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Effect of Cloud Computing Environment on Total Cost of Ownership; a Case of Internet Service Providers (Safaricom and Access Kenya)

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Abstract: *Cloud computing plays a crucial role when addressing the concept of data storage and determining total cost of ownership in organizations. The purpose of the study was to assess the effect of cloud computing environment on total cost of ownership among the internet service providers focusing on Safaricom and Access Kenya. The objectives of the study were to determine the effect of cloud computing on acquisition costs of computer accessories and to determine the effect of cloud computing on infrastructure support costs. The study was based on a descriptive study design. Primary data was collected using qquestionnaires. The findings showed that cloud computing can be used to curb cost in organizations. The adoption of cloud computing environment in Safaricom and Access Kenya can reduce server, configuration and upgrade costs. In regard to iinfrastructure cost, there was some effect on having reduction in WAN, structured cabling, data transfer as well as network performance improvement. It is recommended that cloud computing should be fully embraced to reduce hidden costs. Also the costs associated with upgrades, support, maintenance and securing these computer accessories that often go unnoticed can be reduced.*

Keywords: *Cloud Computing, Total Cost of Ownership, Acquisition Cost, Infrastructure Costs, Internet Service providers, Safaricom, Access Kenya*

I. Introduction

Cloud computing is guided by the principles of virtualization. The concept of cloud computing in Kenya is still a new phenomenon and many organizations are still struggle to understand and adopt it. As technology gets complex there is need to eliminate capital investment for infrastructure, the ongoing technical management update costs, reduction of financial risks and upfront costs (Barretos, 2010). Total cost of ownership (TCO) as an estimate of the total costs of goods and services over the whole of their life has set out to be an alternative to solving the organizational overhead issues in regard to pricing. Total cost of ownership combines the purchase price plus all other costs incurred, less any income received. It is imperative to appreciate cost of ownership within an organization between the asset cost and the output that asset produces. These include the initial purchase price plus installation costs, operating costs and ongoing maintenance less the residual value on disposal.

Baron (2006) asserts that TCO is an assessment of all costs involved with an item over its useful life, calculated at the beginning of the purchase process to determine the most cost-effective choice. In most cases many of the costs included are estimates, since they have not yet been incurred.TCO analysis begins when the client identifies the specific asset to be acquired, specifying the ownership life as described by Pariseau and Jones (2014). A number of organizations have got ICT policies that stipulates the rate of computer depreciation for instance, the ownership life is given as a number of years with a known starting date and ending date precisely four years for personal and Laptop computers, Jones (2014). TCO analysis continues when the owner identifies all the cost categories that can be expected to have cost impacts from ownership. Jones (2014) continues to observe TCO analysis successes when the owner includes two major kinds of cost categories that will see cost impacts across ownership life, obvious costs and hidden costs. Technology is a means to an end whose value lies on how companies can apply it to meet business objectives (Barretos, 2010). The dynamics in the current trends in technology realm put the organizations in a state where they have to reorganize, re-strategize, realign and redesign the business models. It is significant to note that every organization enters into business with the aim of making profits, realize the objectives of establishment and fulfill the visions and missions under their formation. Ranging from the enormity of data within the organizations, elasticity and scalability given the company's growth, the challenges continue unabated. According to various ICT policies for instance Boresha ICT policy (2014), after every four years quite a number of computer hardware pieces have to be retired due to depreciation. This continues to push the costs of hardware and software acquisition up in order

to spur business continuity. On the other hand this adhoc manner of purchases has far-reaching implications to organizations. Organizations have invested huge sums of money into technology which keep changing over and over while users end up spending heavily. Boresha (2014) reports that the total cost for computer purchase, repair, maintenance, network support and security stands at 45% of the total budget. With the prevailing trend, the figures are likely to double in the next three years. The main expenditures for safaricom in 2011 comprised fixed data, 3G equipments, fiber and the upgrade of the existing 2G coverage to support the growth in customers (Mbuvi, 2012). Access Kenya being one of the organizations for data collection, they have shown the lead in providing internet services. Kuria (2014) observes that Access Kenya seeks to cement its position as a market leader in the regional cloud technology space targeting organizations within East Africa.

Statement of the Problem

Internet Service Providers (ISPs) have attempted to embrace the concept of cloud. Large data centers with high-end servers that host platform as a service, infrastructures as a service and software as a service have been built but organizations still encounter difficulties in terms of upgrades, maintenance, support and security costs of these resources of computer outrights. Ranging from high end servers, power consumption, clients and dynamism in network infrastructure it is becoming hard for establishments to cope with the changing trends in technology. It is adverse that majority of companies do not factor in hidden costs when acquiring computers and related accessories hence the concept of Total Cost of Ownership tend to be forgotten. In 2013 Safaricom limited reported that the cost of equipment has been on a steady rise thereby increasing the costs in areas with no commercial power, forcing sites to be run on generators. The report reiterated that because Safaricom must rely on outside providers to lay the fiber for its network, the quality and placement of that fiber can vary. As a result, the service provider experiences between 5 and 25 fiber cuts, or accidental tears in the optical fiber, every day (Odera, 2013). Consequently, users show dissatisfaction with and complain of poor information service delivery by the ISPs. This study sought to analyze the effects of cloud computing environment on total cost of ownership at safaricom and access Kenya.

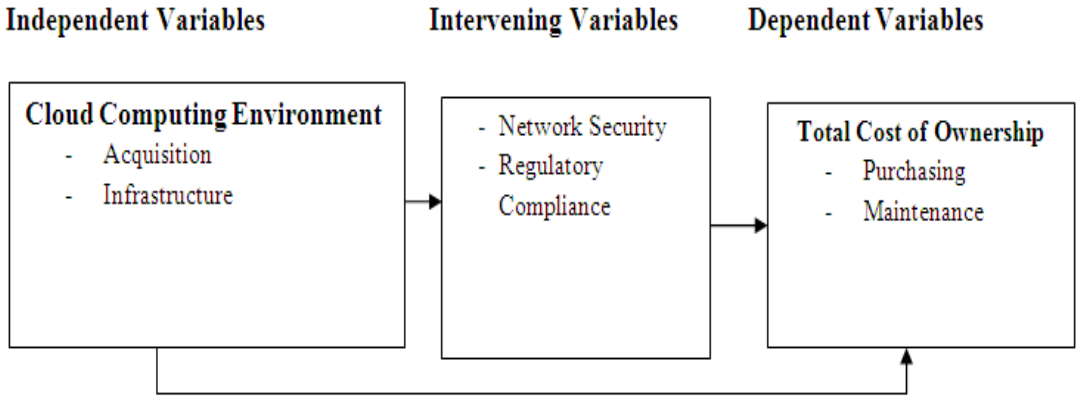
Objectives of the Study

The specific objectives of the work were to:

1. Assess the effect of cloud computing on acquisition costs of computer accessories
2. Assess the effect of cloud computing on infrastructure support costs to the organization

Conceptual framework

The conceptual framework constituted of cloud computing as an independent variable entailing public, private, and hybrid clouds respectively. These are services provided by the ISP to the organization in form of hardware, software, servers, infrastructure, printers and other electronics consumables. In this study, the intervening variables were used to highlight some of the models compelling cloud computing. The indicators of the dependent variable comprised of purchasing, upgrading, maintenance and security.



II. Literature Review

Cloud Computing Environment

The concept of cloud computing is tied to the concept of data storage, a third revolution of Information Technology (Gunvir & Sharma, 2014). The later is constituted by disks, flash, hard drives, networks distributed resource management and utilization as Sarga (2012) notes. Cloud computing is defined as a model for enabling ubiquitous on-demand network access to shared pool of configurable computing resources. Mell and Grance (2011) assert that it aims at allowing access of resources without the need for acquiring or purchasing the

software, network infrastructure but instead outsourcing them from third party vendors specifically Internet service providers (ISPs). Information systems consider cloud computing as the ultimate means of data storage. Being fast, based on pay-as-you-go model, it enables hosting of pervasive applications from consumer, scientific, and business domains (Sharma & Dhanda, 2014). It well addresses the issues pertaining to data storage as Stammers (2014) observes that data volumes will continue growing despite continuing advances in storage technology, business spending on storage will remain flat or it will increase. As establishments thrive to post huge margins on their business more and more data is generated hence need for more storage (Debasish, 2013). Magesh and Ramesh (2014) note that due to large scalability and virtualized resources in a dynamic way over the internet, organization need to unleash the core objectives of their formation. Transfer their services to the cloud to avoid time spend in heavy budgets on yearly allocations to procuring hardware, software and other computing resources. Pandey and Varshapriya (2014) outline the three fundamentals cloud computing models encompassing infrastructure-as-a-service (IaaS), platform-as-a-Service (PaaS) and Software-as-a-service (SaaS).

Total Cost of Ownership

Total Cost of Ownership (TCO) is an analysis meant to uncover all the lifetime costs that follow from owning certain kinds of assets. This being the reason, TCO is sometimes called life cycle cost analysis (Arsen & Darnay, 2008). Ownership brings purchase costs, as well as substantial costs for installing, deploying, operating, upgrading, supporting and maintaining the same assets. For many kinds of acquisitions, TCO analysis finds a very large difference between purchase price and total life cycle costs, especially when viewed across a long ownership period. Those who purchase or manage computing systems have had a high interest in TCO since the 1980s, when the potentially large difference between IT systems prices and systems costs increasing. Competitors of IBM for instance, used TCO analysis to argue that an IBM computing environment was an overly expensive ownership proposition. The five year cost of ownership for major hardware and software systems from any vendor can be five to ten times the hardware and software purchase price of IBM.

Today, TCO analysis is used to support acquisition and planning decisions for a wide range of assets that bring significant maintenance or operating costs across ownership life. Total cost of ownership (TCO) analysis is center stage when management is faced with acquisition decisions for computing systems, vehicles, buildings, laboratory equipment, medical equipment, factory machines, and private aircraft, for instance (Jones, 2013). In regard to information system asset acquisition, computers network infrastructure, hardware and software are the major drivers that qualify information system as assets to an organization. According to Davis and Olson (2003) information systems are various processes data for proper decision making. Assets are the key determinants operations of services such as online transaction processing, high end servers, client PCs, terminals, storage among other computing activities within an organization. For such, there is a need that either assets are acquired through buying implying the costs or receipts as donations. Various elements in regards to TCO are obvious costs and Hidden costs; where obvious costs are the costs familiar to everyone involved during planning and vendor selection, Purchases associated with the actual price of item paid, maintenance constituting warranty costs, contracted maintenance services (Jones, 2013). Hidden costs on the other hand are the less obvious cost that are easy to overlook and even omitted from acquisition decisions. Costs of this kind can be very large and real nonetheless. These costs comprise acquisition costs, item identification costs, selecting, ordering, receiving, inventorying, upgrades, refurbishing costs, reconfiguration costs. Set up and deployment costs of configuring space, transporting, installing, setting up, and integrating with other assets, outside services. Operating costs: constituting human labor, energy notably electricity costs. Change management costs: entailing costs of user orientation, user training, workflow/process change design and implementation.

Infrastructure support costs

Regarding costs brought by the acquisition for heating/cooling, lighting or IT support. Insurance and security costs are meant for safety of organizational assets. Whereas organizations strive to carry out their daily routines, this costs have made many establishments in the long run get out of business since they were neither realized nor factored in at the inception (Altman, 2006). The collapse of many companies like Uchumi stores in the year 2000 was a culmination of several managerial weaknesses leading to unsound investment decisions of tying resources into non-core business.

Departments in an organization are eligible to purchase hardware, software and other items at a guaranteed discounted price using their preferred vendors. There are major components associated with purchases of a PC in an organization. Some vendors may provide added incentives, such as an extra year of warranty service, when products are purchased through online stores. In a typical organization with procurement procedures, Kuyoro (2011) notes that there are steps required for purchasing ICT related items. All purchases involving ICT equipment or software need to go through the right process to ensure success. These include such items as all software, printers, laptops, cameras, among others. ICT will work with the user to

assess the needs of the purchase including surrounding needs entailing network and power drops. ICT will then assess the purchase and work with the user to ensure that nothing is missing from the purchase quote.

An upgrade is meant to move a system from one version of the software to the newer. Versions of both current and old versions of software are imperative to upgrade and clear understanding ought to be observed to minimize service disruption (Ajmani, 2014). There are two kinds of software upgrades: version upgrades and bug fixes. Bug fixes are usually much more frequent, and CIOs do apply them as soon as they become available. In some cases they correct major software performance or security problems. Version upgrades notably the large omnibus service packs such as the ones Microsoft releases for Windows operating systems they include fundamental changes to the software and are much less frequent. Major upgrades are potentially disruptive to business; however, they should be handled with care. Upgrading equally poses more challenges when it comes to distributed data on all nodes at once within the organization (Ajmani, 2014). According to Ajmani (2004) a class upgrade has six components namely oldClass, newClass, TF, SF, pastSO, futureSO. The oldClass identifies the class that is now obsolete; *newClass* identifies the class that is to replace it. TF identifies a transform function that generates an initial persistent state for the new object from the persistent state of the old one. *SF* identifies a *scheduling function* that tells a node when it should upgrade. PastSO and futureSO identify classes for *simulation objects* that enable nodes to interoperate across versions. A futureSO object allows a node to support the new class's behavior before it upgrades; a *pastSO* object allows a node to support the old class's behavior after it upgrades. These components can be omitted when not needed. The effect of an upgrade is ultimately to cause every node running an object of an old class to instead run an object of the new one.

Maintenance

Corrective maintenance is fixing what was wrong in the original program. Whereas adaptive maintenance are changes outside the system of owner's control, the changes in the environment are aspects within the system that enable it to operate (Kent & Williams, 1995). Since we live in a world of technology that moves fast, when a computer isn't running properly it can slow the whole operations down. With desktop computer repair, many problems can be fixed fairly quickly and without a large cost to the organization. Cleaning viruses, bugs, and trojans is something many computer services can handle. These are all very common problems. Sometimes a desktop repair service can fix these problems by connecting to a PC over a virtual web connection. However, if the computer doesn't start then there will be need to ship the unit or take it somewhere to be fixed. This process has led many organizations to hire computer technicians in readiness to any eventuality. Typically, PC repair companies don't give a firm quote on the cost of fixing a computer. It can be tough to determine the exact amount of time it will take to fix a hardware problem. Most people pay $100 to $300 for the completed task. Where you fall on that scale depends on what you require done and the company you hire (Eckert, 2015). System freeze-ups, virus problems, and software conflicts regularly take two to three hours to fix. Recovering information from a crashed hard drive takes a little more expertise and time. Network problems might require a company that specializes in networking solutions. This will compel organization to invest in either a specialist or outsourced for business continuity. A typical computer repair technician doesn't have the proper training to repair a large network with multiple systems. A network technician will charge $75 to $125 for their expertise on this level (Eckert, 2015). Network service costs are more expensive than PC repair services. Many things can go wrong with networks and troubleshooting them can be difficult, asserts Eckert. Home networking problems usually involve discrepancies between the router, modem and the computer in question. Larger networks with computer, printer, and phone networks have a much higher overall cost to fix and diagnose problems. Costs can rise upwards of $5,000 to fix networking problems. Large scale network problems can be difficult to pinpoint, taking many man-hours to detect. If the threat is malicious, an outside specialist may have to be called in to remedy the problem.

III. Methodology

Research Design

The study employed a descriptive design to assess the attitudes and opinions of respondents in regard to cloud computing environment on total cost of ownership. Babbie (1992) commends descriptive design as the best method available for collecting original data for describing a population that is too large to observe directly. The study was carried out in Nairobi, Kenya with non-probabilistic sampling in use to select respondents from Access Kenya and Safaricom. The target organizations were ideal since they had the largest number of clients and potential in terms of voluminous data storage. As a capital city and major town in Kenya, Nairobi was ideal for the data collection exercise because many organizations have accessibility and benefited largely on the network resources and infrastructure, hence they rely heavily on online services.

Study Population, Sampling Procedure and Sample Size

The study targeted 150 employees drawn from both Safaricom and Access Kenya. The respondents included Chief Information Officers, technicians and computer network users. The study employed purposive sampling technique to select the study sample size. Sample size was determined by use of quota sampling technique where the target population was put into subgroups of the CIOs, technicians and network users. Thereafter, proportionate sampling was used to select the representation of each group. To determine the sample size Fischer's formula as quoted in Mugenda and Mugenda (2003) was used:

$$n = \frac{Z^2pq}{d^2}$$

Where: n is desired sample size, Z = the standard normal deviation at the required confidence level, p is the proportion in the target population estimated to have the characteristics being measured. According to Fisher et al, as cited in Mugenda and Mugenda(2003) if the estimate is not available of the proportion (p) in the target population assumed to have the characteristics of interest, 50% should be used and in this case p is 0.5, q is 1-p = 0.5. d = the level of statistical significance set. 1 = a unitary. Thus: $n = (1.96^2 \times 0.5 \times 0.5)/0.05^2 = 384$. However, since the target population of approximately 150 is less than 10,000, the final sample size estimate can be adjusted as recommended by Mugenda and Mugenda (2003).

$nf = n / (1 + n / N)$

Where; nf= the desired sample size when the population is less than 10,000; n = the desired sample size when the population is more than 10,000; and N = the estimate of population size.

Substituting values nf = 384/(1 + 384/150) thus nf = 107. This sample was then distributed according to the number of employees in both Safaricom and Access Kenya in order to achieve representation from various groups.

Instrumentation

Data was collected through a structured questionnaire. Besides the closed-ended questions, the 5-point Likert Scale was used to assess the attitudes of the respondents by asking them to rate given statements.

Data Analysis

The analysis of the research data proceeded through four major steps: data cleaning or editing; coding; tabulations; and interpretation of results (Obure, 2002). Data processing was carried out using the Statistical Package for Social Science. Descriptive analysis was used; descriptive statistics which includes frequency tables, means, percentages and summary tables was used in data presentation and description of the subjects (Lind, 2003).

IV. Results

4.1 Cloud computing on acquisition costs of computer accessories

On the purchase cost the study sought to establish the attitudes and opinions on cost of acquiring server, client, printer, software and network respectively. In order to assess the extent to which cloud users agree that cloud computing reduces the costs of computer accessories in organizations, respondents were presented with a five rating relating to this question and asked to indicate their level of agreement with them. Table 1 shows the distribution of their responses.

Table 1: Cost of server

Cloud Reduction of server costs	Responses (%)														
	CIO					Technician					Network users				
	VL	L	SE	GE	VG	VL	L	SE	GE	VG	VL	L	SE	GE	VG
Acquisition	0.0	0.0	50.0	0.0	50.0	3.4	5.1	23.8	33.9	33.9	3.6	28.6	32	17.9	17.9
Operating System	0.0	0.0	50.0	50.0	0.0	0.0	11.9	27.1	45.8	15.3	0.0	17.9	11	53.6	17.9
Power Consumption	50.0	0.0	0.0	0.0	50.0	0.0	3.8	28.8	50.0	17.3	6.9	13.8	35	31.0	13.8
Setup	0.0	50.0	0.0	0.0	50.0	0.0	27.6	20.8	19.0	32.7	0.0	25.0	39	17.9	17.9
License	0.0	100	0.0	0.0	0.0	1.9	13.5	32.5	36.5	15.6	4.3	4.3	26	39.1	26.1
update	50.0	50.0	0.0	0.0	0.0	0.0	25.0	26.7	15.0	33.3	3.6	25.0	29	10.7	32.1
Support	50.0	0.0	50.0	0.0	0.0	0.0	30.9	27.3	23.6	18.2	0.0	39.3	46	10.7	3.6
Security	0.0	0.0	0.0	0.0	100.0	0.0	0.0	11.5	29.5	59.0	0.0	0.0	3.3	46.7	50.0
Configuration	0.0	0.0	0.0	100.0	0.0	3.8	11.5	7.7	38.5	38.5	8.7	4.3	22	39.1	26.1
Storage	0.0	50.0	0.0	50.0	0.0	1.7	23.3	26.7	15.0	33.3	3.6	25.0	32	7.1	32.1
Maintenance	0.0	0.0	0.0	50.0	50.0	0.0	15.0	16.7	28.3	40.0	0.0	3.6	18	50.0	28.6
Total			**2**					**61**					**30**		

As can be observed, most of the respondents generally felt cloud computing reduces server costs, have a positive attitude towards the cloud in cost reduction, with the exception of the support, updates, licenses and storage. For CIOs, 50%, and 100% felt to a great extent with the statement 'Cloud computing has reduced server costs' in relation to operating system, security, maintenance, storage and configuration respectively. Acquisition, operating systems and support recorded some extent with a total of 50%. Power consumption, setup were sparsely distributed on 50%/50% basis for very little extent and very great extent respectively. But on the other hand (50%) very little and little extent with the statement in relation to the update, license at 100% and storage. Generally, the level of little extent and some extent with the statement in relation to other costs was low, averaging 35% and 25% respectively. Majority of the technicians also agreed with statement, again the exception being the support, setup and update. Only 30%, 27% and 25% demonstrated great extent and very great extent with it in relation to this costs compared with 88% for security, 77% for configurations, 68% each for maintenance, acquisition and power consumption, 61% for operating system, 52% for license, and 48% for updates. Just as the technicians, majority of the network users agreed with statement, again with the exception being the support, setup and update. Only 30%, 27% and 25% agreed with it in relation to this costs compared with 96% for security, 78% for maintenance, 71% for operating system and 65% configurations. The level of agreement to 'some extent' was significant, at 28%. While the CIOs did not agree with the statements in relation to power consumption, license and updates, the agreement to some extent was significant, at 31%. Generally, the technicians showed a higher level of agreement to 'some extent' with this statement: 46% for support; 39% for setup; 32% each for acquisition and storage. But for the costs on configuration and the updates, all network users agreed to a 'great extent' with the statement regarding network users' attitudes towards the server costs. Basing on the attitudes, this indicates that the majority of the users appreciated the fact that cloud computing reduces the costs associated with the servers in organization.

Cost of Client Machine

In order to assess whether cloud users agreed that it reduces the costs of computer accessories in organizations, respondents were presented with a five statements relating to these statements. They were requested to indicate their degree of agreement or disagreement on a five-point range. Table 2 shows the distribution of their responses on these statements.

Table 2: Cost of client machine

Cost of client machine	Responses (%)														
	CIO					Technician					Network users				
	VL	L	SE	GE	VG	VL	L	SE	GE	VG	VL	L	SE	GE	VG
Acquisition	0	0	50	0	50	0	31	32	27	10	0	19	34	24	23
Antivirus	0	0	50	50	0	0	22	27	36	15	0	21	11	51	18
setup	0	50	0	0	50	0	28	33	19	21	0	25	39	18	18
update	0	50	0	0	50	0	25	25	17	33	4	25	29	11	32
Configuration	0	0	0	50	50	0	10	38	38	14	0	0	26	43	30
Total	**2**					**61**					**30**				

As per the table above, nearly all the respondents across the categories agreed to 'some extent' on the client machine reduction costs. With exception of setup, update and configuration costs for CIOs; at least all had an average of 50% and 10% for acquisition, antivirus, setup, update and configuration for the technicians and network users' categories. The cost of antivirus and configurations were agreed a great extent percentages of between 51% and 73% for technicians and network users; it remain 50% each for the CIOs.setup and update costs was agreed to a little extent by 50% each for CIOs, his is perhaps due to the fact that client computer must get some online updates and setups, this item would have been analysed properly should the researcher had chosen to use interview method. However with the number of rating that waspresented to the respondents, the distribution shows that majority of the users agree to a great extent that cloud computing reduces the costs of client computer.

The Cost of Printer

In order to assess an extent whether cloud users agree that it reduces the costs of computer accessories in organizations, respondents were presented with a five statements relating to these statements. They were requested to indicate their degree of agreement or disagreement on a five-point range Table 3 shows the distribution of their responses on these statements.

Table 3: The Cost of Printer

The cost of printer	Responses (%)														
	CIO					Technician					Network users				
	VL	L	SE	GE	VG	VL	L	SE	GE	VG	VL	L	SE	GE	VG
Acquisition	0	0	50	50	0	2	31	32	27	8	0	21	34	24	21
Ink	0	0	50	50	0	0	12	27	46	15	0	18	11	54	18
Setup	0	50	0	0	50	0	28	33	19	21	0	25	39	18	18
Paper	50	50	0	0	0	0	25	25	17	33	4	25	29	11	32
Configuration	0	100	0	0	0	0	12	38	38	12	0	4	22	43	30
Total	**2**					**61**					**30**				

As per the table above, the survey showed that other than acquisition and ink 50% each for CIOs in agreement with the statement for 'some extent' and great extent' respectively; the cost of setup, paper and configuration (50%, 50% and 100%) were regarded to a 'little extent' respectively. The cost of printer setup; 50% of the CIOs agreed to a very little extent, another 50% agreed to a very great extent.28% of the technicians agreed to a little extent, 33% agreed to some extent while 19% and 21% agreed to a great and very great extent respectively.25% of the network users agreed to a little extent on the cost of printer setup, 39% agreed to some extent while 18% was agreed both to a great extent and very great extent respectively. 50% of the CIOs agreed to a very little extent and to a little extent that the cost of paper has been reduced by the advent of cloud computing.25% of the technicians agreed to a little extent, 25% to some extent while 17% some extent, 27% and 8% agreed to a great and a very great extent. 4% of the network users agreed to a very little extent whiles 25%

to little extent, 29% agreed to some extent, 11% and 32% agreed to a great and very great extent 100% of the CIOs agreed out rightly to a 'little extent' and to a 'great extent' respectively that the cost of configuration has been reduced by the advent of cloud computing. 12% of the technicians agreed to a little extent, 38% to some extent, 38% and 12% agreed to a great and a very great extent. 4% of the network users agreed to a little extent whiles 22% to some extent, 43% and 30% agreed to a great and very great extent.

Software Cost

In order to assess an extent to which cloud users agree on reduction of costs for computer software in organizations, respondents were presented with a five statements relating to these statements. They were requested to indicate their degree of agreement or disagreement on a five-point range. Table 4 shows the distribution of their responses on these statements.

Table 4: Software Cost

Software cost	Responses (%)														
	CIO					Technician					Network users				
	VL	L	SE	GE	VG	VL	L	SE	GE	VG	VL	L	SE	GE	VG
Acquisition	0	0	50	50	0	2	31	32	27	8	0	21	34	24	21
license	0	0	50	50	0	0	12	27	46	15	0	18	11	54	18
Setup	0	50	0	0	50	0	28	33	19	21	0	25	39	18	18
updates	50	50	0	0	0	0	25	25	17	33	4	25	29	11	32
Configuration	0	100	0	0	0	0	12	38	38	12	0	4	22	43	30
Total			**2**					**61**					**30**		

The table shows some mixed reactions among the three categories of the respondents. With the exception of the configuration for CIOs 100% for little extent, the level of extent among the respondents was dichotomous for CIOs, 50% for some extent and 50 percent for great extent on cost of software as well as cost of license. The levels of little extent was observed in all other components on cost of setup, updates both little extent and very little extent 50% respectively; configuration costs at 100%. Technicians opinion on this question was continuum; except for the 2% agreeing to a' very little extent' for acquisition costs; an average of 25% was observed to be in agreement for a 'little extent' on software costs of license, setup, updates and configurations. However, there were varied opinions regarding 'great' and 'very great extent' for acquisition, license, setup, updates and configuration software costs; with a high response rate of 'great extent' of 61% for the license costs while a low of 35% for acquisition cost was observed respectively. Majority of the network users had also a mixed of reaction between' little extent' and 'very large extent' with exception of updates costs that reported 4% agreement for 'very little extent' while 25% each for setup and updates agreed to 'some extent'. The entire response rate for the technicians agreeing to 'some extent' on software costs averaged at 27%. Over 70% of the network users agreed to a great extent license cots and configuration costs respectively. 45%, 36% and 43% agreed to a 'great extent' for; acquisition, setup and updates respectively.

Cost of Network Security

Network security being a crucial component in a networking environment, the following three issues were lumped together for analysis; support, firewall and router. In order to assess the opinion of cloud users regarding the extent whether it reduces the costs of computer networks in organizations, respondents were presented with a five rating statements relating to these question. They were requested to indicate their response on a five-point range. Table 5 shows the distribution of their responses on these statements.

Table 5: Network Security Costs

Network costs	Responses (%)														
	CIO					Technician					Network user				
	VL	L	SE	GE	VG	VL	L	SE	GE	VG	VL	L	SE	GE	VG
Support	0	0	50	50	0	2	31	32	27	8	0	21	34	24	21
Firewall	0	0	50	50	0	0	12	27	46	15	0	18	11	54	18
Router	0	50	0	0	50	0	28	33	19	21	0	25	39	18	18
Total			**2**					**61**					**30**		

From the analysis, 50% each for costs of network support and firewall recorded 'some extent' and 'great extent' respectively for CIOs. However, there was a diverse view on the costs of the router where 50% each 'little extent' whiles another to a 'very great extent' was observed respectively. Other than 2% observed to a 'very little extent' among the technicians, 31%,28% and 12% recorded 'little extent' for network support, firewall and router costs respectively; whereas an average of 30% recorded to 'some extent' this seems lower compared to the CIOs though much higher than the network category of 28%. However quite a number still felt to a 'great extent' with 61%, 40% and 35% for firewall , router and support costs respectively. A number of the network users an average of 24% agreed to a 'little extent' against 28% of those who agreed to 'some extent'. However there was high score on those who agreed to a 'great extent' for firewall with 72%, 45% for support and 36% for router. Given the range of options provided for responses, it can be observed that quite a number of respondents agreed to a 'great extent' that network cost has been reduced.

Assessing the effect of cloud computing on cost of infrastructure

This section presents results in relation to the costs associated with computer network infrastructure. In organization there is heavy investment on local and wide area networks, structured cabling, data transfer rates, virtualizing shared resources and network performance. In order to assess the level of cost of infrastructure reduction on cloud services to organizations, respondents were presented with statements to rate as applicable to their organization. The distribution is shown in table 6.

Table 6: Reduction in Network Resources

	Responses (%)											
	CIO				Technician				Network			
	SD	D	A	SA	SD	D	A	SA	SD	D	A	SA
WAN drastically reduced	0.0	0.0	100.0	0.0	3.4	51.7	43.1	1.7	9.4	40.6	43.8	6.2
Data Transfer rate	0.0	0.0	50.0	50.0	1.8	22.8	33.3	42.1	0.0	34.4	9.4	56.2
Structured cabling has been minimized	0.0	100.0	0.0	0.0	0.0	41.8	38.2	20.0	0.0	40.6	40.6	18.8
Virtualization	0.0	0.0	0.0	100.0	0.0	43.9	40.4	15.8	3.0	57.6	33.3	6.1
Thin client	0.0	0.0	50.0	50.0	1.7	43.1	46.6	8.6	6.1	42.4	30.3	21.2
Network Performance improvement	0.0	100.0	0.0	0.0	0.0	34.5	41.8	23.6	0.0	36.4	42.4	21.2

As can be observed from the table 6, most of the respondents felt cloud computing reduces network resources with the exception of structured cabling and network performance improvement for CIOs who disagreed. This is relevant given the nature of work that draws the need for departmental connections having cables run through various sections of the organization. For CIOs 100% each agreed for WAN reduction and virtualization; 50% each was divided amongst those who agreed and strongly agreed respectively for data rate transfer and thin client.A section of the technicians had varied opinions but besides WAN reduction; data transfer rate, network performance improvement, structured cabling, virtualization and thin client (75%, 65%, 58%, 56% and 55%) respectively. But most of them (55%) disagreed with the statement in relation to the WAN drastic reduction in the network. Generally, the level of disagreement with the statement in relation to other components was low, averaging 37%. It appears for the observation the element of WAN was not appreciated in this statement. Just as the other categories, network users reported 50% disagreement for WAN reduction; virtualization scored poorly (nearly 61%); data transfer rate, network performance improvement, structured cabling and thin client was fairly agreed (65%, 63%, 59% and 51%) respectively. Even though a high level of

disagreement was recorded for WAN reduction, in this network category of the respondents 50% still agreed that it has been indeed reduced as a result of network resources.

V. Conclusions and Recommendations

5.1 Conclusions

The study sought to establish the effect of cloud computing on total costs of ownership. Based on the findings it is concluded that cloud computing reduces server cost by reducing security, maintenance, acquisition and power consumption, operating system, license and updates, support, setup and storage. It also reduces the cost of client machines, antivirus and configurations, cost of printer, acquisition and ink, paper and configuration and software costs. Hence, cloud computing reduces purchasing costs for computer accessories (server, client machine, printer, software and network support cost).

It is also concluded that cloud computing reduces network resources such as WAN costs, data transfer rate, network performance improvement, structured cabling, virtualization and thin client architecture, Therefore, the study concludes that except for the WAN connectivity costs, drastic reduction in IT infrastructure for users, the costs of these services have reduced the speed of connectivity.

5.2 Recommendations

The following recommendations are derived from the findings of the study:

Based on the conclusions drawn from the study, the following recommendations are made:

i. Organizations should embrace cloud computing services in order to reduce total cost of ownership of computers and its accessories.
ii. The government should support cloud computing adoption in organizations in Kenya by providing the infrastructure necessary to support the adoption.

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