

An Analysis of the Suitability of Cloud Computing Services in the Nigerian Education Landscape

Sanjay Misra and Adewole Adewumi

Department of Computer and Information Sciences

Covenant University

Ota, Nigeria

{sanjay.misra,wole.adewumi}@covenantuniversity.edu.ng

Abstract— Cloud computing is fast gaining popularity in educational institutions of developing countries like Nigeria. Software as a Service, Platform as a Service and Infrastructure as a Service are the three key models through which cloud computing services are delivered to end-users. A number of studies have been conducted to identify the enabling factors as well as the issues being faced as regards the adoption of cloud computing in the Nigerian context. In this study however, Strength, Weakness, Opportunity and Threat analysis of the service delivery models in the Nigerian Education landscape has been presented. In addition, the issues that an educational institution needs to consider when adopting cloud computing is discussed.

Keywords—cloud computing; SWOT analysis; suitability; Nigerian education; service delivery models

I. INTRODUCTION

Cloud computing has some characteristics that distinguish it from other technologies [1] [2]. They include the following: Users do not necessarily have to own the information technology (IT) resources they utilize. For instance, the servers they interact with might be hosted in data centers at remote locations from them. Also, services are provided on-demand to the end-users and the end-users only pay for what is used. Cloud services can be delivered as software (SaaS), platform, (PaaS), or infrastructure (IaaS) [1]. SaaS is a model in which application software is delivered via the Internet [3]. PaaS is a model where, the service providers supply services to the users, such as development environment, and server platforms through which the users can develop custom applications. In IaaS, computer infrastructure such as servers, and storage devices are remotely delivered through the Internet.

Cloud computing has moved from just being a topic of interest and debate to one that is being adopted and applied to various aspects of the economy in sub-Saharan Africa - prominently the enterprise [4] and in recent times the education landscape. A recent study has identified the need for Nigerian educational institutions to have a plan of action for the adoption of cloud services [5]. The need arises thus for an analysis of the applicability of the various cloud service offerings within the Nigerian educational institution context. This is the main motivation behind this study. Also, the various challenges that may be faced are outlined as well as possible solutions. In addition, the issues the institutions need to

consider when making the move to the cloud are also discussed. Hence, the rest of this paper is structured as follows: Section 2 reviews related works. In Section 3, Strengths, Weakness, Opportunities and Threats (SWOT) analysis is performed to determine the applicability of the applicability of the various cloud service offerings in the Nigerian educational institutions. In Section 4 discusses the issues to be considered by institutions intending to adopt any of the service delivery models. Section 5 concludes the paper.

II. RELATED WORKS

In [6] an empirical study was conducted to determine the potential for the adoption of grid computing in tertiary institutions of Nigeria. Although, grid computing is not exactly cloud computing, they share a lot in common especially in terms of vision, architecture and technology [7]. The study revealed a significant lack of awareness about the benefits of grid computing particularly in tertiary institutions, which generally prevented its low adoption and suggested investing in awareness initiatives, workshops as well as the acquisition of grid resources to facilitate adoption.

In [8] an empirical study was also conducted to assess affordances of selected cloud computing tools for language teacher education in Nigeria. The study revealed that participants were able to perceive the opportunities inherent in the use of cloud computing for classroom learning as well as the unintended affordances. The study however was focused on language Teacher Educators in Colleges of Education and the scope of tools studied comprised mainly of SaaS tools such as DropBox and Google Drive.

In [9] a critical analysis of the benefits and challenges of the adoption and usage of cloud computing in Nigeria was performed. In the study, the relationship between key stakeholders in the Nigerian cloud ecosystem and proposed methods for optimizing the benefits of cloud computing while reducing the inherent adoption challenges was presented. This study however, focused on businesses and corporate organizations as being the consumers of cloud technology and not educational institutions. The study also deemphasizes the cloud service delivery channels (IaaS, PaaS, and SaaS) arguing that the rise of cloud ecosystem would render them irrelevant. Therefore, the challenges identified in this study were for the cloud ecosystem and not for the service delivery models.

In [10] a framework was proposed that would help organization of public and private sectors in Bangladesh to adopt cloud computing technology opportunities and prevent its obstacles. Although SWOT Analysis was performed in this study, it was not directed at the service delivery channels of cloud computing.

In the study [11], the author investigated cloud service adoption extent in Nigeria so as to identify the motivating factors and current issues affecting the adoption of cloud computing in Nigeria. The participants comprised of employees in Information Technology as well as Telecommunication companies in Nigeria. The outcome of the study showed that the level of the adoption was still low. Also of all the available cloud computing services, SaaS was the most used in Nigeria. Increased focus on primary services, collaboration, easy access to data and provision of basic infrastructure were identified as the motivating factors for cloud computing adoption in Nigeria. Poor awareness of cloud computing, unstable power supply and high cost of Internet bandwidth and unreliability of Internet services were the negative factors affecting adoption. This study is limited in the sense that the participants are mainly from the Industry and not academia and so the results may not necessarily be true representation of the Nigerian scenario.

In [12] the opportunities and challenges affecting the adoption of cloud computing in Nigeria was also discussed. The author made recommendations and stressed the need for the nation to determine whether it was going to function as services provider, service implementer or content creator.

The study by [13] investigated the impact and challenges of the adoption of cloud computing by ten public universities in the Southwestern part of Nigeria. The study revealed 90% adoption rate of cloud services. The most used cloud service was SaaS (seven out of the ten universities) followed by PaaS (two of the universities) and IaaS (by only one of the universities). However, the authors call for further studies focusing on readiness assessment of institutions' adoption of the various cloud service delivery models.

III. SWOT ANALYSIS

A. IaaS in the Nigerian Education Context

This service delivery model although popular in some African countries such as South Africa, it is yet to gain traction in the Nigerian Education context due to the state of existing infrastructure [13].

1) *Strength*: With IaaS, educational institutions will have full control and are able to manage their computing resources.

2) *Weakness*

- Skilled personnel may be required: Since this service delivery model has not been widely adopted in Nigeria as a whole and particularly in the educational context, the need for skilled personnel becomes imperative.
- Increased cost: IaaS providers to Nigeria can charge premium prices especially where there is limited competition and increasing demand. Institutions that

adopt IaaS would need to own data centers as part of best practices for sustainable development. These data centers require the provision of constant electric power with the requisite output and stability for the IT equipment as well as provision of adequate cooling systems for the equipment. As such institutions would require alternative means of generating power to complement what is currently obtainable.

3) *Opportunity*: If the problem of power is addressed in Nigeria, then this has great prospects for the Nigerian education sector as well as other sectors. Also service providers such as IBM [14], Amazon [15] and Google have developed a number of solutions for the educational context at subsidized rates, which might encourage more educational institutions to buy into IaaS.

4) *Threat*: One major threat to the wide spread acceptance of IaaS in the Nigerian education context will be power supply. Until this is addressed, the question of setting up a data center for sustainable development within Nigerian educational institutions will not arise.

B. PaaS in the Nigerian Education Context

With PaaS, programmers that work in educational institutions can develop cloud services and applications. Google being an education-focused organization have introduced Google App Engine as their PaaS, which supports a number of programming languages. Although, it is difficult to tell how many institutions actually use Google App Engine, a recent literature shows that there is possibility of it being used for research purposes in some Nigerian institutions [16].

1) *Strength*: PaaS provide development environments and familiar programming languages for developers that can be leveraged to develop custom applications either for commercial – thereby helping the educational institution to generate revenue; or research purposes as seen in [16].

2) *Weakness*: Vendor lock-in - when developing on a particular platform, developers are usually restricted to what obtains in that platform

3) *Opportunity*: Being an emerging area in the Nigerian software development ecosystem, it could be of value especially at the undergraduate level to incorporate PaaS development into the curriculum.

4) *Threat*: Once IT staff (who are developers) adopt a platform, it might be difficult to migrate to another platform.

C. SaaS in the Nigerian Education Context

In 2012, Microsoft launched Liv@edu (now integrated into Office 365) for a number of secondary schools in Nigeria [17]. The service allows the use of Microsoft Office apps on Windows and OS X, provides storage space on Microsoft's cloud storage service OneDrive. Also, a number of tertiary institutions in Nigeria have subscribed to Google Apps for Education [13] - a suite of free productivity tools for classroom collaboration. A recent introduction into the suite is Classroom [18], which was designed to save time, and keep classes

organized. It allows for the creation, sharing and grading of assignments with ease.

1) *Strength*

- Requires little physical infrastructure: An educational institution adopting this service delivery model will not require more than an Internet-enabled device to access the services.
- No need to purchase licenses or install any software: Educational institutions that adopt this platform will require no software licenses or updates as this will be taken care of by the SaaS provider. Some providers may not even charge individual users within an educational institution (e.g. Google).

2) *Weakness*: Internet connectivity required to operate: Majority of SaaS products do not operate offline. In fact, SaaS was never designed for offline use and so requires stable and constant Internet connectivity. Also functionalities are limited to what the provider implements.

3) *Opportunity*: The increasing adoption of Internet-enabled mobile devices in the Nigerian educational sector is a great opportunity. For instance, the University of Ilorin has launched a scheme where Internet-enabled tablets are provided to all students. It serves as a medium for receiving and storing lecture materials. Google has also embarked on initiatives to make more bandwidth available to institutions subscribed to the Google Apps for Education.

4) *Threat*: If a SaaS provider ceases to operate then the software may become unavailable for use. Also, end-user institutions have no control or access to the underlying technology.

Table 1 provides a summary of the SWOT analysis of IaaS, PaaS and SaaS in the Nigerian Education Landscape.

TABLE I. SWOT ANALYSIS

	<i>IaaS</i>	<i>PaaS</i>	<i>SaaS</i>
Strength	Full control and access to manage computing resources	Ability to develop custom applications for commercial or research-purposes	Reduced cost as a result of not needing to purchase licenses or possess too many physical infrastructure
Weakness	Skilled personnel required Increased cost	Vendor lock-in	Functionalities available in the software is limited to what a provider implements Internet connectivity often required to operate
Opportunity	Possible partnerships and collaboration of institutions	Reviewing the present undergraduate curriculum to include PaaS	Ubiquity of Internet-enabled mobile devices as well as the provision of

	<i>IaaS</i>	<i>PaaS</i>	<i>SaaS</i>
	with technology giants such as IBM, Amazon and Google	development	bandwidth by technology giants
Threat	In consistent power supply	Migration of data in the event of platform change	Lack of control or access to underlying technology Probability of service continuity by provider

IV. DISCUSSION

The goal and mission of an institution will determine the service delivery model that best suits it. An institution wanting to be in full control of and manage its computing resources can opt for the IaaS delivery model. Such an institution should explore partnerships and collaborations with technology companies such as IBM and Google (who currently have branches in Nigeria and offer IaaS services) to help in setting up the institution's data center and training the institution's personnel. However, such an institution should ensure that it is able to provide constant power supply or has alternative power supply sources such as generator sets.

For an institution not necessarily wanting to own its data center but requiring a platform that allows for some form of customization or development either for the sake of research or teaching can opt for the PaaS service delivery model. However, such an organization should do the needed research on the platform to be adopted. For instance, the institution should seek to know how long the provider has been in existence as well as its customers' satisfaction. This is important so as to avoid vendor lock-in.

An institution that is seeking primarily to cut cost by eliminating the need to constantly renew or purchase licenses can opt for the SaaS model. Such an institution may not be interested in owning or running its own data center due to the cost involved. The institution may also not be interested in developing custom solutions to meet its need and is content with using ready-made solutions that are available on demand.

V. CONCLUSION

This paper set out to analyze the suitability of the cloud computing service delivery models (IaaS, PaaS and IaaS) in the Nigerian education landscape. The motivation stemmed from the gap identified in literature, as previous studies did not address this issue. In order to carry out this task, SWOT analysis was conducted across the three platforms and the results presented in Table 1. From the results, three kinds of institution could be identified that would be seeking to adopt cloud computing. Issues that need to be attended to by the various institutions were also discussed.

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