Cost Benefits of Cloud vs. In-house IT for Higher Education

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Abstract

Cloud Computing is an excellent alternative for Higher Education in a resource limited setting. Universities should take advantage of available cloud-based application offered by service providers and enable their own user/student to perform business and academic tasks. In this paper, we will compare the cost between on-premise options and Cloud Computing. Two cost estimates will be created, the firstfor building and setting up IT infrastructure in-house in Federal University of Technology (FUTO), Nigeria while the second cost estimate will be for setting up IT in the cloud for the same Institution.This will enable us know the cost benefit cloud has over on-premise in setting up IT in Higher Educations.

Keywords: Cloud Computing, Higher Education, Cost Estimate, Virtualization, Cost Benefits.

1. INTRODUCTION

Institutions of higher education, in Nigeria and globally, are in the midst of historic times. Endowments at private and public institutions of higher education typically relied on as a source relief during financially troubled times, have experienced losses not seen since the Great Depression [1]. To backfill the deficit and in the climate of unprecedented budget cuts, institutions of higher education are invoking mass layoffs, steep tuition hikes, department closures, mandatory furloughs, and early retirements; even the threat of closures of universities and college systems looms, as evidenced by events in July 2011 that threatened to shutter the entire University System [2].

To address this financial shortfall during this economic downtown in higher education have resorted to a variety of cost-cutting measures, including significant cuts to information technology (IT) budgets. For example, for the 2009-2010 academic year, 50 % of IT leaders at universities and colleges in the U.S reported decreased funding in their IT budgets over the previous year. To compound the problem, the purchasing power of these IT dollars has decreased; IT costs have increased at a faster rate than the rate of inflation [3].

IT areas are perceived as significant cost centers, and for many administrators, despite the institution's reliance on technology in every aspect of its operation, it is difficult to accurately calculate the return-on-investment (ROI) from the cost of information technology; similarly, it is challenging to attribute to bigger cuts in the IT budget than many other areas on campus. The Campus Computing Project, which annually surveys IT leaders at institutions of higher education regarding critical issues in IT, reported that 42 % of colleges and universities experienced a budget cut in their IT centralized services for the 2010-2011 academic year. (As indicated earlier,

50 % has already taken cuts to their IT budgets the previous year.) Yet, in sharp contrast to this decrease in availability funding for IT services and support, the demand and expectations for IT services and resources on college and university campuses, staff and faculty are at an all-time high [4]. These increasing expectations have been ushered in largely by the growth of a new breed of incoming students. Cloud computing is revolutionizing the way Higher Education are implementing their information systems. Cloud computing has elevated IT to newer limits by offering the market environment data storage and capacity with flexible scalable computing processing power to match elastic demand and supply, whilst reducing capital expenditure [5]. As a result, Cloud adaptation is spreading rapidly and represents a new opportunity that Universities and Collages should not ignore given its profound impact.While there is no arguing about the staying power of the cloud model and the benefits it can bring to any organization, mainstream adaptation depends on several key variables falling into alignment that will provide users the reliability, desired outcomes, and levels of trust necessary to truly usher in a “cloud revolution.” Until recently, early adopters of cloud computing in the public and private sectors were the catalyst for helping derive technological innovation and increased adaptation of cloud-based strategies, moving us closer to this inevitable reality. Today, driven in large part by the financial crisis gripping the global economy, more and more organizations are turning towards cloud computing as a low-cost means of delivering quick-time-to-market solutions for mission-critical operations and services [6].

2. DEFINING CLOUD COMPUTING

Cloud computing, is Internet-based computing, whereby shared resources, software, and information are provided to computers and other devices on demand, like the electricity grid [7]. It essentially means that applications are actually accomplished through the use of many computers that exist online, rather than on your local computer or web server. The name cloud computing was inspired by the cloud symbol that is often used to represent the Internet in flowcharts and diagrams [8].

Cloud Computing is a new paradigm in Information Technology (IT). There are several definitions of the Cloud, ranging from very broad as almost everything on the Internet to the very narrow only concerning Virtualization on servers only [9].

The basic idea is that anything that traditionally is possible in computing can be shifted to the cloud; Communication, scientific computing, word processing etc. In their research Vaquero and other researchers, proposed the following definition:

Clouds are a large pool of easily usable and accessible virtualized resources (such as hardware, development platforms and/or services). These resources can be dynamically reconfigured to adjust to a variable load (scale), allowing also for an optimum resource utilization [10].

A closer look at the above definition provides us with the concept of virtualization of resource. Looking at the word cloud, and already existing definitions the researcher propose the following definition: A cloud is first a platform born from the internetworking concept. It provides easily usable resources to its subscribers on a pay as you use basis or on a user agreement level in a situation where organizations come together to put up the cloud platform for their joint benefit. A cloud as the name imply can span over small to large geographical areas and even the entire globe as being seen today. Thus in summary a cloud is backbone that trunks resources to its users on an agreement level, as to usability and accessibility of available resources.

Today is the age of information technology. And according to kambil in the journal of business strategy, the facets of work and personal life are moving towards the concept of availability of everything online and understanding this trend, the big and giant web based companies like Google, Amazon, Salesforce.com came with a model named “Cloud Computing” the sharing of web infrastructure to deal with the internet data storage, scalability and computation [11]. A closer look at the concept of cloud computing brings us to a point of ease and availability of resources

without the need of necessary software platform or compilers to go about application development.

Current technological progress, particularly, in the past few decades, has demonstrated the need for performing more and more complex computations. To meet this requirement, large and complicated distributed systems have become essential. In Conventional IT environments, clients connect to multiple servers located on company premises. Clients need to connect to each of the servers separately. In Cloud Computing clients connect to the Cloud platform. The Cloud contains all of the applications and infrastructure and appears as a single entity to the user. Cloud Computing allows more efficient use of the resources by dynamically configuring resources to cater for changes in the demand for load.

2.1 The Cloud Vs the Internet

The term 'cloud' is analogical to 'internet. Cloud computing is an internet based computing technology where virtual servers provide infrastructure, platform, software, devices and other resources and hosting to customers on a pay-as-you-use basis [12]. Cloud computing customers do not own the physical infrastructure rather they rent the usage form a third-party cloud provider who owns the infrastructure.

The researcher sees the cloud as a concept that is similar to the internet in operation but not same as the internet in principle and usage. The cloud platform runs on the internet platform in that the distributed servers that host application are connected to the internet. In operation, the cloud makes use of its distributed database servers for application utilization and access using the internet as a route.

Basically, the internet is made up of servers located as various points in the globe. This servers range in their capabilities and availability and has some level of limitations compared to a cloud distributed server nature. Taking a bearing from the popular www.facebook.com platform that runs on the cloud and a typical webpage of a government agency in the Nigerian environment; the facebook platform has the ability to grant access at the same time to millions of users while the government agency website may not have such capability. This difference is as a result of the fact that the cloud is a more robust platform for interconnection as is runs on a distributed server concept whereas the website runs on a single server system and might not be able stand millions of hits at the same time from users.

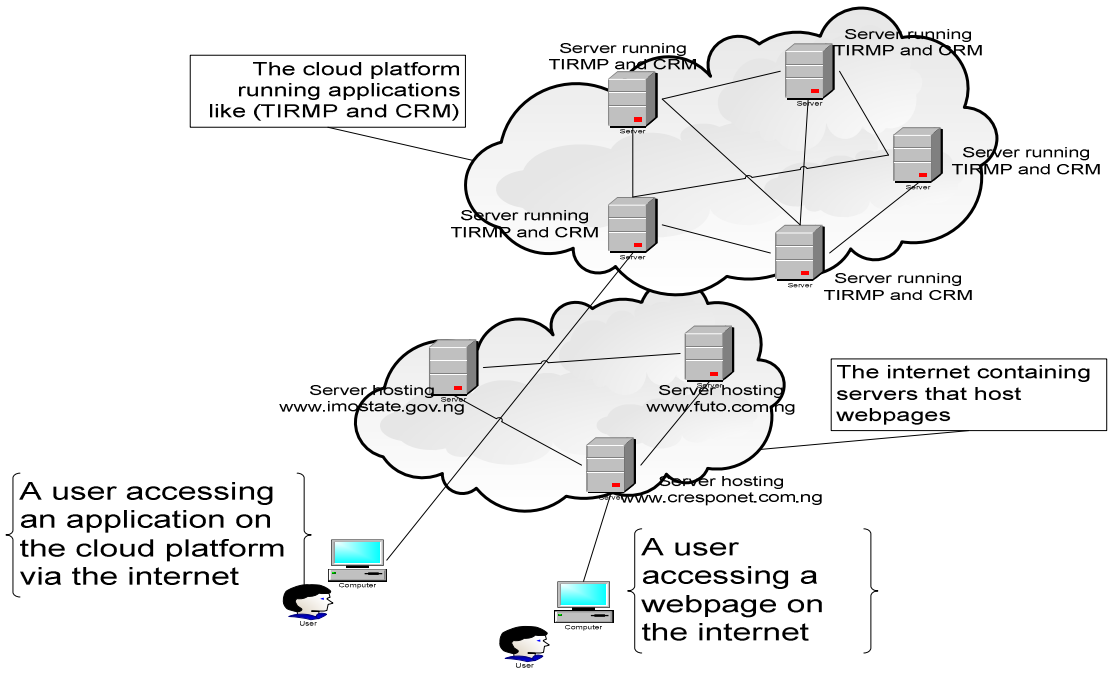

FIGURE 1: The Internet and the Cloud Platform [14].

2.2 Cloud Architecture

Cloud computing architecture consist of two components “the front end” and “the back end”. The front end of the cloud computing system comprises the client’s device (or it may be a computer network) and some applications are needed for accessing the cloud computing system. The back end refers to the cloud itself which may encompass various computer machines, data storage systems and servers. A group of these clouds make a whole cloud computing system. The whole system is administered via a central server that is also used for monitoring clients demand and traffic, ensuring the smooth functioning of the system. A special type of software called “middleware” is used to allow computers that are connected on the network to communicate with each other. Cloud computing systems also must have a copy of all its clients’ data to restore the service which may arise due to a device breakdown; making a copy of data is called redundancy [11].

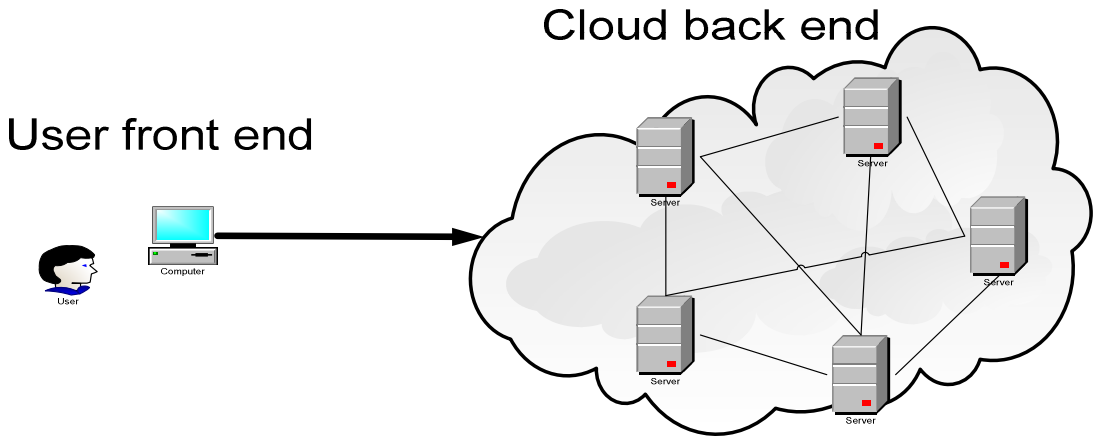

FIGURE 2: Diagram Illustrating the Cloud Architecture [14].

2.3 Cloud Deployment Models

Deploying cloud computing can differ depending on requirements, the following four deployment models proposed by the Dialogic Corporation have been identified, each with specific characteristics that support the needs of the services and users of the clouds in a particular ways. These models include Private cloud, Community cloud, Public cloud, and Hybrid cloud [13].

2.3.1 Private Cloud

The cloud infrastructure has been deployed, and is maintained and operated for a specific organization. The operation may be in-house or with a third party on the premises. The private cloud is also referred to as internal cloud or on-premise cloud, a private cloud intentionally limits access to its resources to service consumers that belong to the same organization that owns the cloud. In other words, the infrastructure is managed and operated for one organization only, primarily to maintain a consistent level of control over security, privacy and governance. Essential characteristics of a private cloud typically include:

- Heterogeneous infrastructure
- Customized and tailored policies
- Dedicated resources
- In-house infrastructure (capital expenditure cost model)
- End-to-end control.

2.3.2 Community Cloud

The cloud infrastructure is shared among a number of organizations with similar interests and requirements. In this case, organizations come together to setup a cloud for their common interest. Each organization has access to the platform based on their contributions to the overall setup of the cloud system. This may help limit the capital expenditure costs for its establishment as the costs are shared among the organizations. The operation may be in-house or with a third party on the premises. This deployment model typically refers to special-purpose cloud computing environments shared and managed by a number of related organizations participating in a common domain or vertical market.

2.3.3 Public Cloud

The cloud infrastructure is available to the public on a commercial basis by a cloud service provider or in some cases the government. This enables a consumer to develop and deploy a service in the cloud with very little financial outlay compared to the capital expenditure requirements normally associated with other deployment options. It is also known as external cloud or multi-tenant cloud, this model essentially represents a cloud environment that is openly accessible. It generally provides an IT infrastructure in a third-party physical data center that can be utilized to deliver services without having to be concerned with the underlying technical complexities.

Essential characteristics of a public cloud typically include:

- Homogeneous infrastructure
- Common policies
- Shared resources and multi-tenant
- Leased or rented infrastructure; operational expenditure cost model

- Economies of scale

Note that public clouds can host individual services or collections of services, allow for the deployment of service compositions and even entire service inventories.

2.3.4 Hybrid Cloud

The cloud infrastructure consists of a number of clouds of any type, but the clouds have the ability through their interfaces to allow data and/or applications to be moved from one cloud to another. This can be a combination of private and public clouds that support the requirement to retain some data in an organization, and also the need to offer services in the cloud.

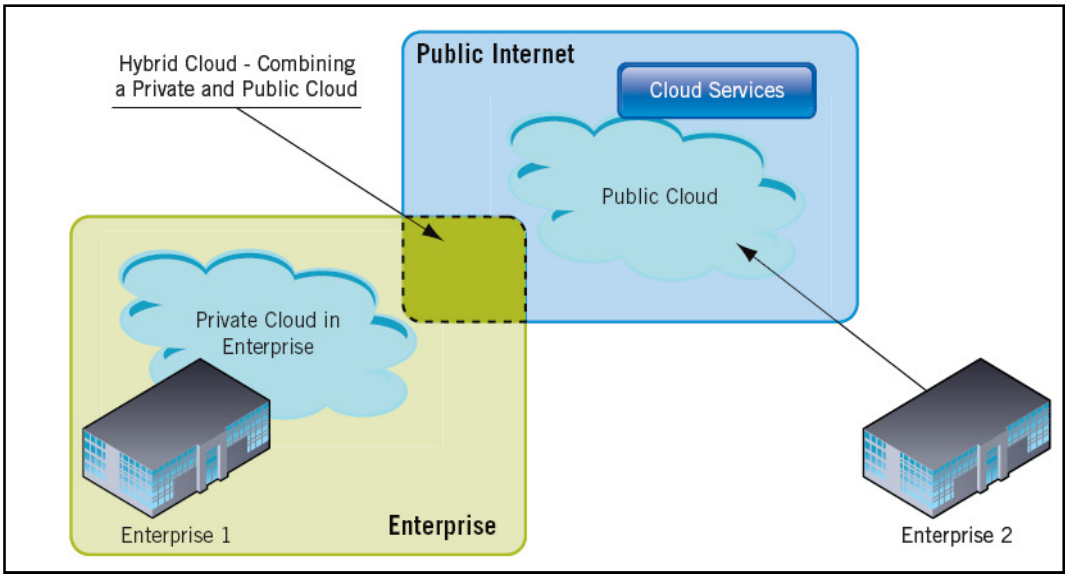

FIGURE 3: Public, Private, and Hybrid Cloud Deployment.

2.4 Cloud Services

Cloud computing services are broadly divided into three categories: Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS) and Software-as-a-Service (SaaS).

A cloud service has three distinct characteristics that differentiate it from traditional hosting. It is sold on demand, typically by the minute or the hour; it is elastic, meaning that a user can have as much or as little of a service as they want at any given time; and service is fully managed by the provider (the consumer needs nothing but a personal computer and internet access). Significant innovations in virtualization and distributed computing, as well as improved access to high-speed Internet and a weak economy, have accelerated interest in cloud computing.

A cloud can be private or public. A public cloud sells services to anyone on the Internet. Currently, Amazone Web Services is one of the largest public cloud providers.) A private cloud is a proprietary network or a data center that supplies hosted services to a limited number of people. When a service provider uses public cloud resources to create their private cloud, the result is called a virtual private cloud. Private or public, the goal of cloud computing is to provide easy, scalable access to computing resources and IT services.

2.4.1 Infrastructure as a Service

Infrastructure-as-a-Service like Amazon Web Services provide virtual server instance API to start, stop, access and configure their virtual servers and storage. In the enterprise, cloud computing allows a company to pay for only as much capacity as is needed, and bring more online as soon

as required. Because this pay-for-what-you-use model resembles the way electricity, fuel and water are consumed; it's sometimes referred to as utility computing.

2.4.2 Platform as a Service

Platform-as-a-Service in the cloud is defined as a set of software and product development tools hosted on the provider's infrastructure. Developers create applications on the provider's platform over the internet. PaaS provides many use API's, website portals or gateway software installed on the customer's computer. Force.com, (an outgrowth of Salesforce.com) and GoogleApps are examples of PaaS. Developers need to know that currently, there are not standards for interoperability or data portability in the cloud. Some providers will not allow software created by their customers to be moved off the provider's platform.

2.4.3 Software as a Service

In the Software-as-a-Service cloud model, the vendor supplies the hardware infrastructure, the software products and interacts with the user through a front-end portal. SaaS is a very broad market. Services can be anything from Web-based email to inventory control and database processing. Because the service provider hosts both the application and the data, the end user is free to use the service from anywhere.

3. COST ESTIMATE: CLOUD VS IN-HOUSE

We will be comparing the initial cost of building and setting up IT in-house and that of cloud in a resource limited setting.

3.1 The Work Breakdown Structure (WBS) forIn-House IT

The list below shows aWork Breakdown Structure (WBS) for building and setting up in-house IT in Federal University of Owerri, (FUTO) Nigeria:

- Project Management
  - Project Manager
  - Project Team Members
- Staffing
  - Database Administrators
  - Network Administrators
- Hardware
  - Laptops
  - Servers
  - Cisco Routers
  - Air Conditioners
  - Back-Ups
- Software
  - Licensed Software
  - Software Development
- Service Providers
  - Installations
  - 1GBps Dedicated ASDN – Broadband Internet Subscription
- Hosting
- Testing
- Training and Support
- Reserves

3.2 Sample Cost Estimate for In-HouseIT

This is the cost estimate for building and setting up in-house IT in FUTO.

3.2.1 *Project Management:*

The budget experts for this project suggested using a labor rate of:

i. 8 hours per day and 25 days/month giving a total working average of 200 hours (8 x 25)
ii. 800 per hour for the project manager
iii. 300 per hour for each team member
iv. Based on the working average of 200 hours per month. The total hours for the project manager per annum under this category are 2400 (200 x 12).
v. Costs are also included for the twenty project team members working an average of 200 hours per month each. The total hours for a team of twenty members per annum will be 48000 (20 x 200 x 12).

3.2.2 Staffing:

i. □400 per hour for each Database Administrator (DBA)
ii. □350 per hour for each Network Administrator
iii. Average working hour for each DBA is 200 hours per month. The total hours for 5 DBAs for nine months will give 9000 (5 x 200 x 9)

3.2.3 Hardware:

i. *Laptops:* Twenty (21) laptops estimated at □150000 per unit. One for each team members and the project manager.
ii. *Servers:* Ten (10) Servers estimated at □250000 per unit, two for each faculty and we have a total of five faculties in FUTO. Each faculty will have one front end server and one back end server.
iii. *Cisco Router:* Two (2) routers estimated at □300000 per unit. These routers will be enough to serve the entire institution.
iv. *Air Conditions:* A total of fifteen (15) Air Conditions will be required. It will be shared three per faculty and estimated at □120000 per unit.
v. *Back-Ups:* Five (5) Back-Ups will be built and setup for each faculty which is estimated at □300000 per unit.

3.2.4 Software:

i. *Licensed Software:* Licensed cost of the Oracle software Edition for the backend server include:
□200000 Oracle Standard Edition.
□1 000000 Oracle Enterprise Edition.
Since the Student Course Registration and Result Assessment Application is going to be deployed for the whole Schools in FUTO and there is also a strong probability that future applications such as accounting software's, information systems and more will be to deployed in FUTO, Oracle Enterprise Edition will be the recommended software to purchase. Selected choice of cost □1000000.
ii. *Software Development:* Based on rough estimate the cost of software development will not be more than □5000000.

3.2.5 Service Providers:

i. *Installations:* MTN will provide the Dedicated ADSL connection with an installation fee that will be based on survey but based on similar projects will be estimated to be □1000000 for fiber optics installation.
ii. *1GBps Dedicated ASDN - Broadband Internet Subscription:* The cost for 1Gbps is estimated at □818/hour. Total number of hours for 9 months will be 7344 hours (306 days x 24 hours)

3.2.6 Hosting:

The estimate for hosting based on similar projects will cost □100000

3.2.7 Testing:

Based on similar projects, testing will be estimated as 10 percent of the total hardware and software cost.

3.2.8 Training and Support

Based on similar projects, testing will be estimated on per-trainee bases, plus transportation cost. The cost per trainee will be □500/hour, and transportation will be □100/day/person for the instructors and project team members. Training is meant to be conducted twice in a week for 2 hours/day. It is estimated that there will be a total of 40 training days. Total training counts for twenty members will be 800 (40 x 20). Total training hours will be 1600 (2 x 800)

3.2.9 Reserves:

As directed, reserves will be estimated at 10 percent of the total estimate.

	# Units/Hrs	Cost/Unit/Hrs	Sub Totals	WBS Level 1 Totals	% of Total
WBS ITEMS					
PROJECT MANAGEMENT				16320000	28.91
Project Manager	2400	800	1920000		
Project Team Member	48000	300	14400000		
STAFFING				9900000	17.54
Database Administrators	9000	400	3600000		
Network Administrators	18000	350	6300000		
HARDWARE				9550000	16.92
Laptops	21	150000	3150000		
Servers	10	250000	2500000		
Cisco Routers	2	300000	600000		
Air Conditions	15	120000	1800000		
Back-Ups	5	300000	1500000		
SOFTWARE				6000000	10.63
Licensed Software			1000000		
Software Development **			5000000		
SERVICE PROVIDERS				7007392	12.41
Installations			1000000		
1Gps Dedicated ASDN Broad-band Internet Subscription	7344	818	6007392		
HOSTING				100000	0.18
TESTING (10% of the total hardware and software cost)				1555000	2.75
TRAINING AND SUPPORT				880000	1.56
Training cost	1600	500	800000		
Transportation cost	20	4000	80000		
RESERVES (10% of total estimate)				5131239	9.09
TOTAL COST OF PROJECT				56443631	100

TABLE 1: This Table shows the Sample Cost Estimate for setting up In-House IT in FUTO.

3.3 The Work Breakdown Structure (WBS) Cloud IT In

The Work Breakdown Structure (WBS) is shown below:

- Project Management
  - Project Manager
  - Project Team Members
- Staffing
  - Database Administrators
  - Hardware
  - Laptops
- Software
  - Software Development
- Service Providers
  - Installations
  - 1GBps Dedicated ASDN - Broadband Internet Subscription
- Testing
- Training and Support
- Reserves

3.4 Sample Cost Estimate for Cloud IT

This is the cost estimate for building and setting up IT in the cloud.

3.4.1 Project Management:

The budget experts for this project suggested using a labor rate of:

i. An average worker works 8 hours/day and 25 days/month giving a total of 200 hours (8 x 25)
ii. □800/hour for the project manager
iii. □300/hour for each team member
iv. Based on the working an average of 200 hours per month. The total hours for the project manager per annum under this category are 2400 (200 x 12).
v. Costs are also included for the five project team members working an average of 200 hours per month each. The total hours for a team of twenty members per annum are 12000 (5 x 200 x 12).

Note: Building applications using cloud computing technology is faster and makes collaboration and team work easer and transparent hence, fewer number of team members can be used to achieve more than would have with in-house development.

3.4.2 Staffing:

i. □400/hour for each Database Administrator (DBA)
ii. Average working hour for each DBA is 200 hours per month. The total hours for 5 DBAs per annum will give 12000 (5 x 200 x 12)

Note**:** Network Administrators will not be required because there are no servers to be managed when using a cloud platform to manage IT recourses.

3.4.3 Hardware:

Laptops: Twenty (6) laptops estimated at □150000 per unit. One for each team members and the project manager.

3.4.4 Software:

Software Development: Development in the cloud is faster and cheaper because there are fewer line codes of codes to write hence, based on rough estimate the cost of software development will not be more than □2000000.

3.4.5 Service Providers:

i. Installations: MTN will provide the Dedicated ADSL connection with an installation fee that will be based on survey but based on similar projects will be estimated to be □1000000 for fiber optics installation.

ii. 1GBps Dedicated ASDN - Broadband Internet Subscription: The cost for 1Gbps is estimated at □818/hour. Total number of hours for 9 months will be 7344 hours (306 days x 24 hours)

3.4.6 Testing:

Based on similar projects, testing will be estimated as 10 percent of the total hardware and software cost.

3.4.7 Training and Support

The Cloud Platform we will be using provide a lot of hands on video tutorials hence fewer trainers will be required which reduced from 20 to 5 one for each faculty.

Based on similar projects, testing will be estimated on per-trainee bases, plus transportation cost. The cost per trainee will be □500/hour, and transportation will be □100/day/person for the instructors and project team members. Training is meant to be conducted twice in a week for 2 hours/day. It is estimated that there will be a total of 40 training days. Total training counts for twenty members will be 200 (40 x 5). Total training hours will be 400 (2 x 800).

3.4.8 Reserves:

As directed, reserves will be estimated at 5 percent of the total estimate due to lesser risk involved in cloud computing technology.

	# Units/Hrs	Cost/Units/Hrs	Sub Totals	WBS Level 1 Totals	% of Total
WBS ITEMS					
PROJECT MANAGEMENT				5520000	24.01
Project Manager	2400	800	1920000		
Project Team Member	12000	300	3600000		
STAFFING				4800000	20.88
Database Administrators	12000	400	4800000		
HARDWARE				900000	3.92
Laptops	6	150000	900000		
SOFTWARE				2000000	8.70
Software Development **			2000000		
SERVICE PROVIDERS				8165680	35.52
Installation			1000000		
1 Gps Dedicated Internet Subscription	8760	818	7165680		
TESTING (10% of the total hardware and software cost)				290000	1.26
TRAINING AND SUPPORT				220000	0.96
Training cost	400	500	200000		
Transportation cost	5	4000	20000		
RESERVES (5% of total estimate)				1094784	4.76
TOTAL COST OF PROJECT				22990464	100

TABLE 2: This Table shows the Sample Cost Estimate for Setting up Cloud-Based IT in FUTO.

4. RESULT

Table 3 states the cost estimate for the various items in the work breakdown structure used to deploy IT on-premise and in the Cloud for FUTO.

WBS ITEMS	ON-PREMISE	CLOUD
Project Management	16320000	5520000
Staffing	9900000	4800000
Hardware	9550000	900000
Software	6000000	2000000
Service providers	7007392	8165680
Hosting	100000	0
Testing	1555000	290000
Training	880000	220000

TABLE 3: EstimatedCost ofIT infrastructure between On-Premise and Cloud.

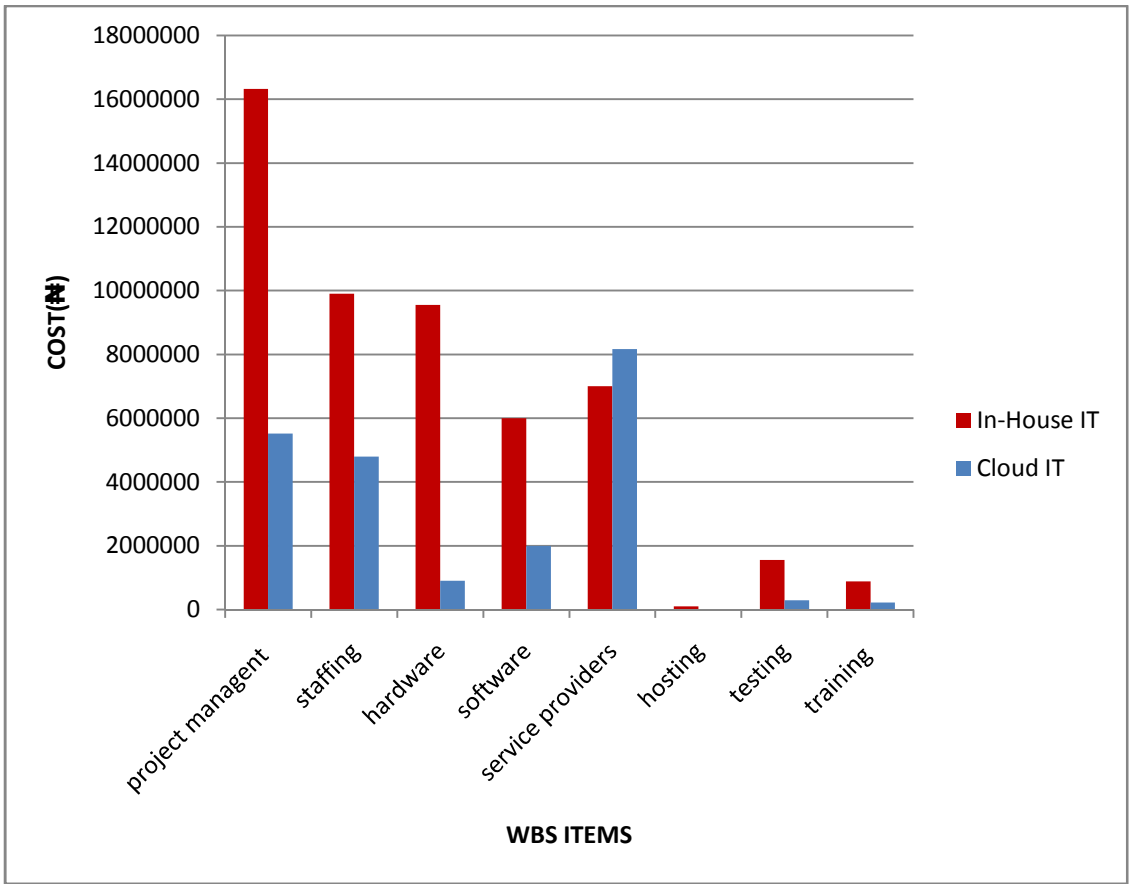

FIGURE 4: Cost versus WBS Items.

The chart in Figure 4 compares the difference between Cost involved in deploying IT On-Premise and that of cloud. However, we can see that the cost of each of the WBS Items required for the Cloud is lesser than that of On-Premise except that of the Service Providers; this is because to enjoy the benefits of the cloud a dedicated network is required to provide constant internet access. Project Management Team, Staffing and Hardware cost is drastically reduced with cloud technology because both the acquisition and maintenance of the IT Infrastructure is handled by the cloud providers. Software development and deployment is done rapidly in the Cloud such that one does not have to start from the scratch. Hence developers can come up with a fully functional application in a very short time also one does not have to pay for SoftwareLicenses making the costing for software development cheaper in the cloud. The cloud does not require any extracost for hosting because the PaaS provides a platform to customize and build applications on the fly all you need to do is just to pay the monthly subscription fee which was included as part of the software cost.Testing applications in the cloud is also less expensive because an organization does not need to purchase separate dedicated servers for testing their applications. Cloud Providers provide on line support, webinars, video tutorials and materials hence fewer trainers is required reducing the training cost drastically.

4.1. Percentage Difference

Comparing the percentage difference of Cloud vs. In-house, the total cost of In-house project in TABLE1 is □56443631 while the total cost of Cloud-based project in TABLE2 is □22990464.
[(56443631 – 22990464) / 56443631] x 100 = 59%.This result shows that Cloud Computing has a way of greatly reducing Capital Expenditure Cost.

5. CONCLUSION

Building and setting up IT infrastructure for an Institution in Nigeria using cloud-based service reduces IT cost by 50 - 60%, while lowering the employee learning curve and minimizing equipment investments.One of the primary goals for Universities is to reduce the amount of time and money required to procure, provision, and install new hardware systems [15]. Cloud-Computing is also future-proof, as it is up to the provider to keep infrastructure up to date and disaster-resistant, as a provider's equipment is more likely to withstand flood than the typical Higher Education in Nigeria.

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