



Using Cloud Computing in Higher Education: A Strategy to Address Trust Issues in Adoption of Cloud Services in Kenyan Public and Private Universities

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ABSTRACT

Cloud computing is fast gaining significant ground as a solution to offer institutions with competitive advantage compared to the old traditional IT. Nevertheless, many institutions are still clenching to the traditional IT where legacy IT systems or applications are hosted in-house and hence administration of the systems or services is local or on premise. This has resulted in high IT expenditures on both hardware and software due to increased storage demands as well as investing on high skilled resources to administer the existing systems or applications which might not be viable in the long run. Despite the potential benefits that is associated with cloud computing which includes reduction of total costs of acquisition or ownership (TCO) of hardware, software and skilled resources, adoption level of cloud services is still very low in higher institutions of learning due to matters security especially trust issue which remains a major concern over cloud solutions. A case study was carried out in selected public and private universities to determine the reason for the low cloud uptake by the key stakeholders in higher institution of learning. An adoption strategy was recommended with reference to the resources, confidentiality, integrity and availability. The focus was on how key stakeholders view cloud services in the context of unique operational efficiency.

General Terms

Cloud Computing, Trust, Higher Education

Keywords

Cloud Computing, Traditional IT, Trust, Higher Education, Operational Efficiency, Adoption Strategy.

1. INTRODUCTION

Cloud computing is seen as the wave that brings evolution to the way business is done in modern era. There are many definitions pegged to cloud computing; [1] defines cloud computing as a technology that shares computing resources, put together with on demand provision and a pay-per-use model. Cloud computing is defined by NIST as “a model that enables ubiquitous convenient, on-demand network access to a shared pool of configurable resources that is rapidly provisioned and released with minimal service provider interaction [2].” Higher education demand for computing needs keeps on changing from time to time. Thus, cloud computing will provide opportunities to utilize external service providers and on demand services that are highly scalable [3, 4] and accessible via internet.

According to an article on CloudTweaks.com by Walter Bailey, cloud is seen as vital in education institutions. He

states that small classrooms, lack of resources, staff and teachers makes advancement, achievement and success as unattainable. As a result, he points out cloud as a valuable tool that can boost performance and a means of attaining advancement, achievement and success [5].

There are key attributes known to support cloud computing; these are optimal resource utilization, elasticity, pay per use and multi-tenancy among many other attributes [6, 7, 8, 9]. The attributes mentioned employs virtualization and resource management to operate large data centres.

Cloud is seen as promoting collaboration and mobility in institutions of higher learning. However, [10] also highlights trust, confidence and surety as the challenges affecting cloud adoption in Higher education.

Moreover, the dynamic growth or shrinkage of cloud makes it agonizing to know what resources are used and the location where they are hosted [11, 12]. As such, complying with the set regulation on data handling is not easy due to the geographical dispersion [1, 13, 14].

Cloud utilization requires users or organizations to trust the cloud providers [15]. Security and reliability [16] are the major concerns seen to affect adoption especially in the professional realm. According to [2, 17, 18] the main concerns on cloud adoption are mainly on safe data management, reliable access control, weak systems monitoring and service availability. Delegating some of the tasks to the service provider is seen as a challenge [19]. All these concerns revolve around the central information security values which are confidentiality, integrity and availability [6].

It is alluded that cloud computing adoption preceded the technologies required to tackle the trust challenges therefore creating a gap between adoption and innovation [13]. There is also an indication that fear on confidentiality, availability and integrity of information have been the driving factors for slow cloud adoption rate [20]. Such fears can only be addressed by a model addressing confidentiality, integrity and availability [21, 22, 23]. Hence, there is need to formulate a strategy to increase the cloud service uptake in institutions of higher education.

The aim of this paper is to find alternative to use of IT through cloud leading to operational efficiency and cost cutting in institutions of higher learning. It also seeks to identify key barriers affecting adoption of cloud computing in Higher Education in Kenya and formulate a strategy or roadmap for adoption of cloud computing in Higher Education in Kenya.



2. TRADITIONAL IT VS CLOUD COMPUTING

Cloud computing provides access to systems or information for the user via internet. Here, the only requirement is an internet link to access information hosted on cloud as infrastructure is offsite.

Traditional IT service represents the contrary as services are hosted and accessed locally [24]. As such there is no agility and the high service demand from these institutions would require high investment on hardware and skilled resources.

Cloud computing thus promotes cost cutting and operational efficiency as no hardware requirement is required locally [25]. This is quite useful for higher education institutions in providing first class services and also distance learning facilities and materials to their students who do not wish to sit in class. It also increases IT agility to support areas of educational, research and innovation activities through cloud computing [26].

The key cloud benefits specified by [27] are to work closely with trading partners, ease and speed of data sharing and better decision making. Advocates of cloud computing asserts that it makes it possible for organizations or institutions to avoid upfront infrastructure costs and thus focus on their core business [28, 29].

Another aspect seen of cloud is that it creates value and transforms traditional economic assumptions [30]. This implies that it can handle varying unpredictable demand due to its scalable nature.

2.1 Cloud Computing and Trust Issues

Cloud Security Alliance defines a trusted cloud as one aimed at increasing the user's confidence. There is a notion that companies whose data are hosted on cloud have little visibility into cloud service providers' activities which includes updates and hiring practices and thus no idea on the security risks faced by the service provider. This is so because they have absolutely no control over the procedures done [31, 32].

According to [33], users lack control of cloud resources and are depicted as unable to safeguard their data from unauthorized access or third party usage or abuse. In their study, they illustrate that trust in cloud security is viewed as either internal or external to the university. This is a drawback as it can result to security and privacy issues or concerns [11].

There are also indications that the cloud service provider might not provide correct reporting on data hosted on cloud; certainly, due to data breaches resulting to loss of sensitive data [25, 34, 42]. This can be a concern to institutions of higher learning as they deal with big data ranging from research work to students' registration and other confidential information pertaining to the institution. As such transparency and accountability which are a requirement for a cloud vendor might be lacking.

Besides, trust in cloud services is portrayed as dependent on automation management, processes and policies [18]. Losing control of data and lack of transparency are issues that reduces trust on cloud [13]. However, the cloud service provider can enhance trust by being transparent on every activity done on cloud.

According to [27], business transactions are globally

conducted on premise of trust only. He further points out that our willingness to place our trust in an entity voluntary lies on the promise made by the entity. This illustrates the trustor to trustee relationship within a cloud computing context.

2.2 Conceptual Framework

The diagram shown in Figure 1, represents the conceptual model used. The model is borrowed from [35] trust model. Four elements, notably; availability, confidentiality, integrity and resources are used as independent variables and the dependent variable is cloud adoption.

In trust relations, trustor and trustee are involved. The trustee provides cloud services to trustor who utilizes the services. According to [36], the trustor has no control over the trustee's activities; and the trustor's belief is that trustee's behavior or activities is dependent on the trustee's capability, goodwill and integrity. The integrity of the trustee gives the trustor confidence about the predictability of the trustee behavior.

The perceived risk exhibited by the trustor helps assess current trust; the outcome of risk taking determines the cloud uptake. The characteristics of the trustor denotes the tendency of the trustor to trust; this will determine trust levels between individuals [35].

To assess the moderating effect of trust on the relationship between Availability (A), Confidentiality (C), integrity (I) and Resources (R) on cloud adoption, T-test sample will be used.

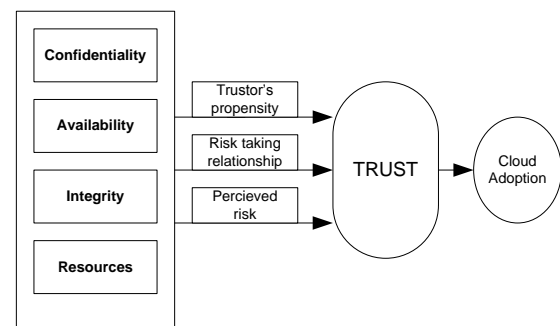


Figure 1 Conceptual Framework for Cloud Service (Source: Inspired by Mayers et al., 1995)

3. METHODOLOGY

This paper adopts a pragmatic research [37] philosophical approach to get credible results by triangulating data from primary source (confidentiality, integrity, availability and resources) collected using the questionnaire and secondary data (from journals and published scholarly articles).

Qualitative model looked into the stakeholder's perceived assumption, behavior and experience that was significant to the study and was compared with secondary data. Quantitative model was used due to the significant amount of data involved that would be significant to the study.

A target of 13 out of 39 universities (Public and Private chartered) was selected; which is a sample of 35% representation of the total population. A sample size 10% or more is ideal to represent the entire population [38]. Systematic random sampling or interval sampling technique was applied; this is one of the sampling techniques used in social science research [39]. Target participants were from IT management (e.g. System administrators, IT Manager, Information Security Manager and other user in ICT)



A questionnaire was used to collect the primary data from a sample of 4 from each thirteen (13) selected universities in Kenya; a sample size of fifty-two (52) questionnaires were distributed. A questionnaire allows for gathering of a large volume of information within a given time [37]. The validation of the questionnaire was based on the independent elements in the conceptual model as seen in Table 1. Validation ensures questions are well founded and relate to the study [37].

Questionnaires were delivered in person and via e-mail to the 13 participating universities. Forty (40) questionnaires from ten (10) universities were filled and returned for analysis which gave a response rate of 76.9%. According to [40], a response rate of 65% is acceptable for such studies and hence the response for this study was sufficient representation of the population within the universities as far as the study is concerned.

Table 1 Framework of interview questions

Objective	Questions	Reason
1. Find alternative to use of IT through cloud, leading higher institution of learning to increase operational efficiency and cut-cost.	The questions under section B on Resources will be phrased or directed to assess or measure resource capability of the institution.	This seeks to understand the institution resources capability and skills to see how best the institution can utilize cloud services to cut cost and improve operational efficiency.
2. Identify key barriers affecting adoption of cloud computing in higher education in Kenya.	The questions under availability, integrity and confidentiality will guide in collecting the various views and fears of key decision makers in the selected institutions of higher learning.	This is to identify the main issues influencing the low uptake of cloud services in higher education of learning. This then will be useful in coming up with an adoption strategy or roadmap for increasing uptake of cloud computing in higher institutions of learning.

4. RESULTS AND DISCUSSION

The research question was evaluated which is in line with the research objectives and the result tabulated as follows:

4.1 Cloud as a cost cutting and operational efficiency tool

To ascertain this, relevant resource work experience was analyzed as in Table 2 and majority of the respondents had worked for an average of 5 years which portrayed their experience in their position of service in these institutions. This indicated that the employees had enough experience and hence they were in a position to give reliable and valid information on usage of cloud computing in higher education in Kenya.

Table 2 Descriptive Statistics of the years of experience

	N	Range	Min	Max	Mean	Std. Deviation
Years of Experience	40	13	1	14	5.17	2.854
Valid N (List wise)	40					

Analysis of the functions hosted on cloud was done and tabulated. Table 3 shows the frequency table of function hosted on cloud. This is an indication of receptiveness to cloud computing adoption by some of the institution. 67.5% cumulatively agreed that they host their services on cloud. This is an indication that some of the institutions have already seen the benefits associated with cloud computing such as increased operational efficiency, ease of deployment of applications and low cost.

Table 3: Frequency table of functions hosted on cloud

		Frequency	Percent	Cumulative Percent
Valid	Strongly Agree	14	35.0	35.0
	Somehow agree	13	32.5	67.5
	Not Sure	1	2.5	70.0
	Somehow disagree	4	10.0	80.0
	Strongly disagree	8	20.0	100.0
	Total	40	100.0	

Analyzed results of the resources response are tabulated in Table 4. From the result, majority strongly agree that there is enough resources and skills to manage systems in-house.

Majority of respondents agree that the institutions have an average working experience. This is based on mode of 2 which is somehow agreed in the Likert scale. Majority of the respondents had a mode of 2 on plans to adopt cloud computing fully as a cost cutting venture and to increase operational efficiency.



Table 4 Resources

Resources	N	Mode	Std. deviation	Range
Have enough resources and skills to manage your systems in-house	40	1	1.011	3
Their average working experience	40	2	.516	2
Is cloud computing significant to your institution	40	1	1.071	3
There are plans to adopt cloud computing fully as a cost cutting venture and to bolster operational efficiency	40	2	.975	3

Finally, on what stage the institution is in regard to cloud services adoption, majority had a mode of 1 (strongly agreed) which is an indication that majority of the institutions were already in use/implementing cloud services in their institution. This is an indication that some institutions have already started the journey into cloud as an alternative way into use of IT to help in cutting cost and increasing operational efficiency.

4.2 Key barriers of cloud computing in Higher Education in Kenya

All the components of investigation had a significant value at $p < .05$ in Table 5 and this suggests that they all had significant effect on cloud services adoption. Loss of control of data, availability and privacy are the top three (3) barriers in the study that highly affect adoption in the higher institution of learning

Table 5 One-Sample Test on stumbling blocks to cloud services adoption

Components	t	df	Sig. (2-tailed)	Mean
Loss of control of data	27.324	28	.000	4.310
Privacy	31.165	30	.000	4.194
Data Leakage / Loss	14.809	30	.000	3.613
Security	22.919	27	.000	4.071
Compliance Issues	20.600	26	.000	3.815
Contractual Issues	22.718	23	.000	4.083
Availability	25.720	24	.000	4.200
Performance	18.207	22	.000	4.043
Data Portability / migration Issue	22.277	24	.000	3.960
Lack of standards	11.694	22	.000	3.435
legal issues	10.834	20	.000	3.426

On other stumbling blocks, from Figure 2, 2.5% of the respondents indicated that cost was a stumbling block, 5.0% indicated that trust was a stumbling block to cloud services adoption. The rest who were majority (92.5%) did not suggest the other stumbling block. This could mean that of the 92.5% who did not respond to this question, the percentages for cost or trust could go high as they might seem to incline on either side. As such further research is required to determine the extent cost and trust have on cloud adoption.

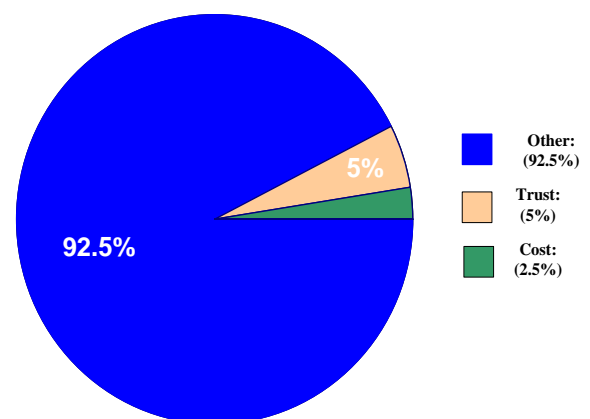


Figure 2 Pie-Chart for other Stumbling blocks of cloud computing

The respondents were also asked to give their views on the cloud service providers' (CSP) capability and skills to handle the institutions data. As seen in Table 6, 75% cumulatively agrees that CSP have the necessary skills to host their data on



cloud while 25% are of contrary opinion. This has negative effect on cloud adoption within these institutions as it is an indication of lack of trust.

Table 6 Skills and Capability of Cloud service provider

		Frequency	Percent	Cumulative Percent
Valid	Strongly Agree	9	22.5	22.5
	Some-how agree	21	52.5	75.0
	Not Sure	1	2.5	77.5
	Somehow disagree	3	7.5	85.0
	Strongly disagree	6	15	100.0
Total		40	100.0	

In order to determine the impact of cloud service providers' privacy policy on cloud purchasing decisions made by these institutions, the respondents were asked to give their views on the service provider privacy policy and how it affects their cloud purchasing decisions. The results were as shown in Figure 3.

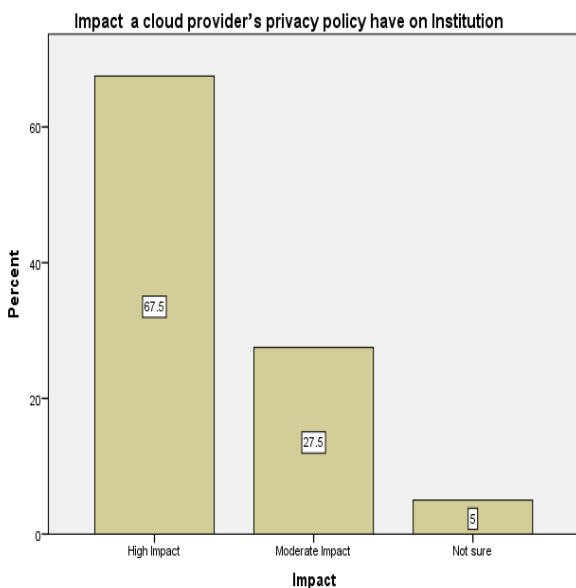


Figure 3 Bar-chart of the Impact of cloud provider's privacy policy on cloud purchasing decision in institution of higher learning in Kenya

In above analysis, majority of the respondents (67.5%) accepted that the cloud providers' privacy policy, did have high impact on the institutions cloud purchasing decisions. 27% of the respondents had the view that it had moderate impact while 5% were not sure.

From the study, it is correct to deduce that about 95% agrees that the kind of privacy policy the cloud provider has in place plays a role in cloud service uptake. The respondents were also asked to give their views on the visibility, accountability

and transparency of cloud service provider. The result was as seen in Table 7.

From the table output on visibility, accountability and transparency of the cloud service provider, there was a common response from the majority of the respondents that there is visibility over cloud services being offered by the cloud service provider. The mean is 2.08 which is close to 2 on the Likert scale which denotes somehow agree.

Accountability and transparency has a mean of 1.10 and 1.43 respectively, which is strongly agree on Likert scale. This implies that as the institutions warms up to cloud computing adoption, they are likely to put more emphasis on accountability and transparency of the service provider as this greatly affects them.

Table 7 Statistics on visibility, accountability and transparency

	N	Mean	Std. Deviation	Std. Error Mean
Is there visibility over the cloud services being offered by the cloud service provider	39	2.08	.664	.106
Is there need to hold service providers accountable based on the service level agreement signed.	40	1.10	.304	.048
Transparency of the cloud service operations might influence the cloud adoption process within the institution.	40	1.43	.501	.079

4.3 Statistical analysis of effects of independent variables on Cloud Adoption

To test the moderating effect on the relationship between the independent variables (availability, confidentiality, integrity and resources) on dependent variable (cloud adoption), we used the T-test sample (Table 8)

From the output results of the T-test in Table 8, the p-value at two tail < .05. Hence, it indicates that availability, confidentiality, integrity and resources have significance influence on cloud adoption in institution of higher education in Kenya.

Table 8 One-Sample Test of Independent variables

	Test Value = 0					
	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Resources	21.692	39	.000	1.892	1.72	2.07
availability2	41.081	39	.000	3.019	2.87	3.17
Confidentiality2	33.744	39	.000	3.202	3.01	3.39
Integrity2	32.753	38	.000	3.392	3.18	3.60



4.4 Formulate a Cloud Adoption strategy for Higher Education in Kenya

Based on the identified stumbling blocks to cloud computing in institutions of higher learning, a five (5) stage roadmap or strategy to address low cloud uptake issue in the higher education of learning was formulated. This is as shown in Figure 4 below:

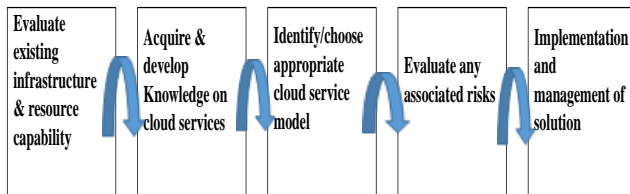


Figure 4 Proposed Cloud adoption strategy / roadmap
(Source: Inspired by Mircea et. al., 2011)

Stage 1: Evaluate existing infrastructure & resource capability

SWOT matrix tool may be used to assess the strength, weaknesses, opportunities and threats of infrastructure and resources. Review policies and standards in this stage.

Stage 2: Acquire & develop knowledge on cloud services

Gain knowledge on cloud service types. This is through workshops, seminars, conferences and benchmarking with other IT experts. Create knowledge base repository for sharing information on technology trends.

Stage 3: Identify / Choose appropriate cloud service model

For budgetary purpose, it is important to perform cost benefit analysis. Involving key stakeholders is important; business case will help highlight the wins. Migration plan is essential to help with logistics.

Stage 4: Evaluate any associated risks

Risk evaluation is key in identifying cloud service providers' capability. Evaluation of legal, contractual and compliance is pertinent. Carry out source audits of the cloud provider facility; this will help with transparency; analyze service provider privacy policy critically to determine any possible exposure to risks. Relevant and specific metrics should be provided in the SLA for monitoring purpose.

Stage 5: Implementation and management of solution

Documentation of the processes is important for the team supporting the solution. Internal skills required for first level support; resource needs to be empowered to support solution. Address any feedback under this stage.

5. CONCLUSION

The research findings demonstrated that there is a growing receptiveness towards cloud services by the higher education institutions in Kenya. This was indicated by 67.5 percentage of the institutions who have hosted some functions on cloud. This number is likely to go up if the key stakeholders and the technical staff embark on the journey to cloud together.

In order to implement viable cloud solutions to these institutions, good understanding by the IT personnel in institutions of learning on the various cloud service models and deployment types is required and this can only be achieved through active engagements with cloud service

providers, benchmarking, technology workshop and seminars pertaining to new cloud technology trends in the market. Understanding of the cloud service models and deployment types gives the institution an edge in identifying the most cost effective and efficient solution for the institutions.

The concept of trust issue that affects adoption in these institutions comes out clear in the form of loss of control of data, availability of services or data and on privacy policy from the cloud provider. From the result it is apparent that the cloud consumer in this case the higher education institutions are highly influenced by the impact of cloud provider's privacy policy. Ninety-five (95%) percent of the respondents cumulatively indicated that the cloud service provider's privacy policy will influence their cloud purchasing decisions. It is therefore clear that privacy protection shapes trust between service providers and consumers.

Cloud service providers needs to be accountable on the services provided to the cloud consumers. Accountability plays a major role in adoption of cloud computing in higher education. This is so especially where safe data handling or management is required, the client in this case the cloud consumer requires utmost care with his sensitive data and would not like any breach on data to occur.

Given that institutions of higher learning handle a lot of sensitive data, it will be prudent that the data is kept safe and is not leaked in any manner whether on transit or in-situ.

It is worth mentioning that from the findings, transparency by the cloud provider was also deemed as a great influence towards the cloud adoption process within the institutions. Therefore, a good relationship requires to be developed between the cloud provider and the cloud consumer not just on good will but also on effective service delivery. This will greatly boost adoption of cloud services in our institutions of higher learning.

Finally, the roadmap is meant to address the low uptake of cloud services in higher education. With proper support from management and good implementation plan, this should be able to bring positive results and increase uptake.

5.1 Further work

This study recommends further research to be carried out along the following points:

- Study on implementation challenges while adopting cloud service in Higher Education in Kenya
- Study on cost and trust as stumbling blocks and how they affect cloud adoption in Higher Education in Kenya
- Study on the effective ways of implementing a roadmap for adoption of cloud computing in Higher Education in Kenya.

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