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Sustainable School management systems in Kenyan secondary schools: A comparison between cloud based systems versus on premise based systems.

By

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Declaration

This research project describes the work undertaken as part of a program of study at University Of Nairobi, School of Computing and Informatics. The research is my work and has not been submitted for an award of a degree in any other university.

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Abstract

Use of ICT in managing secondary schools in Kenya has been rarely used; Schools started embracing ICT tools and used them for typing letters and exams. Seven years ago schools began automating their management systems; however some schools experience a lot of problems with these systems such as high cost of ownership, maintenance and lack of ICT personnel.

The purpose of this study was to compare the two available methods of running SMS; on-premise and on cloud. In doing so the study revealed the challenges experienced by on premise SMS and many opportunities for solving these challenges that cloud SMS presents.

The capital expenditure required in each case was studied, also studied was recurrent expenditure and security issues in each case. The study looked ICT costs, qualitative benefits and quantitative benefits.

The study targeted schools that have automated school management processes in Limuru District of Kiambu County and ICT companies that offer SaaS cloud computing services in Kenya. Data collection was done by use of questionnaire and interview.

The study revealed many problems experienced by Kenyan secondary schools while implementing on-premise SMS; the major problem being insecurity in their locations, which has lead to hardware loss for up to 50% of the schools while 30% of the schools lost their data due to poor data protection measures attributed to lack of ICT personnel. ICT costs was another problem facing secondary schools, it was observed that initial hardware costs were very high and wished to have an option of reducing these costs. Use of inappropriate technology is prevalent in schools with 50% of schools using MS Access as a database.

Cloud computing can help schools solve a lot of problems such as providing better security for their data and by avoiding capital expenditure for ICT which is in millions of shillings. It will also provide easier access to school information by stakeholders without the need to travel to school to access the same information. The much needed ICT expertise lacking in schools will then be provided by the cloud provider.

It is advisable for school to move their SMS to the cloud and the schools that have not automated their systems should consider adopting cloud SMS directly. This will allow them reap the benefits of the cloud on reducing costs, securing data and available ICT staff.

Keywords: SMS, on-premise SMS and cloud SMS

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Dedication

To my wife Nelisa,

My children

Lincoln, Ryan and Abby

And my Parents; Julius and Margaret

I cherish you all for what you are and continue to be

I love you all.

God bless you.

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Definition of terms

ICT - Information and communication technology.

CC – cloud computing.

ICT – Information and communication technology.

SaaS – Software as a service.

CAD – computer aided design.

DBMS – Database management systems.

CRM - Customer relationship management.

MIS – management information systems.

ERP – Enterprise resource planning.

HRM - Human resource management.

CM – Content management.

PaaS – Platform as a service.

IaaS – Infrastructure as a service.

SMS – School management systems.

CAPEX - Capital expenditure.

OPEX - Operation Expenditure.

CEO - Chief executive Officer.

CIO - Chief information officer.

UN – United Nations.

DEO – District education officer.

TSC - Teachers' service commission.

PTA – Parents teachers' association.

BOM – Board of Management.

KNEC - Kenya national examinations council.

HOD – Head of department.

ESP - Economic stimulus package.

API – Application Programming interface.

BECTA - British Educational Communications & Technology Agency.

TCO - Total cost of ownership.

CHAPTER ONE

INTRODUCTION.

1.1 Background Information.

Due to huge workloads and repetitive work of managing schools, some public secondary schools have automated tasks of school management. This has be done by use of school management systems, which are computerized systems (hardware and software) that help teachers and administrators prepare records of students and other staff for easy operation at the paying salaries, producing academic records among others. When schools acquire these resources and make good use of them, they experience a reduced workload, faster and neater ways of working and reduced errors in their records.

Many school management systems are typically hosted within the schools (on premise). They are procured and fully owned by individual schools. The SMS are usually custom made by a vendor for the school, since different schools have different needs. Some schools buy servers, desktop computer and the software which includes: school management systems (SMS), application software, operating systems etc.

Despite the benefits of automated SMSs, many of the schools that run automated SMSs continue to experience quite a number of challenges.

1.2 Challenges experienced by schools in running on premise SMSs

In government secondary schools, the major challenge to the management is the cost of running them. To determine school fees a school prepares it budget by collecting and summing all the needs of the following year. The total is divided among all the students in the schools, the amount arrived at is reduced by the amount the government subsidizes per student per year, currently the amount is ten thousands two hundred and sixty five Kenyan shillings (10,265) which is expected to rise to thirteen thousands Kenya shillings (13,000)   per year per student from the year 2015; the remaining amount is paid by each parent for their children. Kenya being developing nation in sub-Saharan Africa, means that majority of the people are poor living on less than a dollar per day, this underscores the difficulties through which schools undergo while trying to fund schools projects and every opportunity available to reduce cost should be utilized. It is therefore very important for the school management to make a cost effective choice for a school management system so as to ease financial budget on parents.

The **cost** of owning computer **hardware** required is very high, a standard sever which guarantees a lifetime of 5 years and good processing speed may cost as much as Ksh.400,000. This cost coupled with the high cost of maintenance and upgrading puts a lot of financial demand on schools which are already poorly funded.

Despite the high cost of owning servers, they are idle most of the time during the school holidays (3 months in a year). And during their peak performance they are not be fully utilized. This leads to the resources being **underutilized**.

Maintenance of any device is as important as owning it, if it shall continue to be useful during its lifetime to the organization owning it and other stakeholders. In many schools teachers lack the technical knowhow on computer maintenance and the poorly funded schools donǿt have resources to train their teachers on the same or even hire qualified technicians.

Those with enough resources have had bad experiences of training their teachers who are later transferred to other schools by their employer the TSC or have moved to better paying jobs, as schools cannot afford to **retain** them, leaving the schools which trained them with no one to maintain their devices. Some schools hire technicians because some teachers are not willing to undertake the tasks of maintaining these devices, they only want to concentrate on their tools of trade, teaching. Schools that hire qualified technicians have little workload, these technicians idle most of the time which is not in tandem with their pay.

Computers consume **electric power** which is very expensive to make initial connection; all this cost is borne by schools if they are to connect to the grid as a result many schools are still not connected to the national grid. Installing power brings with it a monthly bill; this bill increases with computers hence high cost of running schools.

Softwares are expensive to purchase and even after purchasing schools have to contend with annual license fee per user. When summed up all these costs are so high that schools cannot afford unless they are give softwares as donations which is not common or opt for open source software.

Many schools find it challenging to guarantee **physical security** to their schools assets; this is because security officers in schools have poor or no training and use inferior weaponry such as pangas, bows and arrows as compared to robbers who may have firearms. It is common in Kenya for schools to lose their assets over the school holidays through theft and vandalism. Some schools had their computers stolen the same night they received them e.g. the new computers supplied through the economic stimulus package (ESP).

Some teachers don't live in the school compound and might be required to travel over the weekend or during the holidays to provide some feedback to school on exams results or other information relating to students. To do this, these teachers will require **access** to the SMS, which is not possible except when in the school. This means that the results will not be available or the teacher will be inconvenienced and incur more expenses by travelling to school to access the system.

In the current world people have a **busy lifestyle** and even finding time outside their busy schedule is hard. Parent teacher interaction is a problem because of the busy lifestyle of both the teachers and parents, this means busy parents are not able to respond to summons and as a result do not take corrective measures incase anything goes wrong with their children or when they do, it might be done too late. Whenever parents want to get information on their children in schools they have to travel to schools or initiate a request for information to schools. The response may not be in time or might come in the format that is not helpful.

1.3 Problem Statement

The cost of owning, maintaining and securing the servers and software required to run the on premise SMS is very high to many schools which are poorly funded.

There has been a shift within the IT industry towards cloud computing. Cloud computing enables organizations to outsource IT resources from a cloud provider for a limited period of time and pay for only what they use, instead of purchasing, installing and maintaining their own on premise IT resources (mainly server hardware and software). As a result procurement, maintenance, security costs etc are borne by the cloud provider who benefits from economies of scale. These benefit trickles down to cloud customers. If schools choose cloud computing for their SMS it is expected that their costs will drastically fall.

Faced with the challenges of owning, maintaining and securing the servers and software required to run the SMSs as discussed above, it is possible that a paradigm shift in the provision of ICT solution to schools by use of cloud computing could lower cost and make SMS highly accessible. However currently there is very limited information on the comparative costs of running SMSs on premise and running them on the cloud. There is need to close this gap and provide such information so as to enable school administrators make an informed decision on whether or not cloud computing is a more suitable and more cost effective platform for running SMS.

1.4 Overall Objectives

To compare cloud computing SMS to on premise SMS as a solution to Kenyan secondary schools SMS solutions and recommend on their suitability in the current schools setup.

1.5 Specific objectives

1. To investigate the challenges faced by Kenyan secondary schools in owning and running on premise based SMS systems.

2. To investigate the financial costs incurred in owning and running on premise based SMS systems in Kenyan secondary schools.

3. To investigate the possibilities available to the Kenyan secondary schools to connect to the internet in order to facilitate access to cloud services and the cost involved.

4. To investigate the operational requirements and costs of running SMS for Kenyan secondary schools on the cloud.

5. To determine if cloud computing forms a more suitable solution for running SMSs in Kenyan secondary schools than on premise based solutions.

1.6 Research questions

This study will seek to answer the following questions; all derived from the study objectives:

- What are the challenges faced by Kenyan secondary schools in setting up and running on premise based SMS systems?

- What are the financial costs of running on premise based SMS systems in Kenyan secondary schools?

- What are the costs of connecting to and accessing cloud services in Kenya?

- What are the operational requirements and costs of running SMS for Kenyan secondary schools on the cloud?

- How does the cost of running on premise SMS systems in Kenyan secondary schools compare to cot of running cloud based SMS systems? Is Cloud computing a suitable solution for providing ICT resources to Kenyan schools?

1.7 Hypothesis

- On premise SMS is more expensive solution to run than cloud based SMS
- Cloud computing will provide more suitable ICT resources in Kenyan schools than on premise SMS.

1.8 Justification

The results of this study will be useful and will provide useful information to the following groups of people.

- The study will provide guidance to schools management so as to make wise decisions while implementing SMS in their school.
- The study will provide addition knowledge on cloud computing and school management systems (SMS).
- Investors in cloud computing and SMS will get the necessary information concerning what is the concerns their customers in their systems.

1.9 Scope

The study shall involve all the secondary schools in Limuru District of Kiambu County of the republic of Kenya.

1.10 **Overview of the report**.

This report is made up of the following chapters;

Introduction is the first chapter in this report and it explains the problem at hand and looks at the objectives and justifies the study.

Literature review is the second chapter and it provides information on the work done on cloud computing, school management systems and cloud based school management systems from other studies that are related. It also has a framework upon which the study shall be based.

Methodology is the third chapter and explains what the researcher did do to actualize the study. It highlights the data to be collected, sampling and sample size and how data shall be analyzed.

Chapter 4 has information on data analysis, interpretation and discussions. Data is presented and research questions are answered.

Chapter 5 is about summary, conclusion and recommendations. It highlights the findings without going into details and also provides the researcher's view on the solution.

The books and academic papers used in the study are summarized in the **reference** section.

Appendices has the following components, the questionnaires, time plan for research, budget and analysis from supporting data which has no direct impact on the study.

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Chapter Two

Literature Review

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2.1 **Overview**

This chapter gives a detailed overview of cloud computing and school management systems. It also looks at the past studies on the two topics.

2.2 Cloud computing

The definition of cloud computing is obscure and still evolving, but in a nutshell cloud computing is the provision of ICT resources on the pay-as-you go basis just like we pay for utilities such as electricity. Cloud computing is a model for enabling ubiquitous, convenient, on demand network access to a shared pool of configurable computing resources and services that can be rapidly provisioned and released with minimal management effort or service provider interaction (Mell P. & Grance T., 2011).

In earlier days companies used to generate their own electric power for consumption. This power was very expensive because each company required its own personnel, machines and transmission lines on each branch. When power companies put electricity on the grid and electricity became a utility the cost went down and the time to connect electricity reduced drastically. This is what is also happening to IT; many companies have owned and operated all the ICT resources required to run a company: servers, personnel and software. Cloud computing is turning computing to a utility where servers, main IT personnel and some software are provided by cloud providers on pay as you go basis (Acher G., 2013). The author also notes that major enabler of this is the availability of high speed broadband enabling consumption of IT over the internet.

The origin of the term cloud computing is derived from the practice of using stylized cloud to denote networks in diagrams of computing and communications systems. This technology has evolved for many years from the time of dumb terminals and mainframes. This was discarded when people were able to own computers due to reduced prices of computers, thanks to microprocessors.

This new way of acquiring ICT services has really grown in the last few years and is likely to grow even more. The users no longer need to buy, build, install and operate expensive computer hardware and software. Users will simply access the resources they need and just pay for these resources which they use, these resources are ubiquitous.

In today's globalized world it is important for companies to secure their competitive advantage. Companies must leverage their core competencies and be agile enough to evolve with the environment,

especially in IT. Cloud computing is essentially important for small businesses who cannot predict their future growth, they only consume just a handful of resources and they pay as they grow. When they experience booming businesses they are able to scale in the cloud. Tango.me a company that provides mobile video conferencing services, is a good example of a small company which utilizes the cloud services. Small companies want to save as much as possible without having to tie much of their financial resources in IT expenditure especially when their future growth is uncertain.

Many people knowingly or unknowingly have adopted cloud services and are part of their lives, such services includes Google maps, Apple itunes, Amazon Webservices and Microsoftøs hotmail. In the modern world some of the companies that provide software as a service (SaaS) to people include: Google, Microsoft, Vmware, Bluelock, salesforce.com and Citix among others. In Kenya there are safaricom, seacom , access Kenya e.t.c.

2.2.1   Cloud Characteristics.
The following are characteristics of the cloud as defined by Mell P. and Grance T. (2011).

On-demand self-service. A consumers of cloud services can provision unilaterally computing capabilities such as network storage and server time as needed automatically without requiring human intervention.
 Broad network access. Cloud capabilities are available over the network and are accessed through standard mechanism that promotes use by heterogeneous thick or thin client platforms e.g. mobile phones, tablets, laptops and workstations.

Resource pooling: The computing resources have been put together to serve multiple consumers using multi-tenant model. These physical and virtual resources are dynamically assigned according to consumer demand. They provide location independence where a consumer does not know the exact location of the resources they consume.

Rapid Elasticity. Computing capabilities are provided automatically, capabilities scale outwards or inwards depending on demand. A consumer views this capability as being unlimited and that it can be availed at any quantity at any time.
Measured Service: The resources available in the cloud are automatically controlled and optimized by leveraging a metering capability at different abstraction levels depending on the kind of service. Resources are monitored, controlled and reported with transparency to both provider and consumer.

2.2.2 Cloud Service Models.

The following are the services which the users are able to get from the cloud. These services are at different maturity stages.

a) Infrastructure as a service

Infrastructure as a Service (IaaS) allows providers to lease equipments used to support operations such as storage, hardware, servers and networking components. These resources are scalable by consumers, available when needed and on pay as you use basis. They are also available from anywhere provided there is a connection to them and there is an agreed protocol. These resources are provided with a degree of redundancy to avoid a single point of failure. A good example is sky drive by Microsoft which provides a free storage upto 6 Mb of data.

b) Platform as a service

Platform as a Service (PaaS) in this model the consumer makes software using tools availed to him by the cloud provider, the consumer controls software deployment and configuration settings. The provider also provides network, servers and capability provided to the consumer is to deploy onto the cloud infrastructure consumer created or acquired applications created using programming languages. One of the examples of this is the azure by Microsoft.

c) Software as a service

Cloud provides the following service models: Software as a service (SaaS) where a consumer is able to access and use an application provided by the cloud provider. In this model a customer is able to access and utilize an application and its associated data some of the most common used applications in this model include Office & Messaging software, DBMS software, Management software, CAD software, accounting, customer relationship management (CRM), management information systems (MIS), enterprise resource planning (ERP), human resource management (HRM), content management (CM) one of such company is salesforce.com which provides CRM. SaaS removes the need for companies to install, set-up, maintain and the cost of buying hardware

Infrastructure	Platform	Software
Data storage	Operating system	Email and Word Processing
Processing power	Web servers	Human Resource Management
Server virtualisation	Development platforms	Customer Relationship Management (CRM)

Figure 1   Examples of cloud services: Source Acher G.(2013).

2.2.3   Cloud deployment models

Cloud computing has several deployment models such as: private deployment model where an organization solely runs the cloud infrastructure; community cloud where the infrastructure is shared among several organizations and supports a given community; public cloud which is made available to the general public and owned by organizations selling and hybrid cloud which is a composition of two or more of the above deployment models.

a) Private cloud

In Private deployment model the cloud is owned, used and maintained by an enterprise. It contains a common pool of virtualized resources. This model is quite similar to traditional methods of deploying IT but they offer some benefits of cloud computing such as better latency and security. It is suitable for large organizations that have huge demands, government agencies, banks and insurance agencies that require lots of security to their data.

b) Community cloud

A group of organizations which do not compete against each other in a geographical location may work together with the common aim of realizing the economies of scale. These organizations may jointly create a community cloud. Such organizations include schools, churches and NGOøs.

c) Public cloud

The public cloud is owned by any one that wants to do the business of providing IT services to the general public through the internet. These services are shared amongst clients and are located in any part of the world. In this deployment model the real benefits of cloud are realized. Examples of public cloud providers include Google, Microsoft, Amazon, Safaricom, Access Kenya, E-momentum among many others.

d) Hybrid cloud

In the hybrid model a company has a private cloud where it seeks to fetch the benefits of a private cloud such as security by putting the data that needs security in it. The company also reaps the benefits of public cloud such as scalability by using the public cloud model.

2.2.4   Benefits of cloud computing

Reduction of costs: One of the much talked about benefit of cloud computing in many businesses is reduction of costs. The consuming company will not invest in the expensive server hardware; space for the server is another cost which is removed among others.

The cloud service can seamlessly integrate into the existing IT infrastructure without requiring installation of additional programs or new hardware. Once registered with the service provider you simply log in and using the cloud services. The good thing with the cloud is that you can work and access your files whenever you are or want to be e.g. from holiday, home or when on transit. This provides the workers with a lot of **flexibility** and **mobility** in their work places.

Agility is another advantage of cloud computing where institutions are able to quickly adapt to changes. Since schools do not specialize in ICT provision, new requirement may take a bit of time to achieve. Such a change would be quickly done by a cloud provider for school they provide services to. Such a requirement would be a request for some special reports by the government.

Communication and sharing in a cloud environment is done more easily. It is possible to share files across locations when having projects across different locations. It also provides quick and secure methods of sharing records with accountants and financial advisors. This leads to **efficiency** in doing business.

During peak hours a business ICT resources are far much higher than the normal working hours. **Elasticity** capability in the cloud allows the consumer to automatically request and get more resources during peak hours, when the resources are no longer required they are released.

2.2.5 Inhibitors of the cloud computing Adoption

Every new technology comes with some challenges this is also true with cloud computing, despite its above mentioned benefits it brings some serious challenges as described here below. Physical or logical access is one of the best catalysts for any computer crime to happen. The cloud provides   logical access to a company data from any part of the world. It also provides access to data while it is on transit.

The following are threats to cloud computing;
- Security and data protection.
- Uncertainty of continuity of service.
- Legislation and regulations.

Many companies only feel secure if their data is behind their firewall and under strict security policies and for that reason many companies would not put their very sensitive data in the cloud. Putting one's data in the cloud brings about a lot of trust to the cloud providers employees whom may not be known by cloud clients and may not have even participated in their recruitment. These employees can get this

data if they want and even sell it to marketers, this can be witnessed in some companies when their customers or staff starts receiving unsolicited messages from their competitors. So companies may feel **insecure** if their data is in the cloud.

Another major challenge of the cloud is **uncertainty of continuity of service**, suppose something terrible goes wrong in the company providing cloud services and they close overnight without further warning what happens to their clientsødata and customers? This situation is disastrous and companies CEOøs would not even want to imagine such a situation. õThe Linkup,ö which ceased operations after losing nearly half of customersødata (Hilley D., 2009) is a good example of uncertainty.

Some of the cloud service providers might reside in a different territory from the country of the clients. This might bring a lot of difficulties in dealing with **legislation and regulations** when laws have been broken. The two different states might have different laws to address the situation.

2.2.6   Cloud computing in developing nations

Developing nations are in the wrong digital divide, cloud computing would bring them closer to the right divide by applying this technology in various areas as illustrated below;

Mobile **banking** is one of the financial applications that make use of cloud computing; three initial mobile banking services in Kenya, Tanzania and Afghanistan are hosted in the cloud by Rackspace. This allows many people without bank accounts to transact and do business. In Afghanistan a policeman receives his salary in a form of a message in his mobile phone while in Kenya a person dials a few numbers to send money to a relative who is several miles away at a very low cost within a fraction of a second, through M-pesa (Goundar S., 2011)

One of the major fights since independence five decades ago has been the fight against ignorance. As this fight continues many people have sought **education** from different parts of the world. This has been very expensive and has resulted to brain drain. With cloud computing there has been introduction of online degree where students can study from their villages in the developed worlds and receive degree from any university in the world. (Goundar S. (2011) notes that in developing nations due to inadequate teacher training and child labour, literacy levels are low. He continues to say that half of these people in remote areas will have access to mobile phones by 2012 and they can access quality teaching materials anytime anywhere through their mobile phones.

Because cloud computing can be integrated with mobile phones then the developing nations can now access all that they had missed in many decades. They can now easily join the right side of the **digital divide**.

Cloud computing provides developing nations an opportunity to create entirely new **businesses** that could not be imagined a few years ago. Cloud computing also opened new markets that were unreachable.

Many people in developing nations do not have **access** to the latest **hardware** and **software**; Graduates from Makerere University (Uganda) have no such access Greengard S. (2010). He continues to say that when there is access to cloud even these people in developing nations can have access to the latest hardware and software.

Cloud computing would benefit people in the developing nations a lot in **agriculture** by providing the relevant information to farmers at the right time so as to make the right decisions. In Sahel In sub-Saharan African farmers are able to get information on planting schedule, crop status, harvesting times and market prices through mobile telephony thanks to cloud computing (Greengard S., 2010). Goundar S. (2011) states that ICT has reduced distances between individuals and institutions and removed the rough geographical terrain experienced by farmers in developing nations. He notes that by using mobile phones farmers are able to market their produce without commuting to towns. He gave examples of Ghana, Bangladesh and Jamaica as places where such benefits have been extended to farmers through mobile phones.

People in the developing nations can benefit by providing affordable **labour** to companies in the developed world. And since there are very stringent visa requirements these people cannot move to the developed countries. These jobs are provided through the cloud. Greengard S. (2010) sights Kenyan refugees to have benefited from **jobs** offered by a company known as CrowdFlower through the cloud, these refugees have ended up earning up to eight times what they used to earn in ordinary jobs in the camps.

The cloud can connect **developers** enabling them share and solve problems together, it can also provide developers in developing nations with development platforms they would otherwise not access. This is exemplified by a 22 year old Kenyan who developed an Iphone application using an online Iphone simulator (Greengard S., 2010). This application can then be sold throughout the world.

Another major challenge in developing nations is in **health**; this is majorly due to poverty. Goundar S. (2011) noted that Africaøs 56% population lives in rural areas. He notes that the problem of health is

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aggravated by poverty, lack of good health education, dietary issues, and distances to health centers among others. In developing world lack of infrastructure prevents health workers from delivering efficient health care to rural areas. One of the initiatives of UN and Vodafone is to use mobile phones to better aid those in need of health care in developing nations (Goundar S., 2011). One of the software that can be used for health is FrontlineSMS. People can be provided with relevant information concerning their health, they can be reminded when their appointment with the doctors is due. They are also informed of diseases outbreaks and precaution to take. This is done by use of text messages.

2.3 School Management.

2.3.1 Overview of schools administration

Schools in Kenya are under the ministry of education through stewardship of a **cabinet secretary**. Under the cabinet secretary is the **principal secretary** who is the chief accounting officer in the ministry. In each county there is **commissioner of education** who coordinates all the activities of education in a county. In a district, a **district education officer** (DEO) is in charge of all matters of education in the district except staffing which is done by the **TSC county commissioner**. These are the officers in charge of managing education outside the school settings. Within the school we have the **board of management** (B.O.M.) whose secretary and executive officer is the school principal. The B.O.G. is the one who directly manages a school. The **Principal** of the school is the overall in charge of the school and oversees everything in the school that includes: finance, staffing, relationship with the outside world, infrastructure development and any other. Under the principal are the deputy, H.O.Ds and teachers.

The school has other stake holders like **parents** who pay fees and are represented through **parents teachers association** (P.T.A.), **KNEC** who are the external examiners on behalf the government and the sponsor who is represented in the B.O.G.

2.3.2 Use of ICT in schools

The use of ICT in Kenyan schools has been neglected (Makewa L. et al, 2013). The earliest attempt by the governments to use ICT to aid management was in using EMIS to collect data on schools census Moest(2005). Mingaine L. (2013) identifies one of the major challenges faced by principals in implementing ICT in public secondary schools as ICT costs. The major uses of ICT in schools have been in;

- Typing of documents such as letters and examinations.
- Communication.

- Teaching and learning.
- To aid in school management.

Schools first got computers as donations and put them into offices for typing letters and examinations. Later with the proliferation of internet in workplaces, schools started using computers to communicate, at almost the same time the ministry of education through the Kenya literature bureau started developing e-content and encouraged teachers to use ICT for curriculum delivery. The use of ICT in management is the latest move initiated by principal and teachers to ease in the management of schools.

2.3.3   School management systems

2.3.3.1 Introduction

The trends towards SMS started in the early 1990øs, when many schools started receiving donation from western countries (Mingaine L., 2013). And on realizing that many companies had automated their tasks to ease management, schools started acquiring these systems. For some schools they developed their systems through their teachers while others got their solutions from local vendor who developed for those specific schools. Some of those systems lacked support when these vendors rounded off their business or moved to do other things or when the teachers were transferred to other schools. Some of them were made from Ms Access and when the schooløs data reached some level Access become very slow or even could not open. Some schools lost their data and regretted automating their systems. Makewa L. et al (2013) in their study found out that in Kuria districts (North and South) only 15 out of 35 schools had computers. The authors also notes that the use of ICT in schools vary from one district to another due to academic, economic, political, and cultural levels of development factors. They also noted that a neglected part of computers in education is the use of computers to facilitate school administration processes.

These days with much training of school managers, schools are employing technicians to maintain these systems, training their teachers to do so or outsourcing these services.

There has been a lot of hyping about the worthiness of the cloud, however before adopting this, the worthiness and challenges should be considered individually and based on objective framework. This technology will help solve some problems in organizations but not all problems will be solved by technology.

In business, **specialization** is important where organizations concentrate on their line of production while outsourcing services that are not key to their businesses. While each company is specialized in its own industry, market or product, and some companiesø benefit, due to size or requirements, from

designing, building, managing, and renovating their own private office building, it is in the best interest of the vast majority of companies to share the office services they all use, notably certain fundamental utilities. Schools main business is to disseminate knowledge to learners and should outsource the ICT resources from cloud providers to promote efficiency, reduce costs and make this sustainable. Cloud computing enables businesses reduce cost of running businesses by outsourcing support and maintenance to providers that have lower marginal costs and better expertise.

2.3.3.2 Functionalities of a school management system
A school management system has the following functionalities.

1. **Recording student's details** when they are admitted in schools. They include names, date of birth, admission number, home address, guardian name and telephone number among others. These details are stored and edited whenever changes occur.
2. One of the functions of an SMS is in **processing of examination results**. In this module teachers accumulate studentsø marks in the course of the term, each time an examination is done the teachers inputs the results of exams in the system. After the end of an examination the results are analyzed and reports generated. These reports are used to grade students as well as appraise teachers.
3. A school like any other organization employs various people to work and help teachers to achieve their goals, these employees of the school are paid. To achieve this in an efficient manner schools use a module called **payroll.** This module holds workers details on age, days worked, basic salary, salary deductions among others which as used in deriving a personø net salary.
4. A school has got various sources of revenue one of the most significant is from parents and guardians of the students in the school; others include the government and sponsors. When money is paid to a school the person paying is given a receipt while those to be paid issue an invoice to the school. All this is managed by a module called **finance management** module.
5. A **time table** module is used to create a schedule for teachers on the time and class to teach. It reduces the complexity and enormity of this daunting task, and reduces it to a click of a button.
6. Another common module in SMS is the **communication** module where stake holders can be communicated to using text on their phone or to their emails. Using this module communication to stake holders is more efficient and cheaper.

2.3.3.3 On premise based SMSs
In the beginning of this century many western countries started giving donations to African schools so as to try and bridge the digital divide. This was in some instances seen as contributing to e-wastes in African. Moest(2005) cited a case in Narok High school where Macintosh computers were found at a corner in the school. This is when schools started considering SMS.

The first schools management systems were simplistic. They ran on a single computer and every person who wanted to input data had to book to use the computer. They were mostly made from MS Access. The school had very poor practices of running and maintaining them. They were mostly used to process examinations results. With time they became very slow and unusable and some schools even lost data. The schools had to go back to the drawing board.

The second generation school management systems had a centralized database either on a server or a desktop, accessible through the network through desktop computers or laptops which have the school management system installed in them. They have eased the management of schools by quickly providing the required information from a click of a button. The process of making students report forms has been made easier and neater.

They are only accessible within the school premises. They lead to a great capital outlay in buying the hardware and software. They also bring issues with licensing of software and hardware and software maintenance burden to schools.

2.3.3.4 Cloud-based SMSs

In a cloud based SMS school software and information is stored on remote servers and accessed over the internet just like Gmail and Hotmail.

2.3.3.4.1   Examples of cloud based SMS in developed nations

In developed nations there are significant number of examples of cloud based SMS currently in use. Such examples are highlighted below.

The **Bromcom** MIS provides capabilities for entering test and assessment scores, building timetables, tracking attendance and managing many other student-related data needs in a school. It is specifically made for secondary schools although it can be scaled up and down to serve other institutions.

InterSIS is an integrated school management suite and has modules for planning, assessment & reporting, admissions & enrollment to mention a few it is built on top of Xero, a cloud accounting solution.

Fedena is school management software which is used by thousands of educational institutions worldwide for all administration, management and learning related activities. It is used to manage students, teachers, employees, courses and all the systems and processes related to running a school.

Openschool is an open source cloud based SMS running on MYSQL database and built using PHP. It is readily available for downloading and use. The code is available to be changed to suit the given situation.

Intel Corporation is has been designing their cloud based school management system referred to as learning management system. Their paper on the systems states as follows.

Cost: Cloud computing will bring down the cost of ICT but Intel C.(2012) mention that the cloud is not for free. Even if a school was to use open source which are free to educators they still need to pay for storage and network.

Intel C. (2012) urges schools to consider the following while thinking about cloud:

- Security of the school data and student intellectual right.

- The capability of infrastructure to support the cloud now and in the future.

- Cloud may mean a long time commitment with external vendors, so vendors should check thoroughly before engaging a provider so as to avoid disappointment.

In this solution the data is accessible from anywhere with network and can be accessed through the phone. McIntosh D. (2013) states that a cloud based Administrate LMS would be available from March 2013. Just as reflected on the available materials on education systems where much literature is written about e-learning and very little of school management systems many cloud based education systems are for e-learning as compared to those of management. Much emphasis is put on e-content.

2.3.3.4.2   Examples of cloud based SMS in developing nations with emphasis on Kenya

Developing nations can benefit a lot from the use of cloud computing in schools. Cloud based SMS is not very common. In Chavakali high school in Vihiga County, parents can access the performance of their children through the networks.

Brilliantte School Management System is Kenya's cloud-based Enterprise School Management System software developed by Brilliantte Solutions Limited. It is suitable for secondary schools. It is web-based, cross-device, cross-browser and comes with a beautiful user interface and user friendly. It is easily accessible by the stakeholders.

A school management system by **Kenya Cloud Space** is integrated management software with cloud computing services which allows for automatic upgrades, automatic backups and access of information from anywhere using mobile phone, tablet PC, laptop or desktop PC.

2.3.3.4.3   Benefits of cloud based SMS
The following benefits will be achieved by schools when they adopt cloud based SMS.

Due to high costs, servers requires very tight **physical security**, this is another challenge to companies especially the ones that are setup in remote locations, when servers are acquired through the cloud then the consumer will be relieved of the physical security cost bothers that comes with these servers;

Some highly **IT trained personnel** would require **retention** in schools by providing with competitive salaries and other stipends.   These companies will require less internal IT personnel because much of the work will be done by the cloud provider. This high cost is eliminated from the company; the company will only budget for a very lean IT team.

Apart from hardware, **software** also comes at a cost. There are various types of software required in a company and they include: sever operating system, database management system, server antivirus, desktop operating systems, desktop antivirus, specific institution management software, Office among others. All these software comes at a cost for initial purchase and later requires annual license and later will require upgrading from one version to another and this will also cost more money. To avoid this financial burden then one just need to adopt cloud computing and will realize a lot of savings.

Many companies will buy server hardware with more capacity than they require because of the expected growth in the future, meaning most of the time this capacity is **underutilized**, the hardware just lies idle while the money used to buy it could have been put in an alternative use.

The shaded regions of diagram a below show the underutilization of resources which leads to waste, this happens in the initial years when schools buy equipments having a lifetime of say 5 years. The shaded region of diagram b shows how some needs are not met by the available ICT resources due to underprovisisoning, this happens in the final years of the systems when a schools capacity in terms of data and processing has grown. This happens in on premise SMS.

(a) Provisioning for peak load

(b) Underprovisioning 1
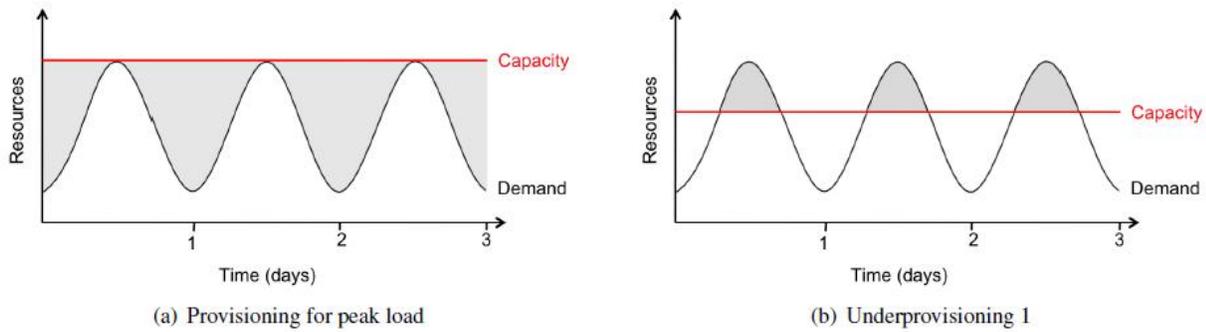
Figure 2: Source Armbrust M. et al (2009)

When finally the business reaches the optimum capacity of these hardware devices, it takes time for them to acquire the new hardware that can meet their needs. In the course of doing business an organization may occasionally require more computing resources than is available this becomes impossible or very difficult to get.

The figure 3 below shows **elasticity** of the cloud, when a company wants to use more resources than allocated, the cloud will automatically allocate the required resources and when demand for the resource goes down the resources allocated to the consumer will be reduced so as to only meet the new demands. This reduces underutilization of ICT resources.
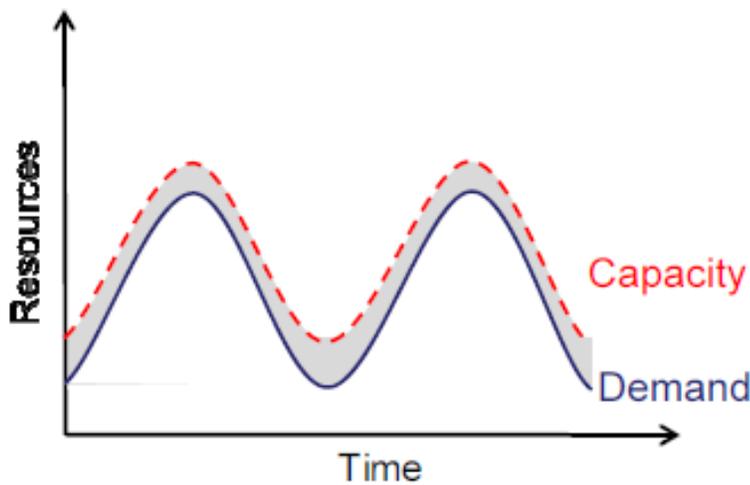
Figure 3: source Hilley D. (2009)

In the current world **telecommuting** has become inevitable. For this to happen a company may have to provide a fast internet connection to its servers for its staff to access. This comes with lots of cost and threats bundled together. This can also be avoided by using cloud computing.

The high **cost of electricity** caused by many servers in an organization is eliminated by adopting cloud computing. This burden is moved to the cloud provider and because of their size they benefit from the efficiency of economies of scale.

Acher G.(2013) noted that cloud computing would be particularly suitable for small and medium enterprises that cannot benefit from economies of scale. Cloud computing would enable them concentrate on their core business. By all standards school can be classified as small enterprises and would therefore benefit from cloud computing.

Buying **servers** and the required **software** costs schools a fortune. By adopting cloud computing these items are not required, they are provided by a cloud provider and are availed on pay as you go basis. The capital expenditure could be used to buy scarce books, employ the much required teachers or construct a much required classroom among others.

Had these servers been bought, they would have brought **recurrent** expenditure on **electricity** and because of their cost they would require more tight **security**. The cost on electricity is passed to the provider who reaps benefits of economies of scale. Cloud providers are located in the cities where security is better than in many schools which are located in rural areas where security is easy to compromise.

By adopting the cloud, schools would easily allow **access** of their systems to teachers, from anywhere and will find it very convenient instead of having to travel every time to school when providing feedbacks. Parents would also reap the benefits, because they would also retrieve any information they need about their children without having to travel to school.

2.4   Costs and benefits of an ICT system.

For an institution to choose an ICT system to fit its needs from a pool of many available systems there are several factors which need to be considered.

- The costs of the system.
- The expected benefits from the system.

The benefits must outweigh the costs, for a good system. These factors are considered here under in order to come up with a framework for guiding teachers in choosing the correct system for schools.

Total cost of ownership represents all of the costs to own and operate a piece of equipment over its useful life Wong S. (2012). He states that TCO model is made up of the following components;

- Purchase price.
- Installation and setup.
- Metrology (e.g., calibration).
- Repair.
- Downtime mitigation (e.g. spares and extra test capacity).
- Training and education.
- Technology refresh (e.g., code compatibility).
- Facilities.
- Consumables.

Another framework that show how to calculate the total cost of ownership of an ICT system. This framework is the **Becta TCO model for schools** which is shown on the diagram below.
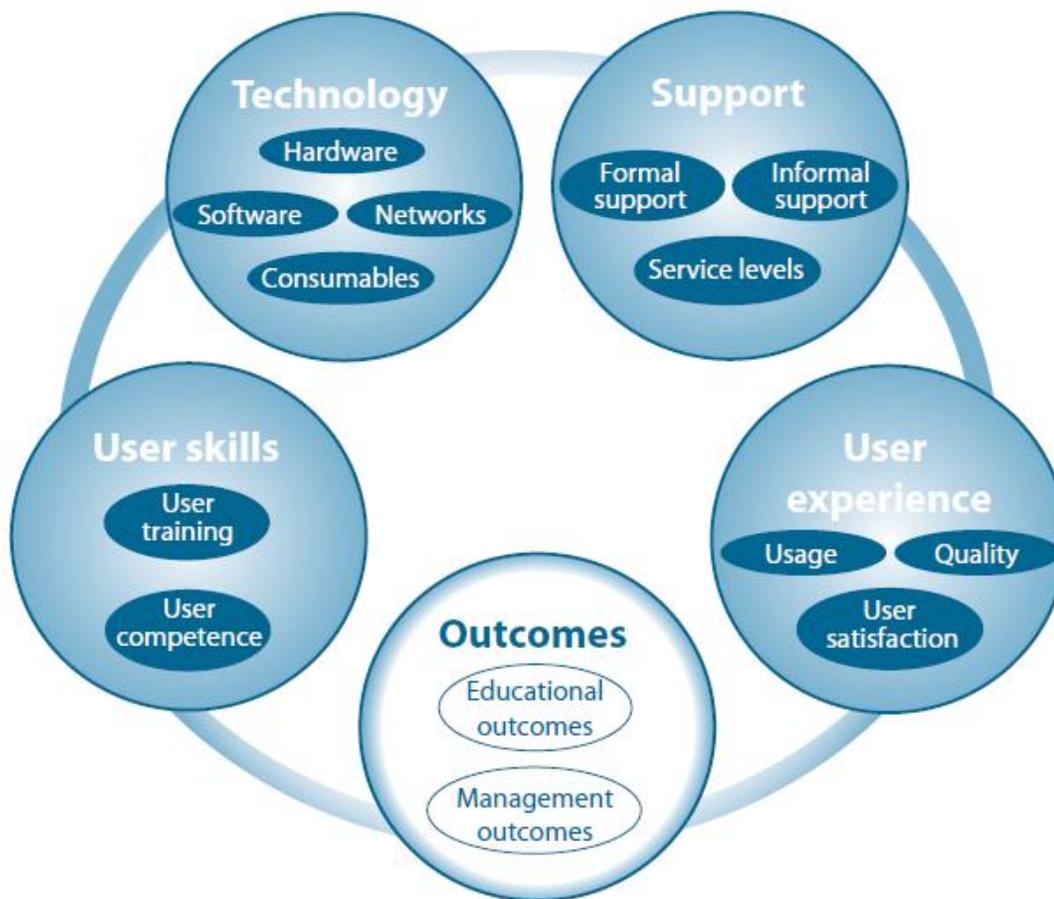
Figure 4: Source Becta (2006)

Becta TCO model mentions that the TCO of an ICT system in a school is made up of the following.

The **cost on technology** which consists of; Hardware costs, software costs, networking costs and the costs of consumables.

The cost for support which is made up of formal support, informal support and services levels.

To enhance **user skills** will cost institution both time and resources and involves; user training and user competence.

There are outcomes expected from a system and users experiences.

The other framework which is also very important is for justifying the investment in IT as shown next;
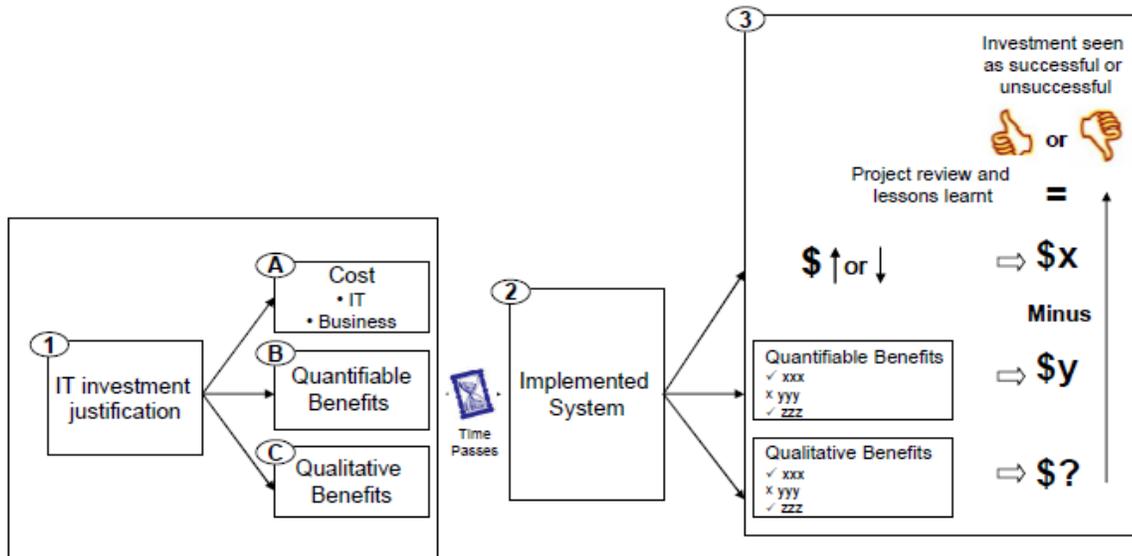
Figure 5: Source Binney B. etal (n.d.)

ICT investments require some form of justification. This justification depend on costs and benefits Binney B. etal (n.d.). The following will justify ICT investment.

- ICT costs hardware and software.
- Costs to the business changes e.g. staff training, potential disruptions to service, etc.
- Quantifiable benefits.
- Qualitative benefits.

2.5 A framework for comparing ICT systems for suitability.

In order to compare the cloud based SMS to on premise SMS the following framework based on the justification for investment framework, TCO and BECTA TCO was created.
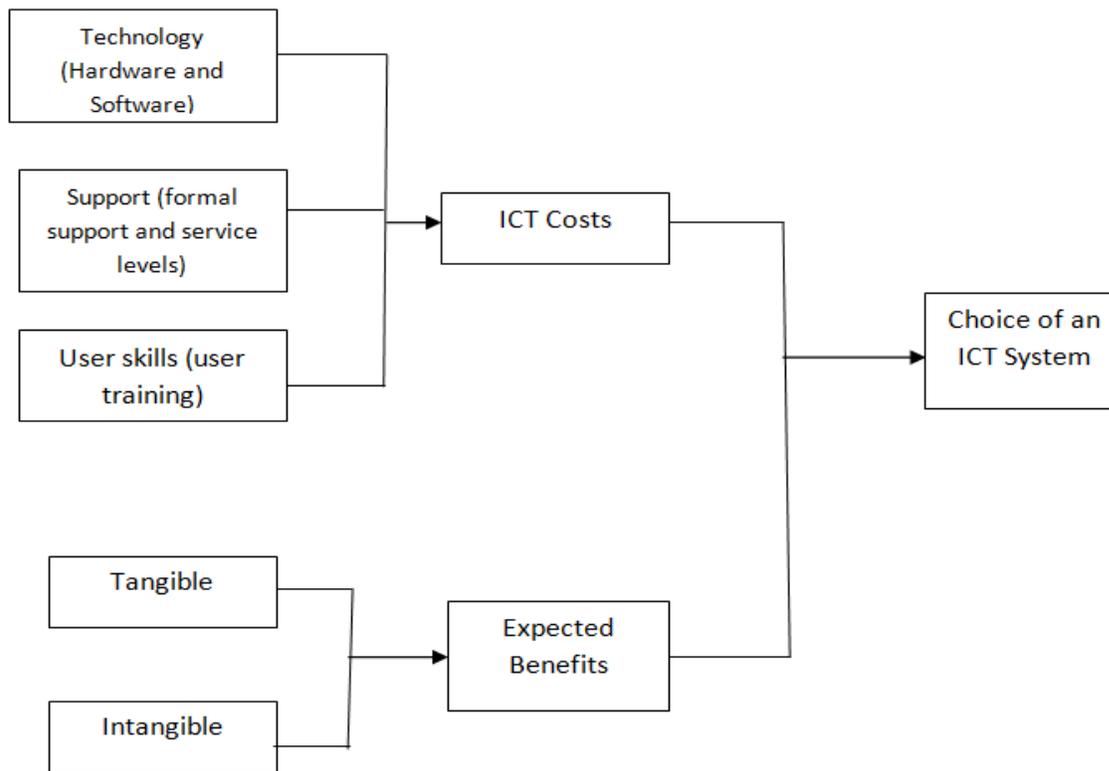
Figure 6: Source Research.

ICT Costs are made up of;

Technology costs which are costs incurred in buying computer hardware and software, they were included in the model because they vary from one kind of a system to another. The costs of networks and consumables from the BECTA model were not considered in this model because they do not vary with the choice of a system.

Support costs are the costs which are incurred when an institution requests for help when there are errors to be corrected or enhancements to be made to their systems. Formal support and service levels support were included in the model as they are likely to vary in costs and quality depending on the mode of SMS. Informal support is not included they may not be quantified.

User skills costs are paid when users are trained on use of technology. This can be incurred on new employees or when there are changes in the current system. They are not included in the model as their costs will be included in the software and hardware.

Benefits from the ICT are either tangible (quantifiable) or intangible (qualitative).

Tangible benefits are those benefits that can be assigned a monetary value such are reduction of workforce, savings on paper e.t.c. This is included in the model and is borrowed from Binney B. etal (n.d.) model.

Intangible benefits are those benefits which cannot be assigned a monetary value and includes a neater report, a feeling about the system e.t.c. This will also be included in the model and is adopted from Binney B. etal (n.d.) model.

Chapter Three

Methodology

3.0 Overview

This chapter is a plan how the study was carried it looks at the data that was collected, study population and sampling techniques used. It is also a plan on how data was collected and data analyzed.

3.1 Data to be collected/Selection of variables

In research data can be collected from different sources, these sources can be classified as primary sources or secondary sources. Primary data is collected by the researcher during the period of study using questionnaire, interview or observation while secondary data has already been collected and the researcher gets it from books, government publications journals among others.

There are different types of data in research: Nominal, ordinary scale, interval scale and ratio scale. The following data was collected.

In order to investigate the challenges faced by Kenyan secondary schools in owning and running on premise based SMS systems the following data was collected.

CONCEPT	Data	SCALE
Costs	Server hardware	Ratio
	Server software	Ratio
	SMS annual subscription	Ratio
Funding challenges	Parents have problem in paying fees	Likert
ICT personnel	Available.	Nominal
	Employed / Hired.	Nominal
	Maintain and track software licenses.	Nominal
	Data security measures.	Nominal
	DBMS used.	Ratio
Power	Always available.	Nominal
	Rate of power surges, blackouts and brown outs.	Likert.
	Measures to curb power surges.	Ordinal.

Physical Security	Theft of ICT	Ordinal.
Remote Access	SMS accessible remotely.	Nominal.

Table 1.

To investigate the financial costs incurred in owning and running on premise based SMS systems in Kenyan secondary schools the following data was collected.

Concept	Data	scale
School budget/Sustainability	Total school budget.	Ratio
	Total ICT budget.	Ratio
Internet connectivity	Connectivity costs	Ratio
Hardware cost	Purchase price	Ratio
	Recurrent costs (maintenance fee,)	Ratio
System Software cost	Purchase price	Ratio
	Recurrent costs (license fee etc)	Ratio
SMS cost	Purchase price	Ratio
	Recurrent costs (license fee, upgrading etc)	Ratio
Physical Security	Cost of security personnel on IT	Ratio
	Cost of secure environment	Ratio
Data security	Cost of backup material.	Ratio
Remote SMS access	Costs incurred by teachers if no remote access	Ratio

Table 2.

To investigate the possibilities available to the Kenyan secondary schools to connect to the internet in order to facilitate access to cloud services and the cost involved the following data was collected.

Concept	Dimensions	Scale
Internet	Access to connectivity	Nominal
	Cost of connectivity	Ratio.

Table 3.

To investigate the operational requirements and costs of running SMS for Kenyan secondary schools in the cloud the following data was collected.

Concept	Dimensions	Scale
Requirements for a school to access cloud services.	Hardware.	Ratio
	Software.	Ratio
	Connectivity.	

Table 4.

To determine if cloud computing forms a more suitable solution for running SMSs in Kenyan secondary schools than on premise SMS based solution. To achieve this, the data collected from the above sections was compared as follows;

- Cost of cloud SMS against cost on premise SMS.
- Challenges involved in each method of SMS.
- Compare accessible of each of the systems.

3.2 Type of study

This study carried out is a comparative study, it is described below.

- Analytic/comparative

In analytical research the researcher uses the available material to analyze and make a critical evaluation of the available material. It seeks to compare two or more phenomena. The phenomena that was compared was the on premise SMS against the cloud based SMS.

In this comparative study a mixed methodology was used, which is made up of the following methods;

- Quantitative

  Quantitative research collects data about measurable quantities such as mass, age, height among others. It seeks for knowledge on phenomena that can be expressed in terms of quality. This is done by using statistics, mathematics and computation techniques.

- Qualitative

  Qualitative research is concerned with investigating phenomena which can only be expressed in words. It seeks to investigate human behavior and why they behave in a give way. The results of a qualitative study are only applicable to the cases studied.

The study compared quantitative data from schools and from cloud providers such as cost of hardware, cost software among other costs. It also compared qualitative data from schools to that of cloud providers such as security measures taken to protect data in each case and people's feelings and in both schools and cloud providers.

3.3 Method of data Collection

A researcher needs to collect data, this can be done by the researcher himself or by another person employed to do so. Data can be collected from the source also called primary data or from documents called secondary source such as from books newspapers among others. The following are the primary methods of data collection observation, interview, doing experiments, questionnaires and schedules.

Data was collected using both the questionnaire and interview. Questionnaire was used to capture personal data and company profiles while other details were captured using interview.

a) Interview

This method involved presenting questions orally and the same method is used to give the response. This method can be done through personal interview or through telephone. The interviewer visited the respondents at their place of work and asked questions directly to the respondent and recorded the response using a pen. A recorder was not used because it was not available.

The reasons for choosing this method are; Questions and answers were clarified, the person conducting it may also used observation while interviewing.

The challenges that were experienced in this method were that it is expensive and time consuming among others.

b) Questionnaires

This method is very popular in case of very big enquiries. Questions are printed in a form and sent to respondents who write the answers and send them back to the person undertaking the study. Before collecting data using this method it is always good to carry out a pilot study to test the questionnaire and if a problem is found then it is corrected.

The motivations for using questionnaires were; the cost is low even when the sample is very big; it is free from interviewer¢s biasness, respondents have enough time to give the answers, large sample can be used and respondents who are not easy to reach can easily be reached by using this method.
The challenges of using questionnaires were: low rate of return, only used on literate people and it is the slowest method.

For this study the researcher formulated the instruments himself because none existed which could meet the purpose and so as to formulate the questions using a simpler language.

The researcher took the questionnaires to the respondent and waited for response, some parts of the questionnaire were filled directly by the respondent such as personal details and company profile while.

In collecting data there are important factors to be considered which includes data validity and reliability of the measuring instrument and are explained how they were achieved here below.

Validity

In research there are two types of validity name; Internal and external validity.

Internal Validity:

This checks whether the research measures what it was meant to measure.
The questionnaire was discussed with the supervisor to ensure that it measures what it was meant to measure.
The questionnaire was piloted to validate its effectiveness in extracting the right information so as to answer the primary research questions. This pilot study preceded the main data collection to correct any errors in the questionnaire or other elements in the data collection technique. This was done with a few school administrators and cloud administrators.

The questionnaires were provided only to school administrators and cloud providers employees.

Reliability / External Validity:

This refers to the extent to which the results of the study can reflect similar outcomes in other populations, and can be generalized to other populations or situations. Cronbach's alpha was used to determine reliability where a value of 0.5 or high showed reliability.

3.4 Sampling

A study is usually done on a part population of the universe. The study's population sets the limit within which the research's findings would be applicable (Olanrewaju A., nd). It is from this population that the researcher will draw his study sample. This population may be people, animals or things in a given area. It is important to state the number as it will have implications while sampling.
Sampling involves getting a small group from study population for studying because studying a complete population involves a huge and unwieldy organization so that most of the errors that would normally occur here cannot be controlled easily, Olanrewaju A. (nd). The size of the sample depends on the research problem and on the research goals. Some population may be small number such that it might be possible to involve the whole population, but more a times the population is big such that it is not possible to involve the whole population.

The sampling method depends on whether the research seeks to collect qualitative or quantitative data. For qualitative data purposeful sampling methods is be used, while if the type of data to be collected is quantitative then random sampling methods are more suitable.

The population which was used in the study was teachers and administrators of Secondary schools in Limuru district of the republic of Kenya which use ICT in management and managers of cloud providers.
Sampling methods that were used were;

            i.   Purposive Sampling.

In this method of sampling the researcher handpicks some groups or individuals based on his understanding of the population for the relevance to the subject of investigation. It ensures participation of some individuals who are very important to the study. The problem is that those selected may not be a representative of the given population.
The schools used in this study were only those that used ICT in management so the sampling was purposeful. Since they are only ten schools that used ICT in management then all the schools were used

in the study because from Krejcier R. and Morgan D. (1970) table a population of ten requires a sample size of ten. These are the schools that were studied.

- Kinyogori high School.
- Tigoni secondary school.
- Mirithu Girls.
- Kamandura girls.
- Limuru girls.
- Loreto Limuru.
- Thigio Boys.
- Thigio girls.
- Ngarariga girls.
- Ngenia high school.

ii. Random Sampling.

Each member of the population has equal chances of being selected for study. The choice of one does not affect the other. The items are numbered and are picked from a random number table or tossing of coin, throwing of dice e.t.c.

The sampling methods for cloud providers should have been random sampling where all the cloud providers in Kenya, were to be written on a piece of paper and the number of companies required for the sample picked at a random, but because the number of cloud providers are eleven then all of them were be used in the study. The companies are as follows;

- Access Kenya
- Safaricom
- Cisco Kenya
- Seven Seas technologies
- Copy cat
- IBM
- E-momentum
- Seacom
- Kenya cloud
- Google Kenya
- Microsoft Kenya

From Krejcier R. and Morgan D. (1970) table the following were sample.

Group	Population	Sample
Administrator	10	10
Cloud providers managers	11	11

Table 5.

The following groups of people were sampled;

- Secondary school administrators in secondary schools in limuru District of Kiambu County.
- The managers of cloud computing providers in Kenya.

The following were selected for the interview;

- One (1) school administrator (principal, deputy principal or senior head of department) per school.
- One (1) manager of cloud computing company in Kenya.

The reason for choosing only one administrator per institution is because the data being sought did not depend on the person being interviewed; they were facts in the institutions and could not change regardless of the person providing the information.

3.5 Data Analysis

After collecting data it was processed and analyzed in order to make meaning out of it. Analysis refers to computation of certain measures along with searching for patterns of relationships that exists among data groups. The following are the steps followed in analyzing data.

a. Editing

During this stage the data collected in a questionnaire was examined to identify errors and omissions. Where possible these errors were corrected. The first editing was done in the field where the person recording the data cross checked his records and made corrections while at the field by requesting clarification. After all forms/ schedules had been returned another form of editing called central editing was done. In this editing method the obvious corrections were made such as a day place in a place of a

month. The answers which could not be corrected were struck off and marked no answer. Any wrong answers were dropped.

b. Coding

This is the method of assigning numerals or symbols to answers so as to classify responses. These classes must be defined in only one dimension. Every answer must only fit in only one classification. Coding is very important because it reduces a wide range of response into a few classes required for analysis.

Coding was done during the time of designing the questionnaire.

c. Classification

This is reducing the data provided into homogenous groups to look for patterns and meaningful relationships. Data was arranged into groups or classes in the basis of common characteristics. Classification was done using the following methods: classification according to attributes or according to intervals.

- Attributes

This is done to data with descriptive characteristics or qualitative data. It describes characteristics such as literacy, sex, honesty among others.

This classification classified an attribute to two classes which is known as simple classification where items with and without the attribute were considered. Another one is manifold classification where two or more attributes were considered and simultaneously divided into a number of classes.

- Class-intervals

In this classification quantitative characteristics are measured using numbers. Such data may involve income, production, age, weight etc. Data was grouped according to intervals (class intervals). These classes have upper and lower limits. Eg. 10-20.

Both attributes and class-intervals were used in this study.

d. Tabulation

This is the process of arranging of data in a concise and logical order. Data was summarized in rows and columns. Tabulation was done by hand. The choice of this method was because of affordability and lack

of machines that could do that job. Tabulation can either be simple or complex. Simple tabulation gives information on one or more independent questions while a complex tabulation involves division of data into two or more categories and gives information on one or more interrelated questions. Both were used.

In order to investigate the challenges faced by Kenyan secondary schools in owning and running on premise based SMS systems the following data was analyzed as indicated.

Concept	Variables	Analysis
Hardware cost	Purchase price Recurrent costs (maintenance fee,)	Average costs, standard deviation, variance, maximum and minimum costs per year.
System Software cost	Purchase price Recurrent costs (license fee etc)	Average costs, standard deviation, variance, maximum and minimum costs per year.
SMS cost	Purchase price Recurrent costs (license fee, upgrading etc)	Average costs, standard deviation, variance, maximum and minimum costs per year.
Physical Security	Cost of security personnel on IT. Cost to secure environment.	Average costs, standard deviation, variance, maximum and minimum costs per year.
Data security	Cost of backup material.	Average costs, standard deviation, variance, maximum and minimum costs per year.

Table 6.

To investigate the possibilities available for the Kenyan secondary schools to connect to the internet in order to facilitate access to cloud services and the cost involved the following analysis were done.

Concept	Variables	Statistics
Internet	Access to connectivity Cost of connectivity	Frequencies. Average costs, standard deviation, maximum and minimum costs.

Table 7.

To investigate the operational requirements and costs of running SMS for Kenyan secondary schools in the cloud the following information was calculated.

Concept	Variables	Scale
Requirements for a school to access cloud services.	Hardware. Software. Connectivity.	Maximum, minimum and average requirements.

Table 8.

To determine if cloud computing forms a more suitable solution for running SMSs in Kenyan secondary schools than on premise SMS based solution the following comparisons were made.

- The differences in the total cost in cloud computing SMS against the total cost of on premise SMS.
- List and compare risks involved in cloud SMS against those of on premise SMS.
- Compare accessibility of cloud SMS against that of on premise SMS.

3.6 Ethical consideration

Research ethics is an important factor to consider in research, to enforce ethics the following was done, sought authority from the university, assured respondents of privacy and confidentiality during and after the study, sought consent and honest answers from interviewee.

The study avoided plagiarism by citing and providing references of the referenced materials.

Chapter 4
DATA ANALYSIS, INTERPRETATION AND DISCUSSIONS

4.1 Overview.

This chapter presents the results of the findings, their interpretation and discussions on the suitability of cloud computing in secondary school management systems, with a focus on Limuru district, Kiambu County. The study was guided by the following objectives:

1. To investigate the challenges faced by Kenyan secondary schools in owning and running on premise based SMS systems.

2. To investigate the financial costs incurred in owning and running on premise based SMS systems in Kenyan secondary schools.

3. To investigate the possibilities available to the Kenyan secondary schools to connect to the internet in order to facilitate access to cloud services and the cost involved.

4. To investigate the operational requirements and costs of running SMS for Kenyan secondary schools on the cloud.

5. To determine if cloud computing forms a more suitable solution for running SMSs in Kenyan secondary schools than on premise based solution.

4.2 *Reliability of the data*.

Reliability refers to the extent to which the results represent the true picture, are free from errors and if the same study is to be done at a later date the same results would result.

To test reliability Cronbachøs Alpha coefficient was calculated, a Cronbachøs Alpha coefficient of 0.5 or greater shows that the results were reliable and therefore was analyzed further.

The table below shows reliability of data collected from secondary schools administrators.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.840	.869	35

Table 9: Source Research.

The table below shows reliability of data collected from cloud providers administrators.

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.795	.799	28

Table 10: Source Research.

The Cronbach's alpha analysis shows that the data is reliable and therefore further analysis proceeded.

4.3 Challenges of SMS in Kenyan secondary schools

School administrators were asked how they agreed with statements about; the cost of ICT, Parents having problems paying fees and ICT budget being unsustainable. And the results were as indicated in the diagram below.

ICT Costs Challenges in Secondary schools

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
ICT costs Very High	50%	30%	20%	0%	0%
Fees Problems	30%	40%	10%	20%	0%
ICT budget is not Sustainable	30.00%	50.00%	10.00%	10.00%	0.00%

Legend: ICT costs Very High / Fees Problems / ICT budget is not Sustainable
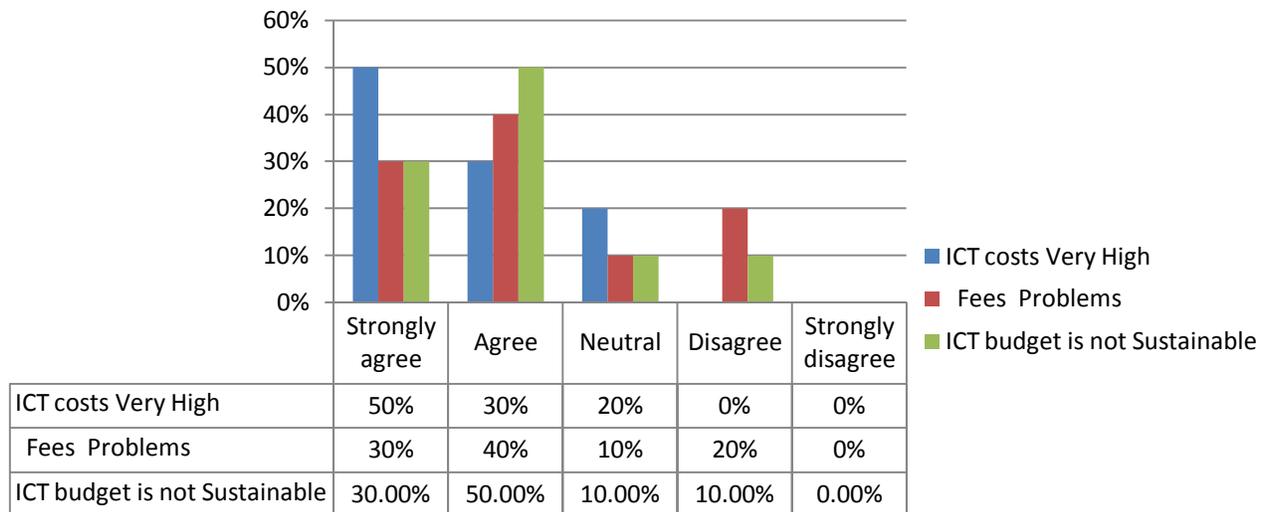
Figure 7: Source Research.

When asked how they agreed on the statement that ICT costs are very high for the schools, the responses were as follows;

- 50% strongly agreed.
- 30% agreed.
- 20% were neutral.

The response on the statement that parents had difficulties paying fees were as indicated below;

- 30% strongly agreed.
- 40% agreed.
- 10% were neutral.
- 20% disagreed.

The response from the statement that the current ICT budget was not sustainable was;

- 30% strongly agreed.
- 50% agreed.
- 10% were neutral.
- 10% disagreed.

From the response 80% of the administrators felt that ICT costs were very high for the schools, it is therefore imperative that if this cost of ICT could be reduced then this money could be put to equally good use.

70% of administrators responded that parents in their schools had difficulties in paying school fees. If these fees could be reduced then it means that parents would have easier times paying fees. One such measure would be to reduce the cost of ICT.

80% of the school administrators responded and agreed that the current ICT budget was not sustainable. Therefore in the future the schools may not be able to foot the ICT bills. The best thing to do for schools should be to seek budget cutting measures.

The administrators responded to questions concerning good ICT practices like; having data backup, using the correct database to store data, maintaining software licenses, the source of ICT staff, whether they had a power backup, whether they had lost data and whether they had lost any ICT hardware and the results were as shown in figure 8 below.

Good ICT Practises

	ICT Personel	Hire ICT Personel	Maintain and track S/W Licences	Backup Data	Use Ms. Access	Power backup available	Lost Data	Lost Hardware	SMS available over the internet
Yes	0%	100%	20%	90%	50%	80%	30%	50%	0%
No	100%	0%	80%	10%	50%	20%	70%	50%	100%
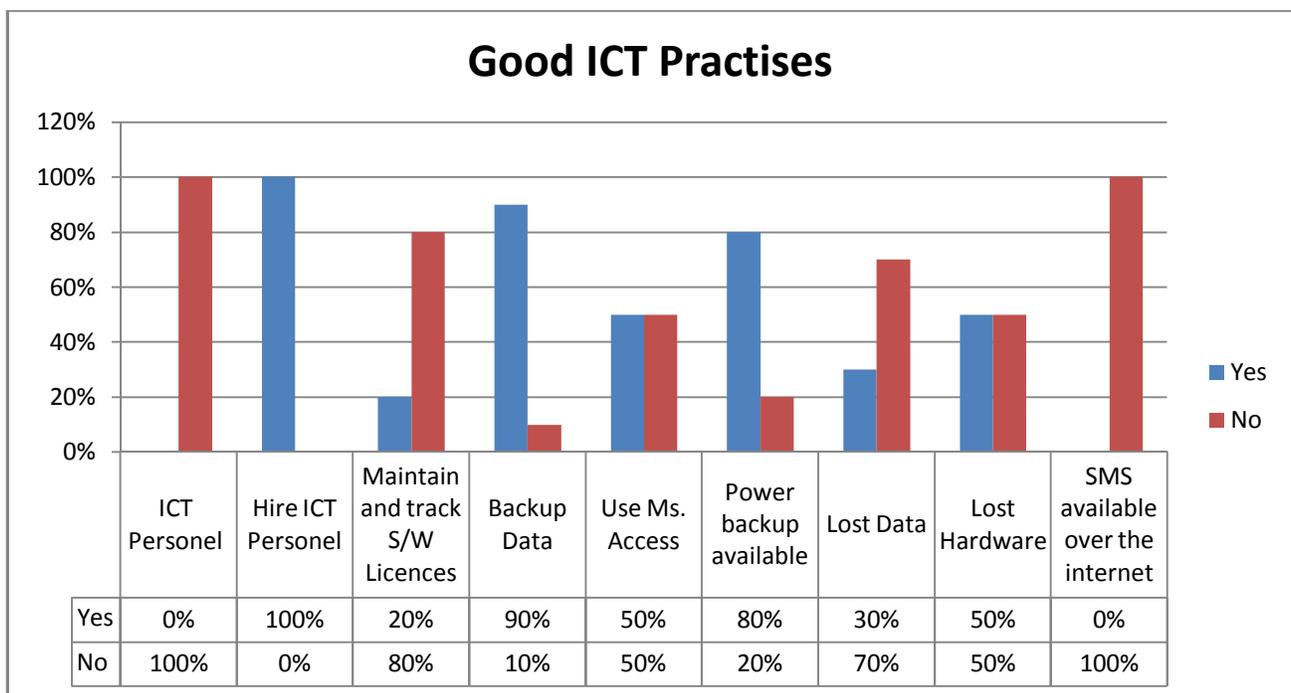
Figure 8: Source Research.

On good ICT practices the response were as follows;

- No school had permanent ICT personnel.
- All the schools hire ICT personnel.
- Only 20% of the schools maintained software licenses.

- 10% of the schools do not backup their data.
- 50% of the schools use Ms. Access as a DBMS.
- 20% of the schools do not have a power backup.
- 30% of the schools had lost their data.
- 50% of the schools had lost their hardware through theft.
- None of the schools had their SMS accessible anywhere else apart from with the school.

The fact that none of the schools had employed an ICT staff, even for support and they had no contract with any ICT firm and relied on any available personnel for support, repairs and maintenance may be attributed to poor ICT practices observed as illustrated in figure 8 above.

Software is owned by companies who claim intellectual property rights on them owning software without a license is against the law. It was observed that only 20% of schools had licenses for the software they operate. Some were priced so low below the market price that, it was obvious they were pirated.

Table 11 below shows comparison of cloud based SMS and on premise based.

	CLOUD SMS	ON PREMISE SMS
Automation	Fully	Not fully
Integration	Fully	Partial
Technology	Desktop/Server	Web
Initial Costs	0	Ksh826,710
Causes of unavailability	Network Loss	Network, Virus, Power and Maintenance.
Measures	UPS, Generators, Antivirus, Backup(on disks)	UPS, Generators, Antivirus, Backup(online), Mirroring, Disk Striping, firewall,
Incidences	None	up to 50%
Availability	99.99%	80% - 99%
Billing	Monthly/yearly	Upfront for up to 5 years

Table 11: Source Research.

From table 11 above the following can be observed;

- None of the on premise SMS had 100% of the modules under study while the cloud providers had more modules than was in study; none of the schools had a library management system.
- Schools had not fully integrated their systems modules such as timetable and finance were mostly not integrated with the other modules.
- The technology used in on premise systems was either server or desktop based while that used in cloud based SMS were web based.
- A school does not requires any initial investment to run a cloud based SMS but requires an average of Ksh826,710 as initial costs so as to run on premise SMS.
- The causes of unavailability in a cloud based SMS is only **network failure** while the following causes were identified to have caused unavailability in schools while using on premise SMS; **Network failure**, **Virus attack**, **Power failure** and system **maintenance**.
- Schools that run on premise SMS have taken the following measures to protect their systems and data; UPS, Generators, Antivirus and Backup (which is done on disks) while cloud providers take the following measures; UPS, Generators, Antivirus, Backup (done online), Mirroring, Disk Striping and firewall.
- None of the cloud providers had lost any data or any devices while 50% of the schools had lost their devices and 30% had lost data.
- Cloud SMS provide availability of 99.99% of all the time while the availability of on premise SMS ranged from 80%-99%.
- Cloud SMS is billed per month or per year upfront while on premise SMS makes a school spend for what they need in the next years ahead upfront.

From the above analysis the following can be identified as the **challenges** of running on premise SMS;

- ICT costs are very high.
- Lack of permanent ICT personnel to manage schools ICT systems. Which leads to;
  - Not maintaining software licenses.
  - Not backing up their data or storing backups wrongly.
- Using the wrong technology to store data (Using access to store data).
- Lack of power backup measures.
- Loss of data due to poor data protection measures.

- Loss of ICT hardware because of challenges in securing their environment.

- Available systems not automating very important functions such as library.

- The available systems are not fully integrated; none of the systems had integrated a timetable.

4.4 Costs of on premise SMS

The cost of running on premise SMS were as indicated in table 12 in the next page.

| School | Capital Expenditure | | | | | Recurrent Expenditure | | | | | Totals | |
	H/W Costs	Physical security Costs	SMS cost	Cost of back up materials	Total capital expenditure	SMS annual Subscription	System S/W Costs Antivirus	H/W Reccurrent costs	Internet Costs	Total Recurrent Expenditure per year.	Total Expenditure for one year	Total Expenditure for five years
1	Ksh120,000	Ksh230,000	Ksh80,000	Ksh100	**Ksh430,100**	Ksh20,000	Ksh0	Ksh1,500	Ksh75,000	**Ksh96,500**	Ksh526,600	Ksh912,600
2	Ksh260,000	Ksh680,000	Ksh400,000	Ksh10,000	**Ksh1,350,000**	Ksh100,000	Ksh57,000	Ksh40,000	Ksh60,000	**Ksh257,000**	Ksh1,607,000	Ksh2,635,000
3	Ksh200,000	Ksh240,000	Ksh60,000	Ksh5,000	**Ksh505,000**	Ksh10,000	Ksh3,000	Ksh24,000	Ksh276,000	**Ksh313,000**	Ksh818,000	Ksh2,070,000
4	Ksh110,000	Ksh180,000	Ksh120,000	Ksh0	**Ksh410,000**	Ksh30,000	Ksh0	Ksh30,000	Ksh60,000	**Ksh120,000**	Ksh530,000	Ksh1,010,000
5	Ksh200,000	Ksh150,000	Ksh50,000	Ksh80,000	**Ksh480,000**	Ksh15,000	Ksh1,800	Ksh19,200	Ksh14,000	**Ksh50,000**	Ksh530,000	Ksh730,000
6	Ksh910,000	Ksh700,000	Ksh350,000	Ksh10,000	**Ksh1,970,000**	Ksh120,000	Ksh130,000	Ksh89,000	Ksh90,000	**Ksh429,000**	Ksh2,399,000	Ksh4,115,000
7	Ksh40,000	Ksh120,000	Ksh85,000	Ksh15,000	**Ksh260,000**	Ksh25,000	Ksh105,000	Ksh3,000	Ksh36,000	**Ksh169,000**	Ksh429,000	Ksh1,105,000
8	Ksh163,000	Ksh285,000	Ksh50,000	Ksh42,000	**Ksh540,000**	Ksh20,000	Ksh12,000	Ksh60,000	Ksh10,000	**Ksh102,000**	Ksh642,000	Ksh1,050,000
9	Ksh270,000	Ksh280,000	Ksh100,000	Ksh50,000	**Ksh700,000**	Ksh35,000	Ksh15,000	Ksh70,000	Ksh85,000	**Ksh205,000**	Ksh905,000	Ksh1,725,000
10	Ksh1,512,000	Ksh60,000	Ksh50,000	Ksh0	**Ksh1,622,000**	Ksh6,000	Ksh42,000	Ksh216,000	Ksh60,000	**Ksh324,000**	Ksh1,946,000	Ksh3,242,000
Average	Ksh378,500	Ksh292,500	Ksh134,500	Ksh21,210	**Ksh826,710**	Ksh38,100	Ksh36,580	Ksh55,270	Ksh76,600	**Ksh206,550**	Ksh1,033,260	Ksh1,859,460
Maximum	Ksh1,512,000	Ksh700,000	Ksh400,000	Ksh80,000	**Ksh1,970,000**	Ksh120,000	Ksh130,000	Ksh216,000	Ksh276,000	**Ksh429,000**	Ksh2,399,000	Ksh4,115,000
Minimum	Ksh40,000	Ksh60,000	Ksh50,000	Ksh0	**Ksh260,000**	Ksh6,000	Ksh0	Ksh1,500	Ksh10,000	**Ksh50,000**	Ksh429,000	Ksh730,000
Standard deviation	Ksh466,284	Ksh221,074	Ksh129,410	Ksh27,112	**Ksh595,119**	Ksh39,151	Ksh47,068	Ksh63,233	Ksh75,161	**Ksh121,842**	Ksh696,959	Ksh1,144,115

Table 12: Source Research.

From table 12 the average recurrent expenditure of schools on ICT is Ksh. 206,550 per year while the total average ICT expenditure of a school on capital and recurrent expenditure adds up to Ksh. 1,033,260 for the first year.

The school that spent most on ICT spent Ksh. 2,399,000 the first year of acquiring ICT, while the one that spent least used Ksh. 429,000.

Schools deviated a lot on the way they spent for recurrent expenditure the standard deviation was Ksh121, 842 per year while total expenditure for one year the deviation was Ksh696,959.

 The big deviation is mostly caused by the school population, the catchment area and whether it is a county school or a national school. Many national schools charge almost double the fees charged by the county schools and have many sponsors because they have many bright students.
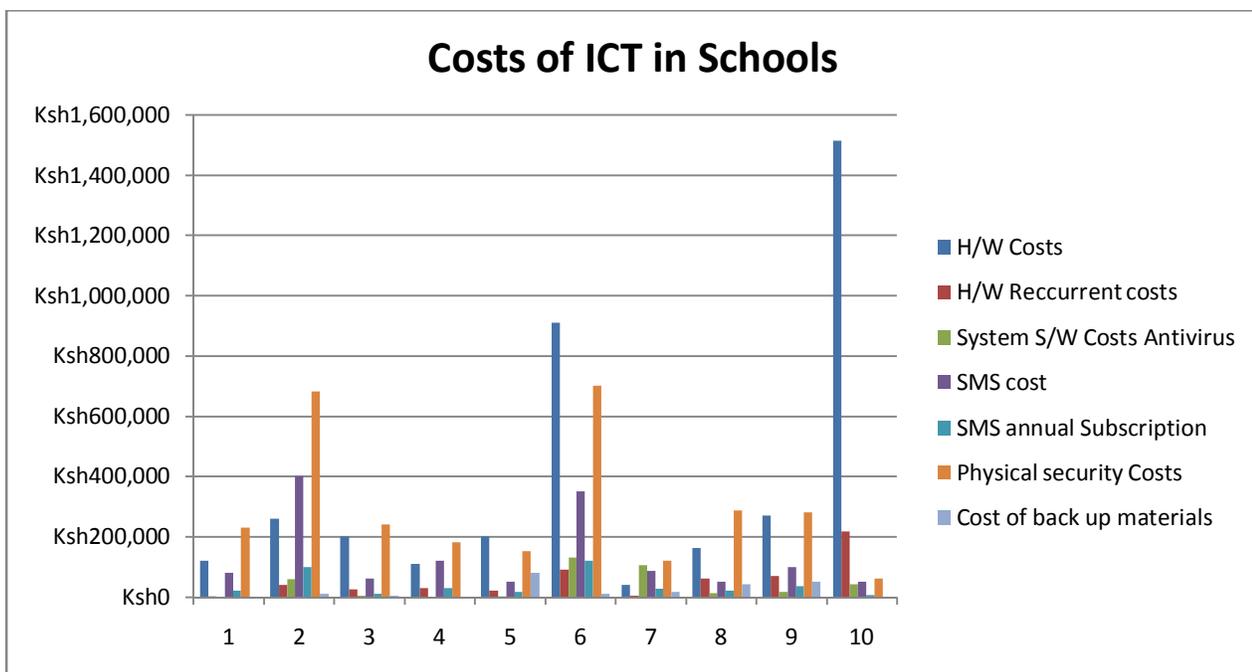
Figure 9: Source Research.

From figure 9 above, Hardware costs are the highest in a year followed by SMS costs. Cost of backup materials contributed to the lowest costs.

The costs of hardware had very high standard deviation because some schools had servers and 18 desktops while others had only two computers.

4.5   Possibility of Kenyan secondary schools to connect to the internet.

Internet Connectivity Options.

	Fiber	ISP	Mobile
Yes	20%	50%	100%
No	80%	50%	0%
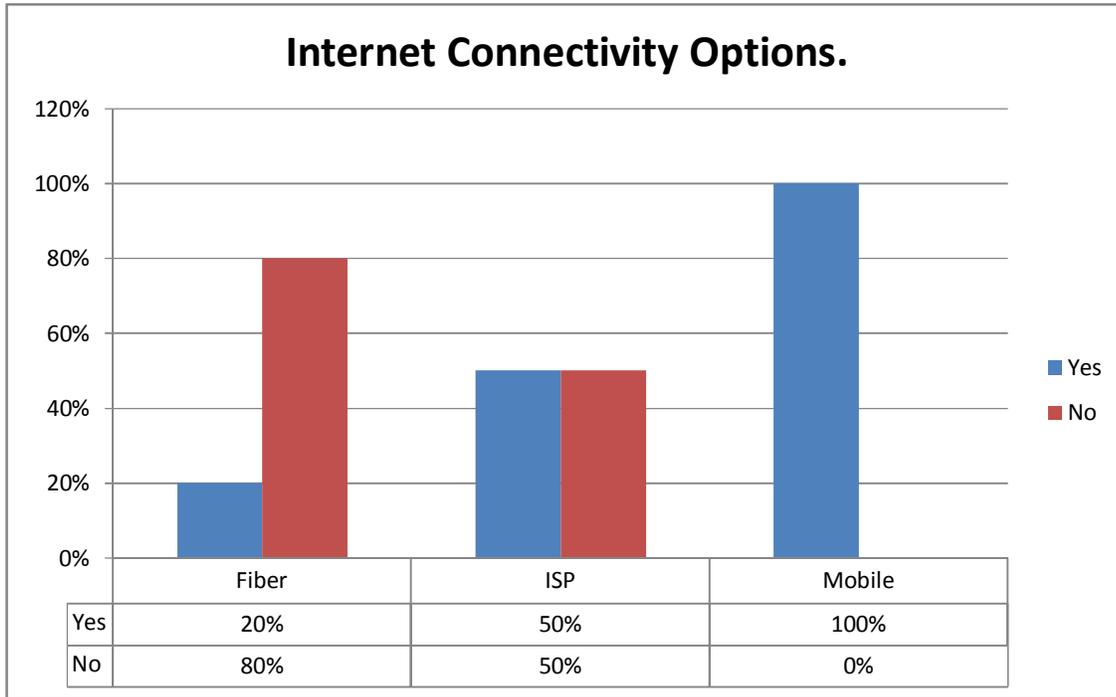
Figure 10: Source Research.

On connectivity to the internet the following were the findings;

- All the schools could connect to the internet using mobile technology.
- 50% of the schools could access the internet through the ISP.
- While 20% could have access to the internet through fiber technology.

School		Internet_costs
	1	Ksh75,000
	2	Ksh60,000
	3	Ksh276,000
	4	Ksh60,000
	5	Ksh14,000
	6	Ksh90,000
	7	Ksh36,000
	8	Ksh10,000
	9	Ksh85,000
	10	Ksh60,000
Average		Ksh76,600
Maximum		Ksh276,000

Minimum	Ksh10,000			
Standard deviation	Ksh75,161			

The cost of internet per years for the schools was as shown on the table 13 above where on average a school would use Kshs.76,600; the highest spender used Ksh. 276,000 while the minimum spender used Ksh. 10,000 per year.

4.6 Requirements and costs of running cloud SMS for Kenyan secondary schools.

4.6.1 Requirements for connecting to the internet.

- Hardware requirements.

A computer which can run windows XP or ubuntu 10.02 . This is be a computer worth about Ksh. 25,000.

- Software Requirements.

Windows XP or any Linux.

An updated browser.

If they run operating system such as ubuntu the cost is free.

- Connectivity.

An internet connectivity of 50kbps.

4.6.2 Costs of running SMS on the cloud per year.

	Computer H/W	Annual subscription	Average Internet Connection	Annual Cost
1	25,000	120,000	76,000	221,000
2	25,000	200,000	76,000	301,000
3	25,000	150,000	76,000	251,000
4	25,000	80,000	76,000	181,000
5	25,000	120,000	76,000	221,000
6				

	25,000	145,000	76,000	246,000
7	25,000	130,000	76,000	231,000
8	25,000	115,000	76,000	216,000
Average	25,000	132,500	76,000	233,500
Maximum	25,000	200,000	76,000	301,000
Minimum	25,000	80,000	76,000	181,000
Standard Deviation	-	34,641	-	34,641

Table 14: Source Research.

Table 14 above assumes that the schools use open source software and therefore the cost is free. In the first year the total cost of running cloud SMS was Ksh.233, 500 in the subsequent years the cost was be Ksh.208, 500.

4.7 Suitability of cloud based SMS v/s on premises SMS.

- The differences in the total cost in cloud based SMS against the total cost of on premise SMS.

On premise SMS costed Ksh1,033,260 for the first year while that of cloud SMS would cost Ksh. 233,500 on average per school. On both situations the costs are high because of initial costs involved.

For the first year the differences in costs is magnificent because of the high capital expenses in the on premise SMS. But as the time passes the two costs tends to converge as highlighted in the following paragraph.

For a period of five years a school that uses on premise SMS spent Ksh1,859,460 on average and if it was running in the cloud the costs would be Ksh1,067,500 on average. The cloud would save the school Ksh791,960 which is equivalent to 42.59% of their investment. Most of this amount is normally invested in the first year of the system and saving that amount for a period of 5 years would bring good returns.

- Further comparison between cloud based SMS against on premise SMS.

Parameter	On premises based systems SMS	Cloud based SMS
Level of automation (Modules)	The level of automation is relatively low. Departments such as library are not automated at all. While accommodation is the lowest with 20%.	With Cloud providers library systems are available and can ease in the management systems. Library systems also available on open school which means it can be available at very low costs.
System integration	The systems are not fully integrated making it more difficult to use and maintain. No school had a timetable system integrated with other systems.	Systems from cloud providers are fully integrated and therefore easy to use and maintain. All the school modules are available.
S/w source	All the SMS in schools were found to be Custom made for the schools. Other software were also proprietary except a small percent of schools which used a freeware antivirus.	In the cloud there is a combination of choices on the software types that were used from proprietary to open source. This can have a lot of implication on the school ICT budget and the overall budget.
Software licenses	Some administrators are not even aware of software license. They observed that it is the responsibility of the software provider. Some had software without license.	Before buying any software the licenses were looked into and discussed into details. Licenses were always paid for. They prefered using open source where they don¢t like the license conditions of a provider.
Years in use.	The first schools in the study were found to have	Cloud computing for school especially in Kenya was less

	automated their systems between 5 -7 years ago while some are still automating the latest was 2 months old.	than a year old.
Technology	All the SMS in schools were found not to be web-based and therefore difficult to move them to other platforms.	All the systems are web-based and therefore can easily be moved from one platform to the other.
Architecture	Some schools had bought servers and used them in the school networks. Other schools used desktops in place of servers. Some schools had a standalone computers running the SMS	They provided big servers which were available on the network.
Hardware	Some had servers with huge resources. Used desktops as servers.	Severs were used and had big capacity.
Initial Costs	The initial cost was very high	No initial cost was required.
DBMS	There were two DBMS used in schools databases these are Access and SQL server. Each school used only one DBMS.	Oracle and MYSQL were dominant in cloud DBMS many used more than one.
Access	Access was limited to the people in the premises. None could be accessed outside the school. Some were standalone and could be operated only by one person at a time. To Access one does not require internet connection.	Anyone who authenticates could access the systems from any part of the world. Many people could access from different parts of the world at the same time. To access internet connection was required.

Internet availability/costs	All the schools could access the internet if they wished as they have the necessary infrastructure. So they could access the cloud services if they wanted. Many had LANs	They were connected to high speed networks able to support multiple clients.
Availability of systems	The availability of SMS was between 89-99%.	All the cloud providers provide an availability of 99.9%.
Causes of system unavailability.	The causes of unavailability were virus attack, Power failure and maintenance.	The only cause of unavailability was due to loss of network since cloud services are dependent on networks.
Measures against power loss	Some schools have no measure against power loss they wholly relied on power from KPLC. A few have generators. The most common is the use of UPS.	Cloud providers had generators which could provide power immediately the power went off. They also had very strong UPS.
Physical security measures	Schools used security personnel, strong doors, lock and key, alarms and sensors, security lights and dogs.	Cloud providers used armed security personnel, strong doors, lock and key, alarms and sensors, security lights, perimeter walls and fire detectors and suppressors.
Physical security	In schools where one had a very easy access to premises. Once a visitor cleared with the security personnel at the gate he could access many parts of the school and	Visitors were checked and access to the premises highly controlled, before talking to a worker individual details are recorded.

	interact with workers and get information.	
Security personnel	Security team is a group of people individually employed by the school. Security personnel were armed with bows and arrows.	Security personnel were hired from institutions such as police and other Securicor firms.. Security personnel were armed with guns and metal detectors.
Alarms grills etc costs	In all the schools the doors to computer rooms and offices were metallic and doors were grilled. Some schools had installed motion detectors and alarms after losing their systems.	Besides metallic doors, metallic grills cloud providers had cameras and fire detectors and suppressors.
Incidences	Some schools had lost data and hardware.	None of the cloud providers had lost any data and or hardware.
Data security measures	Schools used passwords, backup and antivirus to protect their data.	Cloud providers used passwords, backup, firewall, logs, redundancy, disk stripping, encryption and antivirus to protect their data.
Frequency of backup where backup is done and costs of materials	Some schools had no backups while some backed up once every week.	Cloud providersø backup data hourly. They also stored their backups online.
Data loss	About 40% of the schools had lost their data due to lack of good data security measures. Some losses happened few days before the	None of the provides admitted to having lost the customer data , but from the interview this can be attributed to good security

	study. Some schools didn't backup their data; some backed it up and stored it next to the servers.	measures such as remote backup, replication, mirroring and disk striping.
ICT staff availability	Schools didn't have permanent ICT staff. They hired persons to fix their ICT problems when problems arose. Many schools had no contract on maintenance; therefore some problems lacked follow up when a different person was called.	They had permanent ICT staff and had contracts with the suppliers of ICT products.
Fees problems	Many schools had financial problems because parents and guardians cannot afford.	Sourcing SMS from the Cloud is capable of lowering the cost of ICT and hence reduce the financial burden to parents
Access SMS remotely	The SMS were not accessible outside the school by all the stakeholders. Majority of school administrators would prefer the stakeholders to access SMS remotely.	These systems could be accessed remotely by those who are authorized and could authenticate.
Data safer in clouds?	Many organizations don't consider their data safer in the cloud than in their premises, but for schools this is completely opposite where 70% agreed that their data would be safer in remote computers. This may be attributed to the great loss of equipments and data that had	From the study none of the cloud providers had lost any data unlike schools. Therefore data was safer in the cloud than in school premises.

	taken place in schools.	

Table 15: Source Research.

From the above comparison in table 15 many advantages of cloud based SMS had been identified such as;

- Savings on costs.
- Fewer risks involved such as data and equipments loss as compared to schools.
- A lot of accessibility provided by the cloud SMS.

It is evident that cloud based SMS is by far a more suitable way for schools to run their SMS.

The following **tangible** benefit will be realized as a result of using cloud based SMS as opposed to on premise based SMS;

- The average amount spent over a period of five years by the schools using on premise SMS is Ksh. 1,859,460 while they could have used Ksh. 1,062,500 in using cloud computing making a saving of 42.59%

The following **intangible** benefits were established by the study as the result of using cloud based SMS;

- Reduces the risks of attacks in schools because of expensive machines.
- Increases accessibility of the information by stakeholders.
- Support at the server level is much better.
- Schools are able to use the appropriate technology in their databases.
- The availability of the system is increased.

CHAPTER FIVE
SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1   Overview

This chapter is a summary of the entire study. It also looks at recommendations and areas for further research are pinpointed.

5.2   Summary of the study.

In the Kenyan market there are several cloud providers some are multinational companies and some few local companies. The study revealed a situation where a company closed down and it could not be established what happened to their customer data; the said company had their website still active. Their phones were disconnected and no response from their email. Majority of the cloud providers charge their services per month as opposed to what a cloud service entails. Some companies even charge their services per year. The companies also lacked elasticity one could not scale automatically but required human intervention.

Providing of SMS through the cloud is more cost effective especially for small schools that lack enough capital to invest in ICT equipments. It would also provide more physical security for their data and equipments against burglary which is common among schools.

5.3   Challenges faced by Kenyan secondary schools.

The study revealed that 100% of the schools used on-premise based school management systems in doing so they were faced with the following challenges:

- High initial costs of hardware.
- Lack of support and follow up.
- Lack of data and physical security.

Almost all the challenges mentioned in using the on premise SMS could be avoided by choosing the cloud based SMS.

5.4   Cost of running server based school management systems.

As evident the cost of on premise SMS is very high and occurs at the initial stages of the system. The analysis showed that about 42.59% of the on premise costs could be eliminated by using cloud based SMS over a period of 5 years.

5.5   Possibilities of connecting to the internet.

The study revealed that 100% of the schools could connect to the internet without requiring any infrastructural investment as all the schools could access the internet at will. 20% of the

schools could access the internet through the fiber, 50% could access through an ISP and 100% of the schools could access the internet through the mobile technology.

On average the schools used Ksh.76, 600 to access the internet. For schools to access the cloud services they needed to have internet access, it was found that some of the schools already had internet access and would not incur additional internet costs due to adaptation of cloud computing.

5.6   Requirements of running cloud based systems by schools.

It was found that for schools to have access to cloud services they needed to have access to the followings facilities.

- They needed to have access to the internet so that they may get access to their data and software since cloud computing is network dependent. When the internet connection is lost the customers will also lose access to their data. Schools will need to bear this in mind as they consider adopting cloud services.
- A hardware which supports:
  - A current generation operating system which is up to date
  - An updated browser.

5.7   Recommendation.

Many schools faced a lot of challenges in running on premise school management systems ranging from lack of physical and data security to lack of knowledgeable decision on choosing the right technology for their institutions. To curb these problems it is recommend that schools do any of the following; schools in a region should pull their resources together and come up with a community cloud which they would manage and cost share. Another solution would be for schools to adopt the public cloud services where they donøt need to spend on any capital expenditure.

5.8   Suggestion for Further Study

The researcher recommends the following topics to be studied in the future as they could benefit the society;

- ˝ Challenges facing cloud providers in Kenya.
- ˝ Contribution of ICT in Kenyan schools towards the overall global sustainability.

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Appendix

Questionnaire 1 (Cloud providers Questionnaire)

Section A (Personal Details)

1. What is your Gender?

   Male [ ]   Female [ ]

2. What is your level of education? Certificate [ ] Diploma[ ] Bachelors [ ] Masters [   ]

   PHD [   ]

3. What is your age bracket? Between 25 and 35 [   ] Between 36 and 45 [   ] Between

   46 and 55 [   ] Above 55 [   ]

4. Whatøs your Proficiency in IT?

   Very good [ ] Good [ ]   Fair [ ]   poor [ ] Very poor [   ]

   Section B (Services to Schools)

5. Tick the cloud services that are available to public from your company. You may

   choose more than one answer.

   SaaS [   ] Paas [   ] Iaas [   ]

6. Do your organization have cloud solutions to schools?

   yes [ ] No [ ]

7. Tick the cloud services that are available to schools from your company. You may

   choose more than one answer.

   SaaS [   ] Paas   [   ] Iaas [   ]

8. If you provide Saas then select the modules you provide as a service.

   Finance [   ]   Payroll [   ]   Students marks [   ] Library [   ]

   Timetable [   ]   Ledger [ ] Rent Management [   ]

   Any other specify _____

9. Who provides the above mentioned services in (8)

   Ourselves [   ] Third party [   ]

10. What percentage of your clients are schools? 0%-20% [   ] 20% - 40%   [   ]

    40% ó 60% [ ] 60 % ó 80% [   ] 80% -100% [   ]

11. For how long have you been offering cloud computing?

    Between 1 ó 3 years [ ] Between 3 ó 5 years [ ] Between 5 ó 7 years [ ]

    Between 7 ó 9 years [ ] Between 9 ó 11 years [ ] over 11 years [ ]

12. For how long have you been offering cloud computing to schools?

    Between 1 ó 3 years [ ] Between 3 ó 5 years [ ] Between 5 ó 7 years [ ]

    Between 7 ó 9 years [ ] Between 9 ó 11 years [ ] over 11 years [ ]

    Section c (costs)

13. State the initial cost in Ksh. one has to pay to access cloud services, if none write zero(0) _____

14. Based on **storage**, **RAM**, **CPU** speed and **bandwidth** provide the various option available and in each case state the billing period and the cost Ksh?

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15. How do you bill your clients ?

Hourly [   ] weekly [   ]   monthly [   ] annually [   ]

16. If you provide Saas then which are the available modules for schools. You may pick more than one choice. Please also indicate the cost per module per year in Ksh.

Finance [   ] Ksh._____   Payroll [   ]   Ksh._____

Students marks [   ] Ksh._____   Library [   ]   Ksh._____

Timetable [   ] Ksh._____   Payroll [   ] Ksh._____

Anyother specify _____

17. Do you charge for extra security measures on clientsødata?   Yes [   ] No [   ]

18. List and cost these measures. Just list if not charged.

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……………………………………………………………………………………………
……………………………………………………………………………………………
……………………………………………………………………………………………

Section D (Accessibility)

19. Can your systems be accessed from homes and offices away from work?

Yes [   ] No [   ]

20. What are the requirements for one to access your services and costs?

Connectivity

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……………………………………………………………………………………………
……………………………………………………………………………………………
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Hardware

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Software

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í í í

Any other specify.

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21. What level of system availability do you guarantee you customers?

1%-19% [　] 20% - 39% [　] 40% - 59% [　] 60% ó 79 % [　] 80 % - 99% [　]

any other specify _____

22. If the answer to 22 above is not 100% then, what are the causes of system

unavailability. You may choose more than one choice.

Failure in network [　] O/S failure [　]　hardware failure [　]

Virus related problems [　] Database failure [　]　Power failure [　]

System too busy [　] System maintenance and upgrade [　]

Any other specify_____

Section E (usability and Data security)

23. Choose the physical security measures that your organizations take.

CCTV [　　] 　Smart cards [　] 　strong metal grills [　] Strong doors [　]

Security personel [　] 　Biometrics [　]

Any other specify

_____

24. What authentication and authorization methods do you use in your systems?

Passwords [　] Digital certificate [　] Smart cards [　] Biometrics [　]

Any other specify _____

25. To what extent do you agree with the following statement? õThe physical security of

your company is very tightö.

Strongly agree [　] Agree [　] Neutral [　] Disagree [　] strongly disagree [　]

26. What are the various ways through which you protect your clientøs data? You may choose more than one answer.

Encryption [   ] Secured networks [   ]   Mirroring [   ] Redundancy [   ]   Backup [   ]

None [   ] any other specify _____

27. Where do you store your clientsø backup? you may choose more than one

Same room as the servers [   ] Remote location [   ] CEOøs office [   ]

Any other specify _____

28. What is the procedure and steps of connecting to the cloud?

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 # The End.

Thanks for filling the questionnaire.

Questionnaire 2 (Administrators' Questionnaire)

Section A

1. What is your Gender?   Male [ ]   Female [ ]

2. What is your level of education Certificate [ ] Diploma[ ] Bachelors [ ] Masters [   ]
   PHD [   ]

3. What is your age? Between 25 and 35 [   ] Between 36 and 45 [   ] Between 46 and 55
   [ ] Above 55 [   ]

4. Whatøs your in IT Proficiency in IT?
   Very good [ ] Good [   ]   Fair [ ]   poor [ ] Very poor [   ]
   Section B

5. Have your school automated any system yes [ ] No [ ]

6. If yes in (5) above Tick the ones that are automated
   Finance [   ] Payroll [   ]   Students [   ]

7. For how long have you automated these systems _____

8. Tick whatever you have experienced with your system
   Lost data [   ] Difficult to use [   ] Lost Accessibility [   ] None [   ]

9. Please tick the ones your school has access to.
   Fiber [   ] Internet via ISP [   ] Mobile network [   ]

10. Do you always get help/support whenever you experience a problem? _____

11. How much did your organization pay for acquiring the current computer h/w devices
    for the school management system? _____

12. How much did your school pay initially to acquire the current management system
    _____

13. What is the annual subscription for the system? _____

14. Would you prefer a system that would bring this cost down? Yes [ ] No [ ]

Section C

In this section state to what extent you agree with each statement.

15. The current cost of IT facilities is very high for this school.
    Strongly agree [   ] Agree [   ] Neutral [   ] Disagree [   ] strongly disagree [   ]

16. A solution through which the school would only pay for what we use would be
    worthwhile.
    Strongly agree [   ] Agree [   ] Neutral [   ] Disagree [   ] strongly disagree [   ]

17. We wish to get a solution where upgrades to the systems do not bother you.
    Strongly agree [   ] Agree [   ] Neutral [   ] Disagree [   ] strongly disagree [   ]

18. We would be better off if repairs of these services are not our concern.

Strongly agree [   ] Agree [   ] Neutral [   ] Disagree [   ] strongly disagree [   ]

19. We would like your parents to get their children information online without having to visit the school.

Strongly agree [   ] Agree [   ] Neutral [   ] Disagree [   ] strongly disagree [   ]

Budget

The following are budget estimates for the study and may change depending on the prevailing economical conditions.

Serial no.	Item Description	Cost (KShs.)
1	Analysis Software	3,000.00
2	Binding Expenses	6,000.00
3	Data Collection Materials	6,000.00
4	Transport	5,000.00
5	Miscellaneous	5,000.00
6	Printing Materials	5,000.00
7	Typing setting Expenses	5,000.00
8	Writing Research Proposal	5,000.00
Total		**40,000.00**

Table 16: Source Research.

Research schedule

The following table represents time plan for the study.

Activity	Month	Weeks
Creating a topic and registering.	August	1
Proposal Writing.	September	4
Developing Questionnaire.	October	3
Collecting and analyzing data.	October/November	4
Interpreting results and analyzing them.	November/December	2
Writing report draft	December	4
Writing the final report.	February	2

Table 17: Source Research.

Further data Analysis

Bio data of school administrators

Education

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Bachelor	4	40.0	40.0	40.0
	Diploma	5	50.0	50.0	90.0
	Masters	1	10.0	10.0	100.0
	Total	10	100.0	100.0	

Table 18: Source Research.

Age

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	26-35	5	50.0	50.0	50.0
	36-45	3	30.0	30.0	80.0
	46-55	2	20.0	20.0	100.0
	Total	10	100.0	100.0	

IT_Proficiency					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Very good	3	30.0	30.0	30.0
	Good	5	50.0	50.0	80.0
	Fair	2	20.0	20.0	100.0
	Total	10	100.0	100.0	

Table 19: Source Research.

Automated modules

Automation_level

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Almost Full Automati	4	40.0	40.0	40.0
	Medium Automated	2	20.0	20.0	60.0
	Minimum Automation	4	40.0	40.0	100.0
	Total	10	100.0	100.0	

Integration

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Fully Integrated	1	10.0	10.0	10.0
	Medium Integrated	4	40.0	40.0	50.0
	Not integrated	5	50.0	50.0	100.0
	Total	10	100.0	100.0	

Finance

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	4	40.0	40.0	40.0
	Yes	6	60.0	60.0	100.0
	Total	10	100.0	100.0	

Payroll

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	7	70.0	70.0	70.0
	Yes	3	30.0	30.0	100.0
	Total	10	100.0	100.0	

Examinations

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	1	10.0	10.0	10.0
	Yes	9	90.0	90.0	100.0
	Total	10	100.0	100.0	

Library

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	10	100.0	100.0	100.0

Timetable

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	2	20.0	20.0	20.0
	Yes	8	80.0	80.0	100.0
	Total	10	100.0	100.0	

Inventory

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	10	100.0	100.0	100.0

Rent

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No	8	80.0	80.0	80.0
	Yes	2	20.0	20.0	100.0
	Total	10	100.0	100.0	

Table 20: Source Research.

Bio data of cloud providers

Gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	5	71.4	71.4	71.4
	Female	2	28.6	28.6	100.0
	Total	7	100.0	100.0	

Education

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Bachelors	6	85.7	85.7	85.7
	Masters	1	14.3	14.3	100.0
	Total	7	100.0	100.0	

Age

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	25 - 35	6	85.7	85.7	85.7
	36 - 45	1	14.3	14.3	100.0
	Total	7	100.0	100.0	

Table 21: Source Research.

Measures against data loss by cloud providers

	Network failure	CCTV	Smart cards	Grills	Strong Doors	Security personnel	Biometrics	Passwords	Digital Certificate	Tight security	Encryption	Secure network	Mirroring	Redundancy	Backup
N Valid	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
Missing	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Yes	100%	100%	85.7%	100%	100%	100%	57.1%	100%	85.7%	100%	100%	100%	100%	100%	100%
No	0%	0%	14.3%	0%	0%	0%	42.9%	0%	14.3%	0%	0%	0%	0%	0%	0%

Table 22: Source Research.