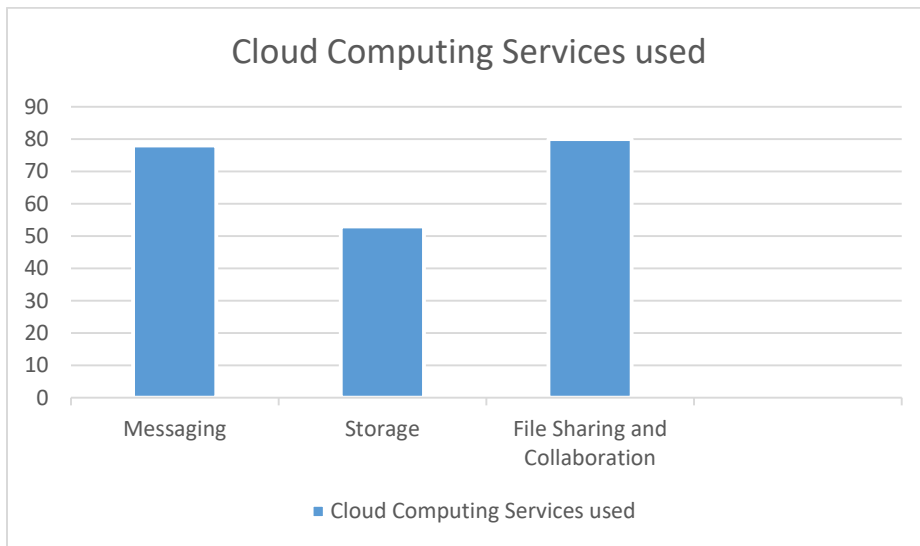

Figure 4.2 Cloud computing services used.

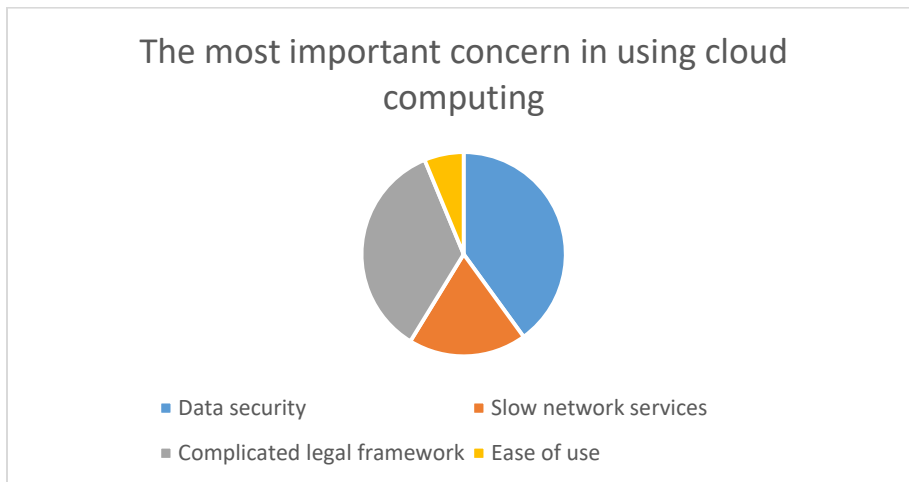**4.3.5 The most important concern in using cloud computing**

Figure 4.3 Respondents' most important concern in using cloud computing.

Figure 4.3 presents results on the most important concern in using cloud computing. The table implies that 40% of respondents are more concerned about the data security aspect of cloud computing, and 35% are understandably more concerned about cloud computing's complicated legal framework, which may be attributed to a low level of knowledge of legal proceedings and unnecessarily lengthy terms of use documents used by cloud computing service providers.19% are more concerned about the slow network services associated with cloud computing while 6% are concerned about Ease of use.

4.3.6 Level of Institution's Adoption of Cloud Computing

Table 4.3

Scale	Frequency	Percentage
1	11	13.8%
2	38	47.5%
3	22	27.5%
4	07	08.7%
5	02	02.5
TOTAL	80	100%

Source: Field Survey, 2022

Table 4.3 above presents the results of the institution's level of cloud adoption. Respondents were asked to rate their organization's adoption of cloud computing on a scale of 1 to 5 (5 being the highest acceptance and one being the lowest). The results imply that the respondents believe their institution uses cloud computing poorly.

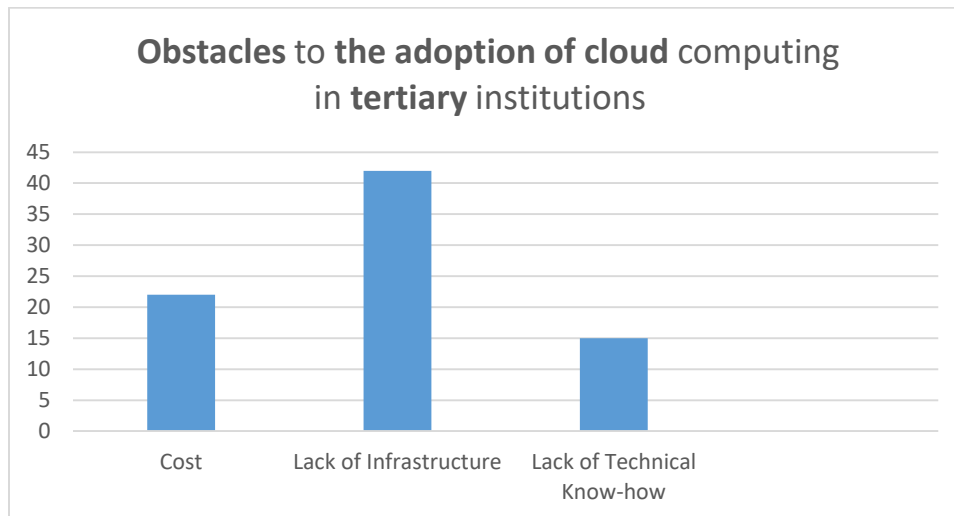**4.3.7 Institutions Limited or Non-Existent Use of Cloud Computing**

Figure 4.4 Reasons for limited use of Cloud computing

The figure above presents results on institutions' limited or non-existent use of cloud computing. The result implies that most respondents believe that the limited or non-existent use of cloud computing results from a lack of infrastructure, and 27.5% believe that it is a result of cost. In comparison, 18.7% believe that the limited or non-existent use of cloud computing results from a lack of technical know-how.

4.3.8 Institution's Willingness to Collaborate with Other Establishments to Develop Cloud Computing in Nigeria

Table 4.4

Item	Frequency	Percentage
Yes	64	80.0%
Maybe	13	16.2%
No	03	03.8%
TOTAL	80	100%

Source: Field Survey, 2022

Table 4.4 presents the result of the institution's willingness to collaborate with another establishment to develop cloud computing in Nigeria. The table implies that 80% of respondents believe that their institution is willing to collaborate, 3.8% believe that their institution is not, and 16.2% are not completely sure of their institution's intent.

4.3.9 Institution level of collaboration over cloud
Table 4.5

Item	Frequency	Percentage
Department	22	27.5%
Faculty	58	72.5%
TOTAL	80	100%

Source: Field Survey, 2022

Table 4.5 presents a measure of Respondents' attitude to the institutional level of Collaboration over the cloud. The result implies that 72.5% of respondents believe a collaboration at the faculty level will be most beneficial, while 27.5% prefer Collaboration at the departmental level. This form of Collaboration will allow intra-faculty or intra-departmental Collaboration between schools of different institutions.

4.4 ADOPTED MODEL FOR ADOPTION OF CLOUD COMPUTING
Alkindi et al. (2014) proposed a hybrid cloud computing architecture for higher education institutions in Oman that includes public and private clouds. Figure 4.1 presents the proposed architecture. Based on this architecture, the framework of Figure 4.2 was developed. It includes the public university cloud-built only as software as a service, the private university cloud as infrastructure as a service, and the hybrid cloud of the public university, private and public universities as a platform as a service.

In the adopted model, institutions of learning with storage and computing capacities will donate their resources to be used as a data center, while those without will pay a subscription fee for the maintenance of the system. All free student resources and collaborative student projects will be hosted on the public cloud, allowing student interaction and Collaboration. The private cloud will host student records, payment history, class resources, and any other details an institution might want to keep private. The intersection of the public and private cloud will host academic research either privately or publicly, depending on the institution's publication choice. It is a platform that will allow personnel from academia to collaborate on different projects and research works while serving in different institutions.
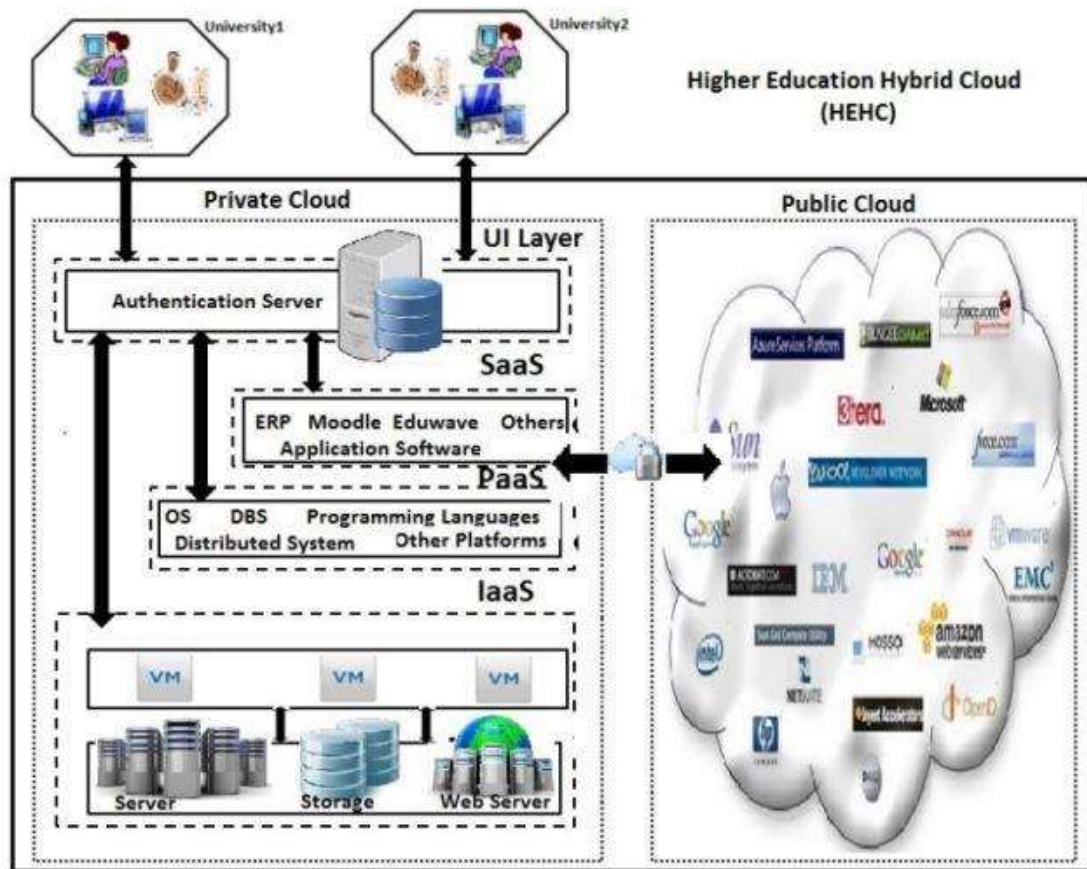

Fig 4.5: Adopted Architecture for Higher Education Cloud Computing (Alkindi et al., 2014)

The advantages of the adopted model include the following;

- Less expensive for institutions without the capacity since they can choose what to subscribe to within the framework, thus eliminating the need to spend huge amounts on computing power.

- Institutions retain control over what they want online and where they want it (public or private), thereby improving Security.

- Enhances Collaboration between staff and students of different institutions.

- It improves students' learning experience as they gain the freedom to interact and collaborate with students from other schools, exposing them to more ideas and dynamic academic discourse.
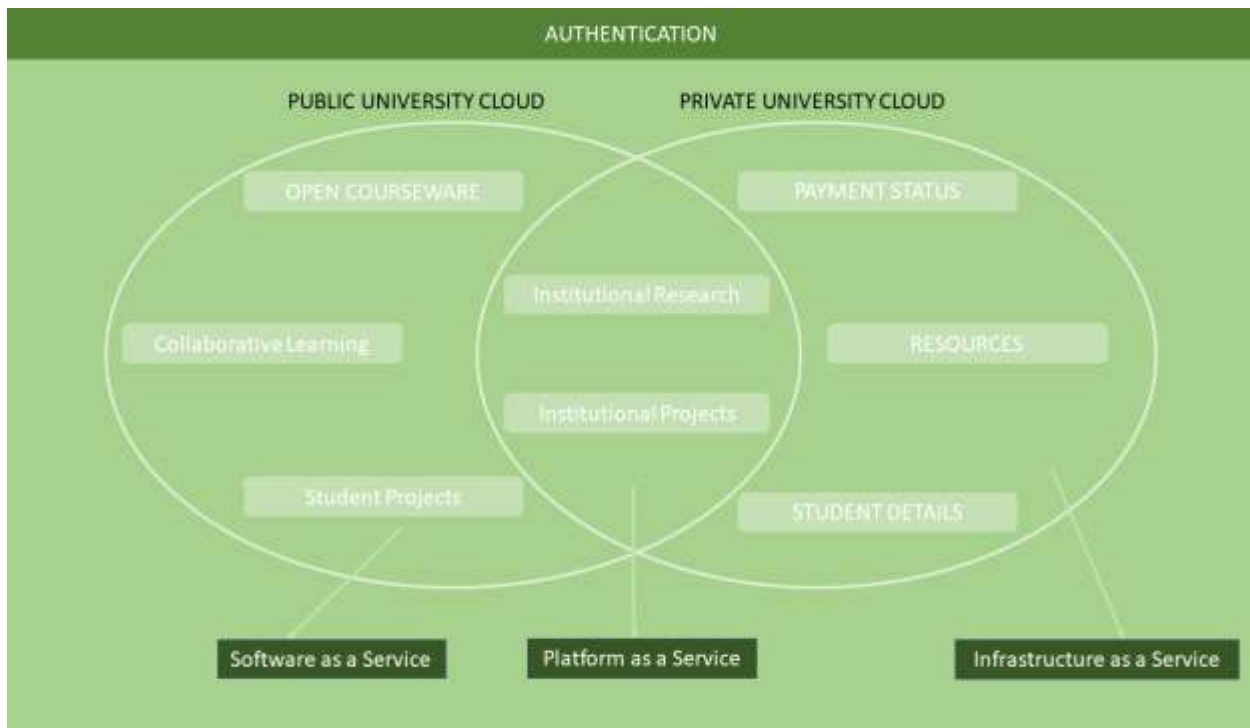

Fig 4.6: Adopted Model for Cloud Computing in Nigerian Tertiary Education

CHAPTER FIVE

5.0 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

This chapter summarizes what the research entails, draws conclusions from the data collected, and makes recommendations based on the research findings. This chapter is handled under the following sub-headings: Summary of main findings, conclusions, recommendations, and suggestions for further research.

5.2 SUMMARY OF MAJOR FINDINGS

A summary of the results of this study is presented below about the study's objectives.

1. There are significant concerns about the data of cloud computing, the complex regulatory framework and the ease of use.

2. Cloud adoption is low due to cost, lack of infrastructure, and lack of technical know-how.

3. Student perception of organizations willing to partner with other organizations to develop cloud computing at faculty and departmental levels is positive.

5.3 CONCLUSION

In line with the finding of this study, the researcher concludes that cloud computing adoption has positive prospects in Nigerian universities, and universities are willing to collaborate and promote its propagation. Therefore, a model was proposed for the adoption, putting the students who will be the major users of cloud computing as well as institutions who will bear the cost into consideration.

5.4 RECOMMENDATIONS

The following recommendations were made based on the study results and subsequent discussion.

- The study beams its light on students in tertiary institutions in Nigeria. A more robust study that will involve educators, administrators and I.C.T. staff should be conducted to ascertain the results of this research.

- The proposed model assumes that at least 40% of schools in Nigeria have computing resources. This assumption should be assessed and, if possible, evaluated to know the number of computing resources available and the capabilities it grants institutions.

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APPENDIX

Item	Frequency	Percentage
Rarely	09	11.0%
Sometimes	13	16.0%
Always	58	73.0%
TOTAL	80	100%

Table A: Respondent usage of Computer

Item	Frequency	Percentage
Messaging	78	97.5%
Storage	53	66.3%
File sharing and collaboration	80	100%

Table B: Respondents' usage of cloud computing

Item	Frequency	Percentage
Data security	32	18.7%
Slow network services	05	06.3%
Complicated legal framework	28	35.0%
Ease of use	15	40.0%
TOTAL	80	100%

Table C: Respondent's most important concerns on cloud computing usage

Item	Frequency	Percentage
Cost	22	27.5%
Lack of infrastructure	42	18.7%
Lack of technical know-how	15	53.8%
TOTAL	80	100%

Table D: Respondent's perception of hurdles limiting the adoption of cloud computing in Tertiary institutions.