

Understanding Forms and Models of Cloud Computing Technologies Adopted in the Selected Institutions in Southwestern Nigeria

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Abstract - The study examined the forms and models of cloud computing technology adopted in the selected institutions from four states in Southwestern Nigeria. The three purposively selected institutions were Federal, State and Private owned making twelve institutions. However, the administered questionnaire was filled in by the ten (10) IT personnel, ten (10) lecturers and five (5) students from each of the selected institutions making 300 respondents. The questionnaire elicited information on the forms and models of cloud computing technology adopted and the extent of use of the adopted cloud computing technologies in the selected institutions. Secondary data were obtained from relevant literature. Data collected were analysed with descriptive and inferential statistics. The study concludes that the forms of cloud computing technology adopted by the selected institutions in Southwestern Nigeria are infrastructure-as-a-service (IaaS), software-as-a-service (SaaS) and platform-as-a-service (PaaS) while software-as-a-service (SaaS) is often used by the institutions. Also, the models of adopted cloud computing technology are private, public, hybrid and community cloud computing by the selected institutions in Southwestern Nigeria. The adopted forms and models of cloud computing technology are used for different business functions such as payroll, procurement, human resources, accounting and finance, CRM, application development, and project management.

Keywords-Cloud computing, Institutions and Nigeria

1. Introduction

The aim of this study is to explicate the forms and model of cloud computing technology adopted in the selected institutions and determine the extent of use of forms of cloud computing technology and the business function deployed on cloud computing technology adopted by the selected institutions in Southwestern Nigeria.

Scholars have defined cloud computing from their perspectives. Cloud computing depends on subscription service to accessing networked storage space and computer resources [1]. By implication, it is a paid service(s) to securing online information and communications technologies' services. As cited in [1] that not all establishments are leapfrogging to adopting cloud computing technologies especially established institutions in developing countries like Nigeria [2].

Globally, higher institutions are encountering with the challenges of needed level of information and communications technology (ICT) required to enhancing good quality education and R&D activities especially in developing countries [3]. Giving yearly educational report of Republic of Yemen, it indicates that the educational sectors are challenged with hindrances to carrying out required quality education to the populace in the country. Among the hindrances to delivering good quality education at Republic of Yemen are due to inadequate needed infrastructure resources, under budget allocation to ICT, absence of ICT technical and teaching personnel [4].

At present, majority of activities are been conducted online. Among the activities are online document editing and writing, email checking, online interaction, collaboration, among others. Therefore, it is imperative globally for educational system to meet up with the advancement in ICT technology for rendering quality education [3]. Also, given the high cost attached to providing and maintaining the needed hardware and software, it is highly needed for educational system to adopt low cost advanced technology such as cloud computing. This cloud

computing addresses the challenge of high cost attached to both computer software and hardware needed to rendering quality education to the populace by providing ICT resources on a pay per use basis [3].

There have been diverse empirical studies on cloud computing technologies adopted in institutions [5-11]. Although, there are some theoretical review studies on the same phenomenon [4, 12-15]. However, scholars have noted that there is dearth of empirical studies on cloud computing technology in institutions especially Nigerian institutions [13,15,16]. Also, there is dearth of information on the forms and model of computing technology adopted in Universities in Nigeria, this is because cloud computing research is nascent in Nigeria [16], hence the need for this study.

The remaining part of this paper is ordered as follows such as review of related literatures, method of research deployed, the study results and discussion, conclusion and recommendations.

2. Literature Review

There is an increasing empirical research interest in cloud computing from both developing and developed economies. This cloud computing research interest have engineered vast intellectual and financial investment in cloud R&D [16]. Given that, it is highly imperative to know that cloud computing can be inform of service model and deployment model [16-18].

(a) cloud computing as a service model: It is service model when it entails Software, Platform and Infrastructure [17]. The discussion of cloud computing as a service is stated below:

(i) Software as service (SaaS) was defined as distribution model that allows users to access applications run on their servers over the Internet and charged customers per usage [18]. In other words, it is a remote online application accessed by users/customers via the network using a simple web navigator [18]. In general, SaaS refers to any online services (cloud services) that users can access remotely or subscribed to and pay per usage basis. These types of cloud services entail accounting, invoicing, performance monitoring, communications, tracking sales and planning among others. Furthermore, using SaaS is like renting rather than purchasing it [18]. Unlike mainstream traditional software with limited license and the number of devices that can use it. SaaS offers the users the opportunity of subscribing to the software instead of purchasing it.

(ii) Platform as a service (PaaS) allows for clients or customers to hire software, hardware, repository and network capacity through Internet. PaaS is of great interest to application developers because it provides for easy changes and upgrades to the features of the operating system in use and also allows for an application to be developed by developers distributed over different geographical locations across international boundaries.

Costs can be reduced by the use of infrastructure services from a single cloud computing service provider rather than have and maintain several hardware facilities that often do identical functions. Examples of PaaS include Salesforce, IBM Bluemix, Cloudbees and Microsoft Azure among others.

(iii) Infrastructure-as-a-Service (IaaS): This service delivery model enables clients to rent the equipment used in service operations and control the deployed applications and operating systems among others. Given that,

however, updating and patching of operating system at IaaS level are the responsibility of the users within the contractual period [19].

(b) Cloud computing as deployment model entails public, private, community and hybrid cloud [17, 20]. These models are discussed below:

(i) Public Cloud: The most common type of cloud computing services skewed towards the public cloud deployment model because as the name implies, are publicly and openly available. Even though they can exist in private clouds, SaaS provisions like cloud storage, online office applications and IaaS and PaaS contributions like cloud-based web application development environments and hosting is in related to public cloud model. Public clouds are also deployed when organisations or individuals do not require the level of infrastructure and security present in private cloud model [21]. Intuitively, large organisations or enterprises may still deploy public clouds in situations where privacy is not required, such as online document collaboration, webmail or storage of non-sensitive documents.

(ii) Private Cloud: It does not allow cloud resources to be shared with unknown third parties. It is otherwise known as internal cloud that is strictly for internal use of an establishment [22]. Private cloud resources perhaps located either onsite or offsite premises of the organization, hence, this model does not come with the benefit of reduced investment or expenditure in IT infrastructure or equipment.

(iii) Community cloud: This type of model is solely for a group or collection of users within an organisation having a shared or common goal [23]. Here, IT resources are provided as a service to group of users in order to enable an elastic collaborative use of computing resource. It is often limited to selected or limited set of employees within an organisation such as security department, head of departments, a team or sub-unit in an organisation.

(iv) Hybrid cloud: This model integrates two different deployment models such as public, private and community models. Organisations often combine two differing models to form a hybrid cloud in a bid to maximise efficiencies. In hybrid cloud, the combined clouds retain their identities but are bound together by standardized or proprietary technology [24].

Given cloud computing as service and deployment models, however, measuring the contribution of Nigerian scholars to the number and impact of cloud computing study was needed [16]. Content analysis and bibliometric was deployed in papers extracted from Scopus database within the specified time and country (2016 and Nigeria). The analysis of the extracted papers shows that majority of cloud computing study in Nigeria tend towards Education and SaaS model of cloud computing [16]. In support of that assertion, [11] studied the effect and challenges of adopting cloud computing technology in government owned universities in the Southwestern Nigeria. In the study, one hundred (100) IT (information technology) personnel, fifty (50) para-IT personnel and fifty (50) students making two hundred (200) respondents in total were selected in each of the selected ten (10) universities using stratified sampling techniques with the aid of questionnaire. Out of the two thousand (2,000) questionnaire administered, one thousand, seven hundred and forty-two (1742) were retrieved which represents a respondent rate of 87.1%. Microsoft excel was used to analyse the data descriptively. The outcome of the study implies that the adoption of cloud computing has an important effect on enhanced availability, cost effectiveness, low environmental impact, reduced and reduced investment in physical asset among others.

Hence, the main issues challenging the use of cloud were data insecurity, regulatory compliance concerns, lock-in and privacy concerns.

Cloud computing is an avenue to experience efficient and optimize IT (information and technology) services at least cost which is induced by pay as you use (PAYU) to cloud service providers [3]. There are other benefits attached to the use of cloud computing, among the benefits is high return on investment [25]. Given the benefits attached to the adoption and use of cloud computing, however, many sectors especially the higher education are skeptical in adopting cloud computing technology [3, 25].

On a contrary, cloud computing technology is highly being adopted by higher institutions mainly because of financial reasons [4]. Thinking beyond financial reason for adopting cloud computing, among the technical reasons for adopting cloud computing by IT manager or decision maker can be attributed to organizational, environment, technological and individual factors [4]. Cloud computing is a feasible in meeting the technological needs of an organisation efficiently, effectively and at reduced investment on physical asset with least environmental impact and IT complexity [1, 11].

[1] examined the behavioural intent to adopting cloud computing technology in large and small organization using an Enhanced Technology Acceptance Model (ETAM). [1] concluded that attitude and adopters' ability to use cloud computing (self-efficacy) were better predictor of intention to adopt cloud computing technology. Perceived usefulness and perceived ease of use of cloud computing were better predictor of attitude to adopt cloud computing technology and perceived ease of use and the relevant of cloud computing to adopters' work (job relevance) were the predictor of perceived usefulness.

Recently, [15] systematically reviewed empirical studies on cloud computing technologies. The study showed from the reviewed studies that empirical studies on cloud computing technology are dearth of cloud computing usage/utilization. The study also identified challenges and benefits attributed to cloud computing adoption. The study empirically showed that universities in the selected area are willing to adopting cloud computing technologies. Meanwhile, [14] had earlier concluded from the reviewed literature on cloud computing technology adoption in organisations that the factors that determines the adoption of cloud computing technologies varies. [14] further noted that most of the reviewed studies operationalised the intention to adopt cloud computing in a binary form rather than the actual use of the technology. Meanwhile, [13] showed from the systematic literature review on empirical studies carried out on cloud computing technology adoption in universities that several universities have utilized different types of cloud computing service models.

[25] examined the perception of IT and non-IT personnel on factors associated to the poor adoption of cloud computing technologies in African enterprises with Nigeria as a case study. The study concluded that the fear of unknown such as job loss, cyber threat, privacy issue and data theft were the hindrances to the adoption of cloud computing technology. In addition to that, [26] showed that top management support, competitive pressure, and compatibility are the factors attributed to cloud computing technologies.

Based on the aforementioned studies, this paper adopts theory of Technology Acceptance Model (TAM) as a focusing device for the analysis of this study. Technology Acceptance Model explains the perceive usefulness of technology, perceive ease of use of technology and attitude toward using technology [27]. The three constructs are key determinants of technology adoption model. First, perceived usefulness (PU) explains thus that people

tend to use or not use a technology based on the usefulness perception of the technology. Second, perceived ease of use (PEOU) explains that potential users of technology are of the opinion that a given technology is useful and requires less effort to use it. Third, attitude of a user toward a technology was a major determinant of whether the user will actually use or reject the innovation [27]. Based on that, the applicable research method is adopted for this study.

3. Research Method

This study deployed multi-stage sampling technique in data collection. Four states were randomly selected from six in Southwestern Nigeria. Three institutions otherwise called universities were purposively selected from each of the selected states. The justification for the purposive selection is to comprise one federal, one state and one private owned university from each of the selected four states making twelve universities in total. Furthermore, questionnaire was administered and filled in by the personnel in the purposive selected institutions: ten (10) IT personnel, ten (10) lecturers and five (5) students were considered from each of the selected institutions making three hundred (300) respondents. The yardstick for selecting the institutions is based on those institutions that are using cloud computing technologies while the purposive selection of the respondents in the institutions were based on referrer of expertise personnel on the subject matter.

The questionnaire elicited information on the forms and models of cloud computing technology adopted. The respondents were asked to tick the forms and models of cloud computing adopted in their institutions. The forms of cloud computing adopted for this study include Software-as-a-Service (SaaS), Platform-as-a-Service (PaaS) and Infrastructure-as-a-Service (IaaS) while the models of cloud computing include private, public, hybrid and community cloud computing. Furthermore, respondents were to rank in five scales (5) the extent of use of the adopted cloud computing technologies in the selected institutions such as: no use (A), little use (B), moderate use (C), highly use (D) and lastly, often use (E); where Alphabet A is the lowest and Alphabet E is the highest.

The respondents were further asked to indicate appropriately (multiple response is allowed) the type of cloud computing technologies deployed in the institutions such as Gmail-Based Institution Email Service, Dropbox, Docusign, Skydrive, Netsuite, Cisco-WebEx, Amazon Elastic or Web Services, Learning Management Systems (LMS), Microsoft Azure Cloud, Integrated Development Environments (IDEs), Cloud based APIs, and Cloud based .NET Platforms. In addition to that, the respondents were asked to rank the extent of use of the adopted cloud computing technologies for business function in five scales such as not applicable (A), little use (B), moderate use (C), highly use (D) and often use (E) where Alphabet A is the lowest and Alphabet E is the highest. The variables for business functions include payroll, application development, project management, accounting and financing, CRM/sales management, procurements, human resources and messaging and collaboration. Data collected were analysed with descriptive statistics such as frequencies and crosstabulation.

4. Results and Discussion

The Table 1 in this study explains the three intuitions selected for this study such as Federal owned institutions, State owned institutions and Private owned institutions. Not only that, the table further shows the number of questionnaires administered to the selected institutions and the number of questionnaire retrieved.

The table shows that out of three hundred (300) questionnaires administered, 56.3% (169) were retrieved and used for the analysis of this study. Meanwhile, from the perspective of [16] majority of cloud computing study in Nigeria tend towards Education and SaaS model of cloud computing, hence, this further contributes to those studies.

Categories of the institutions	Questionnaire Administered		Questionnaire Retrieved	
	Frequency	Percentage	Frequency	Percentage
Federal owned institution	100	33.3	57	19
State owned institution	100	33.3	63	21
Private owned institution	100	33.3	49	16.3
Total	300	100	169	56.3

Table 1 Number of Institutions Selected

Table 2 explains the forms and models of cloud computing technology adopted in the selected institutions. The table shows that majority (78.3%) of the institutions adopts software-as-a-service, while 65.1% and 54.3% of the institutions also adopts platform-as-a-service and infrastructure-as-a-service respectively. The adoption of forms of cloud computing corroborates the reports of previous scholars on the forms of cloud computing technology adopted in institutions [17] [28] [29] and [30]. Hence, the adoption of these technologies will reduce the cost of operations of the selected institutions from keeping hardware, storage facilities, maintenance cost among others. Concerning models of cloud computing technology adopted by the selected institutions in the study area. Table 2 further shows that the selected institutions adopts private cloud computing (53.5%), public cloud computing (54.3%), hybrid cloud computing (51.9%) and community cloud computing (51.2%). This is line with posits of previous scholars on the models of cloud computing technologies adopted by institutions [20-23, 31]. In addition to that, this study corroborated [13] that several universities have utilized different types of cloud computing service models. By implication, universities in the study area adopted different forms and models of cloud computing based on their discretion, cost reduction, needful, necessity, and industrial revolution, technology push and demand among others. In support of the adopted theory for this study, the selected universities inductively adopted cloud computing technology based on perceive usefulness, perceive ease of use and attitude of user toward a technology as indicated as element of technology acceptance model by [27].

Table 2: Forms and Models of Cloud Computing Technology Adopted

Characteristics	Frequency	Percent (%)
Forms of Cloud Computing		
Software-as-a-Service (SaaS)	101	78.3
Platform-as-a-Service (PaaS)	84	65.1

Infrastructure-as-a-Service (IaaS)	70	54.3
Models of Cloud Computing		
Private Cloud	69	53.5
Public Cloud	70	54.3
Hybrid Cloud	67	51.9
Community Cloud	66	51.2

*Multiple response is applicable

Table 3 explains the level of institutional use of the forms of cloud computing technology adopted by the selected institutions. Table 3 shows that majority (38.8%) the selected institutions that adopted infrastructure-as-a-service moderately use the technology follow by 24.8% of the institutions that highly use the infrastructure-as-a-service. Concerning the use of software-as-a-service by the selected institutions, Table 3 further shows that majority (34.9% and 32.6%) of the selected institutions moderately and highly use software-as-a-service respectively. Concerning the use of platform-as-a-service by the selected institutions, Table 3 shows that majority (26.4% and 41.1%) of the selected institutions little use and moderately use platform-as-a-service respectively.

By implication, Table 3 shows that software-as-a-service (SaaS) is mostly used by the selected institutions in Southwestern Nigeria. This might be as a result of idiosyncratic of SaaS that connotes any cloud services that users can access remotely or subscribed to and pay per usage basis [18]. Among the SaaS cloud services that can be subscribed to or use remotely are accounting, invoicing, performance monitoring, communications, tracking sales and planning [18]. In addition to that, this study corroborates [16] that, majority of cloud computing study in Nigeria tend towards Saas model of cloud computing.

Table 3: Level of Institutional Use of Cloud Computing Technology

Characteristics	Level of cloud computing usage (%)				
	A	B	C	D	E
Forms of cloud computing					
IaaS	14	7	38.8	24.8	0.8
SaaS	1.6	14	34.9	32.6	3.9
PaaS	10.9	26.4	41.1	3.9	1.6

*Multiple response is applicable

Key: A = No use; B = Little use; C = Moderate use; D = Highly use; E = Often use

Table 4 shows the cloud computing technology adopted by the selected institutions in the study area. The table shows that most of the cloud computing technologies adopted in the selected institutions are cloud based APIs

(55.8%), cloud based.NET Platforms (51.9%), Cisco-WebEx (48.8%), integrated development environment (IDEs) (43.4%), Amazon Elastic or Web Services (31.8%). More also, other cloud computing technologies adopted by the institutions includes Gmail-Based Institution Email Service (26.4%), Microsoft Azure Cloud (18.6%), Learning Management Systems (LMS) (16.3%), Skydrive (12.4%), Netsuite (8.5%), Dropbox (7.8%), and Docusign (0.8%). This shows that the selected institutions exhibited some level of cloud computing technologies. Perhaps, the necessity to adopt low cost advanced technology such as cloud computing warrant the selected institutions to adopting the cloud technologies. Meanwhile, [3] had postulated earlier that cloud computing technologies addresses the challenge of high cost attached to both computer software and hardware needed to rendering quality education to the populace by providing ICT resources on a pay per use basis. By implication, the selected institutions adopted cloud computing technologies so as to providing high quality that is affordable, accessible at least cost for the stakeholders in the institutions.

Table 4: Cloud Computing Technology Adopted by the Selected Institutions

Characteristics	Frequency (N=111)	Percent
Gmail-Based Institution Email Service	34	26.4
Dropbox	10	7.8
Docusign	1	0.8
Skydrive	16	12.4
Netsuite	11	8.5
Cisco-WebEx	63	48.8
Amazon Elastic or Web Services	41	31.8
Learning Management Systems (LMS)	21	16.3
Microsoft Azure Cloud	24	18.6
Integrated Development Environments (IDEs)	56	43.4
Cloud based APIs	72	55.8
Cloud based .NET Platforms	67	51.9

*Multiple response is applicable

The Table 5 in this study shows the extent of cloud computing technology in business function in the selected institutions in the study area. The selected institutions highly use (30.2%) and often use cloud computing technology in their payroll function. In addition to that, the table shows that the selected institutions highly (34.1%) and often use (25.6%) cloud computing technology in their application development function. Furthermore, Table 5 shows that the selected institutions moderately use (25.6%) and highly use (22.5%) cloud computing technology in their project management functions. The table shows that the selected institutions

moderately use (33.3%) cloud computing technology in their accounting and financing functions. Also, the institutions little use (27.9%) and moderately use (31.8%) cloud computing technology in their CRM/sales management function. This table shows that the selected institutions moderately use (39.5%) cloud computing technology in their procurements function. In addition, the selected institutions moderately use (37.2%) cloud computing technology in their human resources. Lastly, the selected institutions little use (34.9%) and moderately use (32.6%) cloud computing technology in managing and collaboration function.

By implication, the payroll functions of the selected institutions have been digitised and can be done anywhere in the world (telecommuting). Not only that, the selected institutions have deployed cloud computing technologies in their project management, accounting and financing, CRM/sales management, procurements, human resources, managing and collaboration functions.

Table 5: Extent of Use of Cloud Computing Technology in Business Function

Characteristics	Extent of use of cloud computing technology				
	A	B	C	D	E
Business Function					
Payroll	17.8	9.3	18.6	30.2	11.6
Application Development	10.1	7	8.5	34.1	25.6
Project Management	16.3	15.5	25.6	22.5	3.9
Accounting and Financing	17.1	24	33.3	7	0.8
CRM/Sales Management	21.7	27.9	31.8	3.1	-
Procurements	22.5	21.7	39.5	2.3	-
Human Resources	20.2	23.3	37.2	3.9	1.6
Messaging and Collaboration	11.6	34.9	32.6	7	3.1

*Multiple response is applicable

Key:A = Not applicable; B = Little use; C = Moderate use; D = Highly use; E = Often use

5. Conclusion

The study concludes that the forms of cloud computing technology adopted by the selected institutions in Southwestern Nigeria are infrastructure-as-a-service (IaaS), software-as-a-service (SaaS) and platform-as-a-service (PaaS) while software-as-a-service (SaaS) is often used by the institutions. Also, the models of adopted cloud computing technology are private, public, hybrid and community cloud computing by the selected institutions in Southwestern Nigeria. The adopted forms and models of cloud computing technology are used for different business functions such as payroll, procurement, human resources, accounting and finance, CRM, application development, and project management.

6. Limitations and future work

This study is limited to universities in Southwestern Nigeria, further studies perhaps consider the whole universities in Nigeria. The study did not consider factors influencing the adoption of cloud computing technologies, further studies may consider that. The study only use quantitative method in data collection and descriptive analysis, further studies may consider mixed method in data collection and analysis.

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