

Viability of Cloud Computing Adoption by Government of Lesotho at Thaba-Tseka Town

MSc Computer Information Systems

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Dissertation

This dissertation is submitted in part fulfilment of the requirements of Botho University for the degree of Master of Science in Computer Information Systems.

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The journey I took throughout this study may look short in terms of time taken, which is roughly 6 months, but it was a tough, tiring and demanding journey. It had its up and downs, but thanks to the support I had I finally made it to the last sentence of my report.

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After all these support, I even feel like studying further and engage in more researches that can help in betterment of my country Lesotho and Computer Science field in general

Regards!

ABSTRACT

Cloud computing is one of latest computing paradigms where computing resources like processors, hard-drives, data warehouses, servers, operating system and applications are rented to the users in pay-per-use manner and are accessed through the Internet. Cloud computing is one of Information Technology solutions that reduces infrastructure costs for governments and small to medium businesses, and enable them to access latest software versions and hardware resources. Government of Lesotho like other developing countries governments can leverage on these and other cloud computing benefits, should it decide to adopt cloud computing. This study investigates the preparedness of Government of Lesotho for adoption of cloud computing at one of its remote cap town called Thaba-Tseka. The areas of preparedness investigated are civil servants level of computer literacy, Information, Communication Technology infrastructure and Information Technology personnel cloud skillset. This paper consists of six chapters, namely the Introduction, Literature Review, Methodology, Results and Analysis, Discussion and, Conclusion and Recommendation. The literature reviewed the cloud service models, cloud deployments models, background and history of cloud computing, technologies underlying cloud, benefits and drawbacks of cloud and lastly related publications. Survey was chosen as most suitable method of data collections, and the tools used to collect data from various ministries in Thaba-Tseka are questionnaires. The data was analysed using various quantitative and qualitative data methods. The results were discussed and finally the conclusion that Government of Lesotho at Thaba-Tseka is not fully ready for adoption of cloud computing, but just needs improvement in few areas was reached. One of the limitations of this study was failure to successfully acquire data from Government of Lesotho Information Technology department, using digital questionnaire send through email, despite several phone calls as reminder to respondents.

Keywords: *cloud computing, cloud models, survey, cloud adoption.*

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ABBREVIATIONS AND ACRONYMS

ADSL	: Asymmetrical Digital Subscriber Line
CD	: Compact Disk
CORBA	: Common Object Request Broker Architecture
DCOM	: Distributed Component Object Model
HDSL	: High data rate Digital Subscriber Line
ICT	: Information and Communication Technology
ISP	: Internet Service Provider
IT	: Information Technology
LEC	: Lesotho Electricity Company
LHDA	: Lesotho Highlands Development Authority
LTE	: Long-term Evolution
NIST	: National Institute of Standards and Technology
PC	: Personal Computer
PDF	: Portable Document Format
RMI	: Remote Method Invocation
RPC	: Remote Procedure Call
SDSL	: Symmetrical Digital Subscriber Line
USB	: Universal Serial Bus
WAN	: Wide Area Network
xDSL	: Represents all Digital Subscriber Lines, including High rate HDSL, ADSL,SDSL

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1. INTRODUCTION

NIST (2011) define Cloud computing as, a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. This seems to be a definition accepted by several publications. In simple terms, cloud computing is IT paradigm whereby computing resources like software, hardware (processors, hard drive, RAM), network or servers are provisioned to users in a pay-per-use contract and accessed over the internet or private networks. As El-Bakary (2015), Muhammad(2015) and Demissie (2017) asserted, cloud computing brings with it couple of benefits that developing countries which struggle to finance in-house IT infrastructure can leverage on. The main advantages being elasticity, reduced hardware costs, scalability and flexible access. However, cloud computing still goes with challenges that do or may hinder its adoption, such as privacy concern, data modification, need for high bandwidth, lack of skillset, data security concern. For developing countries and Small-Medium-Enterprises, cloud computing is still a better and more cost-effective solution than traditional IT solutions. This study is therefore going to focus on the viability of Government of Lesotho's adoption of cloud computing at their offices in Thaba-Tseka town.

1.1Background

Thaba-Tseka is a capital or captown of Thaba-Tseka district in Lesotho. The town's population is 5,423, according to worldpopulationreview.com (2018), and serves over 135,300 people, according to citypopulation.de (2016). The town is located 171 kilometres East of Lesotho's capital town, Maseru. The Government of Lesotho has more than 10 ministries offices in this town, with each ministry having access to the Internet, using broadband connection (mostly Advanced Digital Subscriber Line, and Optical Fiber Connection to one ministry). All ministries have information and communication technology tools like laptop/Desktop computers and printers. These government ministries, together with colleges, the bank and hotels/lodges in this town are supplied with Internet by major telecommunication company Econet Telecom Lesotho.



Figure 1-1: A picture by Wikipedia.org, showing Thaba-Tseka town where most of the Government of Lesotho ministries offices are located. The Eastern part of Thaba-Tseka town.

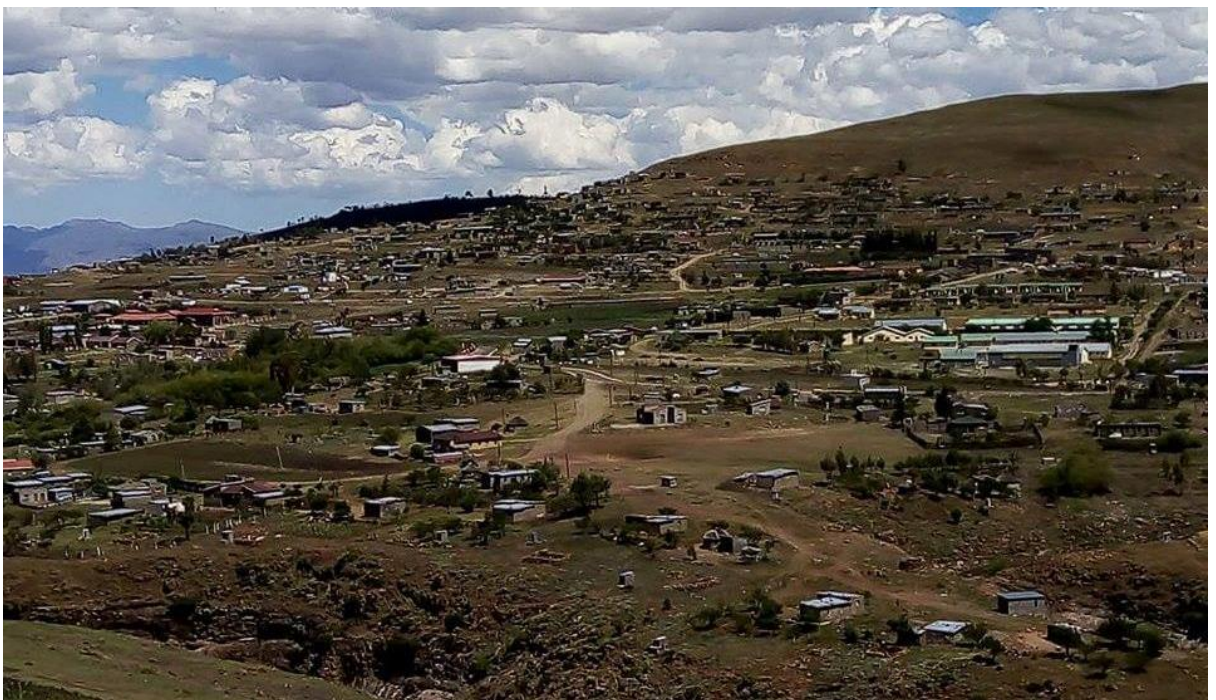


Figure 1-2: The Western part of Thaba-Tseka town, mainly residential side with two colleges, hospital and lodges.

1.2 Statement of Problem

With the believe that Thaba-Tseka town information technology infrastructure is improving and sustaining private businesses, government offices and individuals, I doubt that the infrastructure and human resource computer literacy skills level are ready or adequate for Cloud Computing services adoption by dozens of Government offices. However, I believe that Cloud Computing despite having some challenges, especially in developing countries, its successful adoption can bring more benefits than challenges. Seifu *et al* (2017) too pointed out this, “Cloud computing as a new computing paradigm can now provide remote access resources that were otherwise accessible”. “As much as the adoption of ICT in education becomes imperative, cost of owning of the required ICT infrastructures, licensing, standards requirement, cost of maintenance, electrical power supply and physical security of these facilities come at a great financial expense.” (Akin *et al*, 2014). These says that, even if Government of Lesotho may have funds to own ICT infrastructure, adopting cloud computing will be a much cheaper option, especially for a developing country, that relies heavily on foreign donors for its national budget. As much as cloud computing adoption can bring host of benefits for disadvantaged and remote town like Thaba-Tseka, the skillset of IT personnel , town ICT infrastructure, electricity supply reliability, privacy , data security and employees computer literacy may be some of the stumbling blocks for smooth and successful integration.

1.3 Aims and Objectives

1.3.1 Aims

The aim of the study is to investigate the practicality of cloud computing adoption by Government of Lesotho at its offices at the remote town Thaba-Tseka. To find if the infrastructure, information and communication technology tools, civil servants computer literacy and information technology personnel expertise are capable of handling cloud computing adoption, at Government of Lesotho offices at Thaba-Tseka town.

1.3.2 Objectives

The objectives of this study are to find:

- 1) How advanced the Government offices are in terms of hardware and computing devices needed for Cloud Computing adoption.
- 2) How prepared the information technology personnel expertise and computer literacy of employees in general are for Cloud Computing adoption

1.3.3 Research Questions

The study is to find answers to these questions:

At Thaba-Tseka town:

- 1) Is the internet bandwidth high enough to sustain cloud computing adoption?
- 2) Is the internet supply stable enough to sustain cloud computing adoption?
- 3) Do the Government of Lesotho have information technology personnel with skillset for cloud computing adoption?
- 4) Is computer literacy of civil servants advanced enough to migrate to cloud computing?
- 5) Do the civil servants trust the third party handle their data outside the country or their premises?
- 6) Is the computer security tight and prepared enough for cloud computing adoption?

1.4 Rational of the Study

This study is going to benefit various fields and entities, both in Lesotho and internationally. Should the Government of Lesotho decide to adopt cloud computing at their remote towns like Thaba-Tseka, this study will form the basis on which to assess readiness of their information and communication technology infrastructure and personnel. The government will be in better position to budget for cloud computing solutions and have clearer picture on where to improve their infrastructure and personnel skillset. The study will also help tertiary students who may be interested in studying and carrying research on cloud computing in developing countries like Lesotho. This study will be part of documents that to reference when carrying out investigation on cloud computing. In the future, more learners in Lesotho may even be enticed to study cloud computing after coming across the study like this one. Furthermore, internet service providers like Econet Telecom Lesotho,

Vodacom and LEO will have more research papers to reference, should the users in the future decide to explore cloud computing solutions for their businesses and other services. They will be in better position to know where to improve their infrastructure to handle cloud computing. Successful completion of this study will also mean, international cloud service providers like Amazon, Microsoft, Rockspace, Cisco, and Google will benefit, should they intend to explore markets in developing countries like Lesotho.

1.5 Outline of the Paper

The paper consists of six chapters, namely Introduction, Literature Review, Methodology, Results and Analysis, Discussion, and, Conclusion and Recommendations. The chapters have Sections and sub-sections. Literature Review chapter reviews the current theoretical concepts in the field of cloud computing, and publications closely related to this study. Methodology chapter outlines and explains thoroughly the research methods or data collection methods used during the survey. Then follows the Results and Analysis, where data collected are presented, interpreted and analysed using charts, and other statistical analysis tools. The results are discussed in line with the aims and objectives of the study, together with the current theory in cloud computing. The last chapter is Conclusion and Recommendation, summaries the study, mainly in reference to the aims of the study, and recommends the steps or procedures that the Government of Lesotho can follow if they are to adopt cloud computing. The References of publications and sources cited or used throughout paper are listed.

2 LITERATURE REVIEW

2.1 What is Cloud Computing

“Cloud computing is a computing paradigm, where a large pool of systems are connected in private or public networks, to provide dynamically scalable infrastructure for application, data and file storage.” Harris (2010). In cloud computing, computing resources like hard drives, processors, memory, operating system, network or applications are rented to users in a scalable manners depending on the needs of the users. The users only pay for what they used, and can increase or decrease the scale of the resources any time. With cloud computing, users do not own the computing resources, but only need to rent them and access them through the internet or private networks. As Rajendran (2016) stated, cloud computing is offered through three main service models, namely Software-as-a-Service (SaaS), Platform-as-a-Service (PaaS) and Infrastructure-as-a-Service (IaaS). It is offered in four deployment models, which are; Public Cloud, Private Cloud, Community Cloud and Hybrid Cloud.

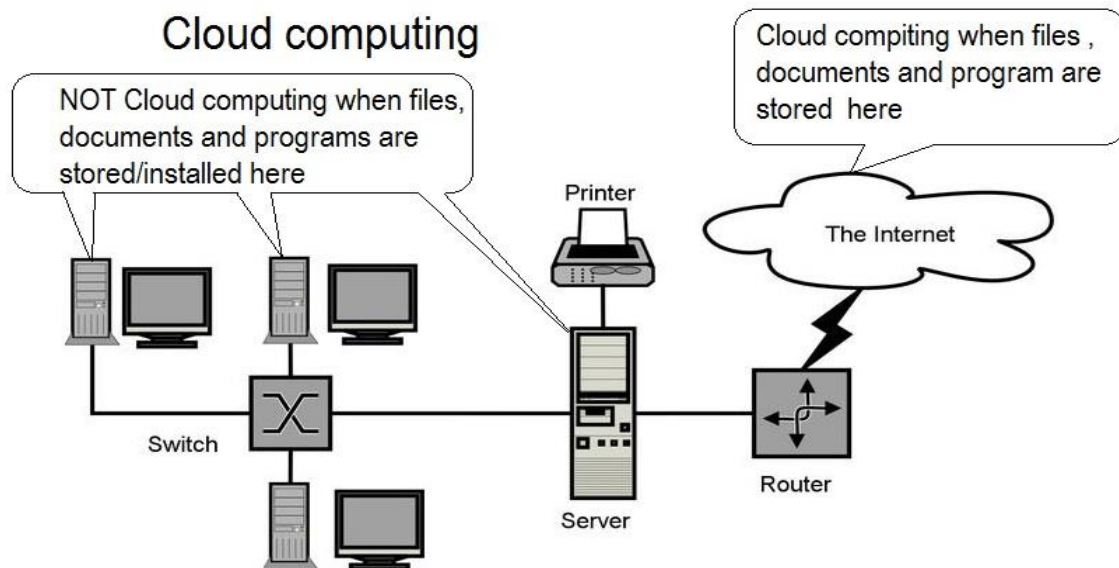


Figure 2-1: illustrates cloud computing

As Muhammed (2016) asserted, cloud computing idea started way back in 1960s when mainframes were invented. Though indirectly, various technologies were invented throughout the following decades until in 2000s when cloud computing came to be. Such technologies

include hardware virtualization, grid computing, clustering, Web 2.0, Service-Oriented Architecture, Web services and autonomic computing. These cloud computing underlying technologies will be explained in Section 2.4 in details. Cloud computing like any new paradigm in IT industry have its pros and cons, which will be discussed in Section 2.7 and 2-8. Due to financial constraints and trailing advancement of other technologies in developing countries, there will always be more challenges and difficulties in adopting cloud computing in developing countries, compared to developed world. Such challenges will be covered in the last section of this chapter.

2.2 Brief History of Cloud Computing

Babbar (2017) states that, cloud computing is the result of evolution and adoption of existing technologies. It was a moderate evolution that began in early 1950's with the motive of mainframe computing. A testimony that, cloud computing as a "new" technology may have taken center stage in IT industry and trended since mid-2000s but the idea may have been as old as born in 1950s.

Voas and Zhang (2009) outline the phases of cloud computing in 6 phases shown in the figure below.

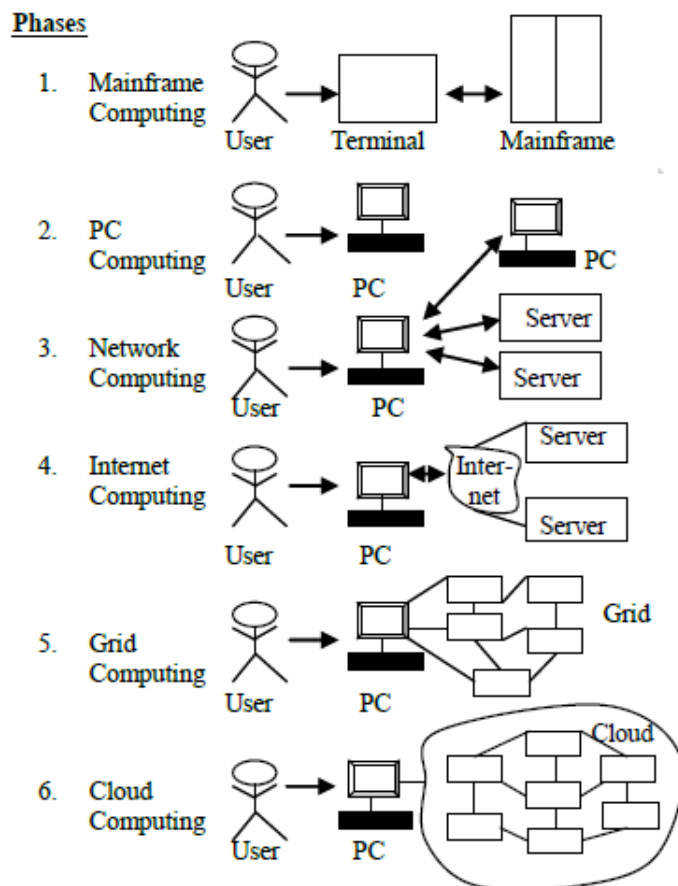


Figure 2-2: A, Picture adopted from Voas and Zhang (2009) showing six phases of cloud computing.

Fig. 1.3 Six computing paradigms – from mainframe computing Internet computing, to grid computing and cloud computing.

Phase1: Mainframe Computing

Mainframe computers were invented in late 1950s throughout to 1970s. They are huge machines that could fill a room. Users connect to a mainframe through terminals, access it simultaneously, with uninterrupted performance as if each user is using their own personal computers. The analogy to current cloud computing being that multiple users are sharing like hard-drive, RAM, processors and applications. In Mainframe computing the resources are in a privately owned computer, accessed just through terminals, while in cloud computing resources are in remote servers, and accessed through the internet or private networks.

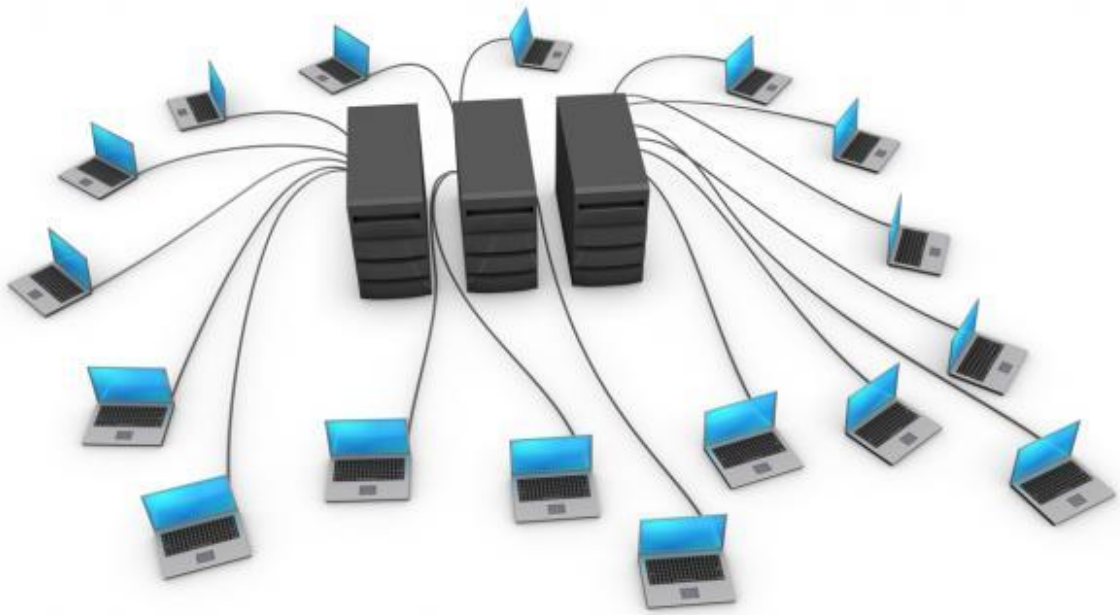


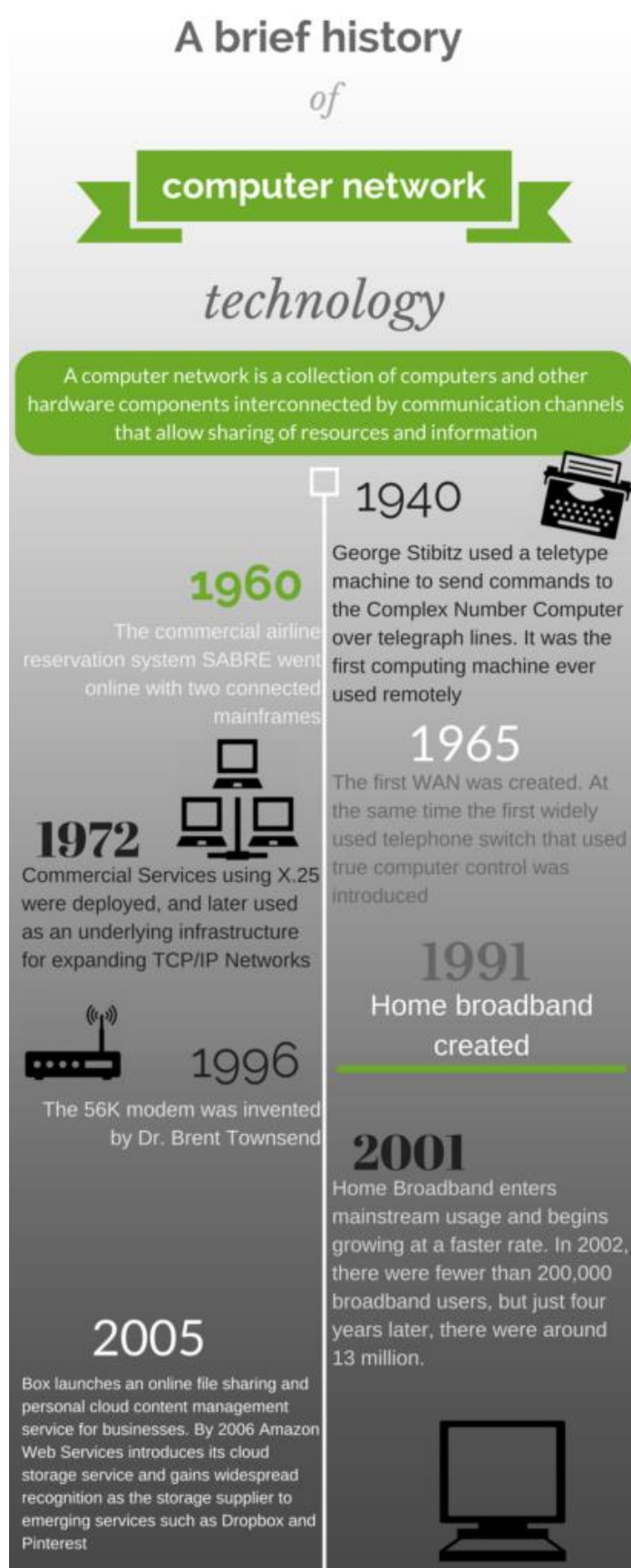
Figure 2-3: A picture by ibmmainframes.com, showing terminals (users) connected and sharing Mainframe computer

Phase 2: PC Computing

Personal Computer (PC) was invented in 1970s and taken to world popularity by companies like IBM, Microsoft and Apple. Because of their size and affordability PCs became household properties in the following decades. PCs are complete computer systems, with input, processing, storage and output capabilities on their own. On top of that they can be connected to other computers, which gave birth to networking. PCs can use resources of their own or access resources in servers, and they are main tools used in cloud computing nowadays, in the form of smartphones, laptops, tablets and desktop computers.



Figure 2-4: A picture by industrailrev.weebly.com, showing of the first modern IBM PCs



Phase 3: Network Computing

Winkleman (2013) states that, a network consists of two or more computers that are linked in order to share resources (such as printers and CDs), exchange files, or allow electronic communications. The computers on a network may be linked through cables, telephone lines, radio waves, satellites, or infrared light beams. Another technology which drove IT industry close to the now trending cloud computing. That is when PCs began to share resources and communicate among themselves and the servers. This what cloud computing is mainly about, or the core of cloud.

Figure 2-5: showing a brief history of networking between 1940 and 2005.

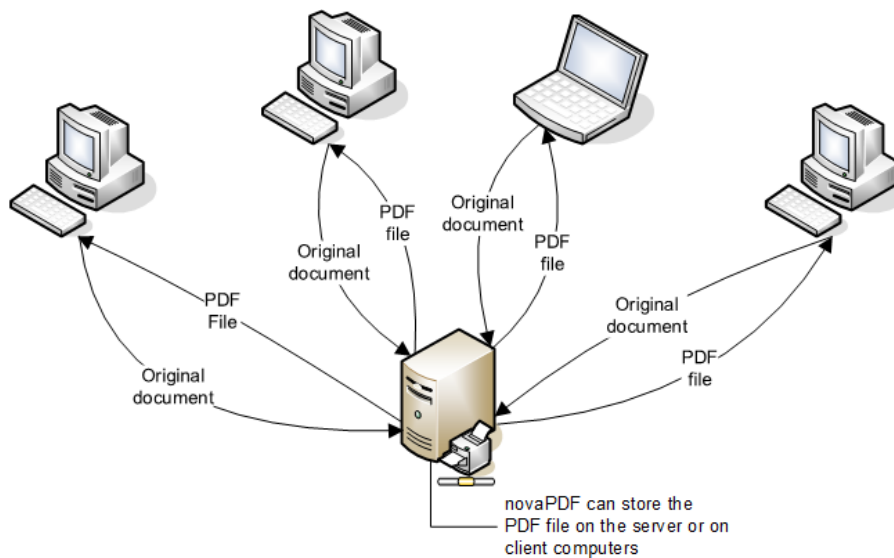


Figure 2-6: Picture by novapdf.com .Shows a network of PCs connected together, and sharing resources in the server.

Phase 4: Internet Computing

The Internet being the largest and global public network, which connect billions of computers through TCP/IP(internet protocol suite), further advanced the networking technology. The internet took IT industry to another level and laid a platform for cloud computing. Users of the internet are able to share billions of files and information stored in shared or privately owned servers and data warehouse all over the world.

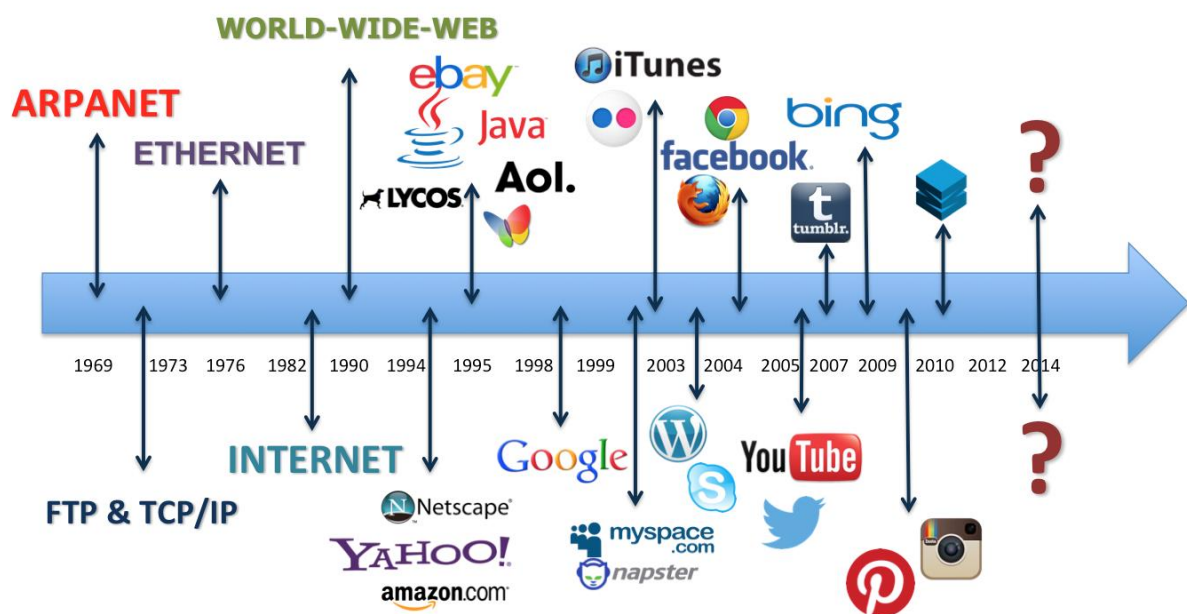


Figure 2-7: A picture by Livescience.com, showing history timeline of the Internet.

Phase 5: Grid computing

Punia (2014): “Grid computing is an emerging technology where computational and information resources shared and managed by various organizations in widespread locations (virtual organizations).”

Dar and Riyaz (2017); “ Grid computing is a virtualized distributed computing environment that aims at allowing the dynamic selection, sharing, and integration of distributed heterogeneous resources based on the availability, capability, performance and cost of these computing resources.” Grid computing enables computers scattered over geographical area to work as a unit, on a given task and give users computational powers of supercomputer. It improves reliability, lower costs and maximise the use of resources.

Phase 6: Cloud Computing

One of latest and most trending paradigm, whereby scalable IT resources/infrastructure (software, CPU, Hard drive, bandwidth etc.) are rented to the consumers through the internet in a pay-per-use agreement.

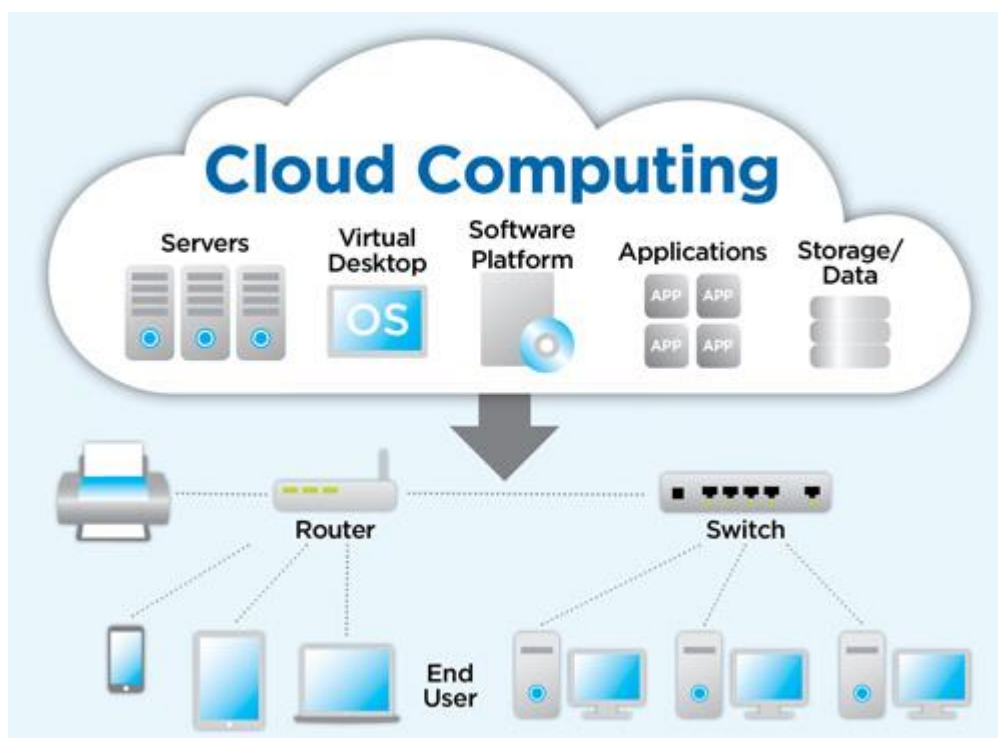


Figure 2-8: A picture by netspaceindia.com, illustrating cloud computing.

The six Phases of cloud computing described in the section, have been going hand in hand or even enabled by the same technologies that regarded as enabling technologies of cloud computing. The next section explains these technologies.

2.3 Cloud Computing Enabling Technologies

Cloud computing may have appeared as new IT technology, but it was enabled by various technology that already existed. These technologies are hardware virtualisation, Web 2.0 and Mashup, Service Flow and Workflows, Web Service and Service Oriented Architecture, Autonomic computing, and Distributed computing(cluster computing and grid computing)

“ Technologically, cloud computing joins several different computing technologies coming from virtualization, grid computing, peer-to-peer computing, autonomic computing, web services, ubiquitous computing, service oriented architecture,” (Armbrust et al, 2010)

Factors enabling cloud computing

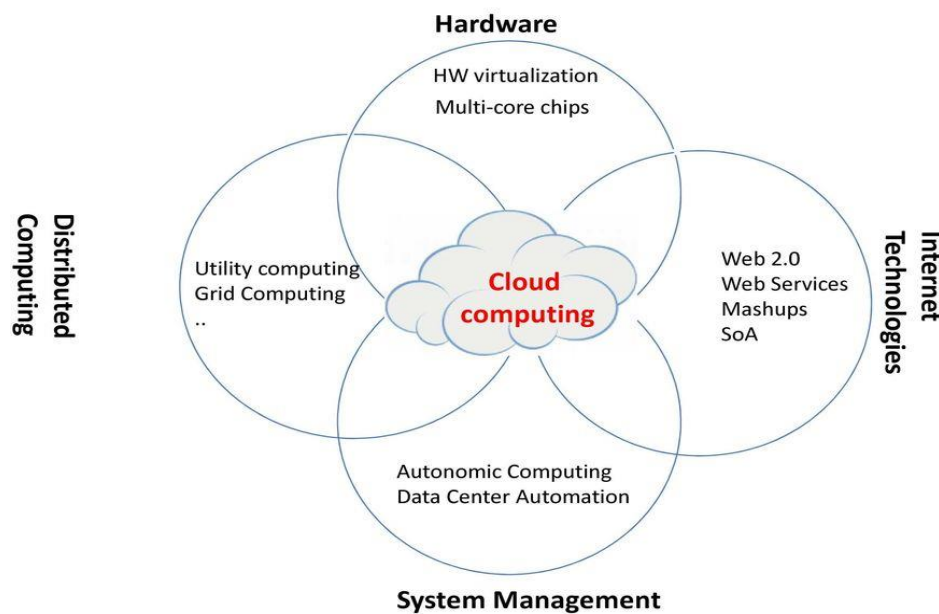


Figure 2-9: A picture by docplayer.net, showing different technologies that enabled invention of cloud computing.

2.3.1 What is Hardware Virtualisation?

As Voorsluys *et al* (2011) asserted, virtualisation started way back in 1960s by IBM's virtual machines. Virtualisation create abstracted instances of hardware resources and thus enables several operating systems to be installed on one machine. Pradeep (2016) stated that Hardware virtualization is accomplished by abstracting the physical hardware layer by use of a hypervisor or VMM (Virtual Machine Monitor). The hypervisor is the key technology that controls or manages virtualisation between resident operating system, host operating system and the server (hardware). With abstraction, hardware resources are shared and used effectively and thus reducing costs and space needed to keep these resources. NIST (2010) lists virtual machine techniques (VMware and Xen) and virtual networks (like VPN) as technologies forming basis for hardware virtualisation.

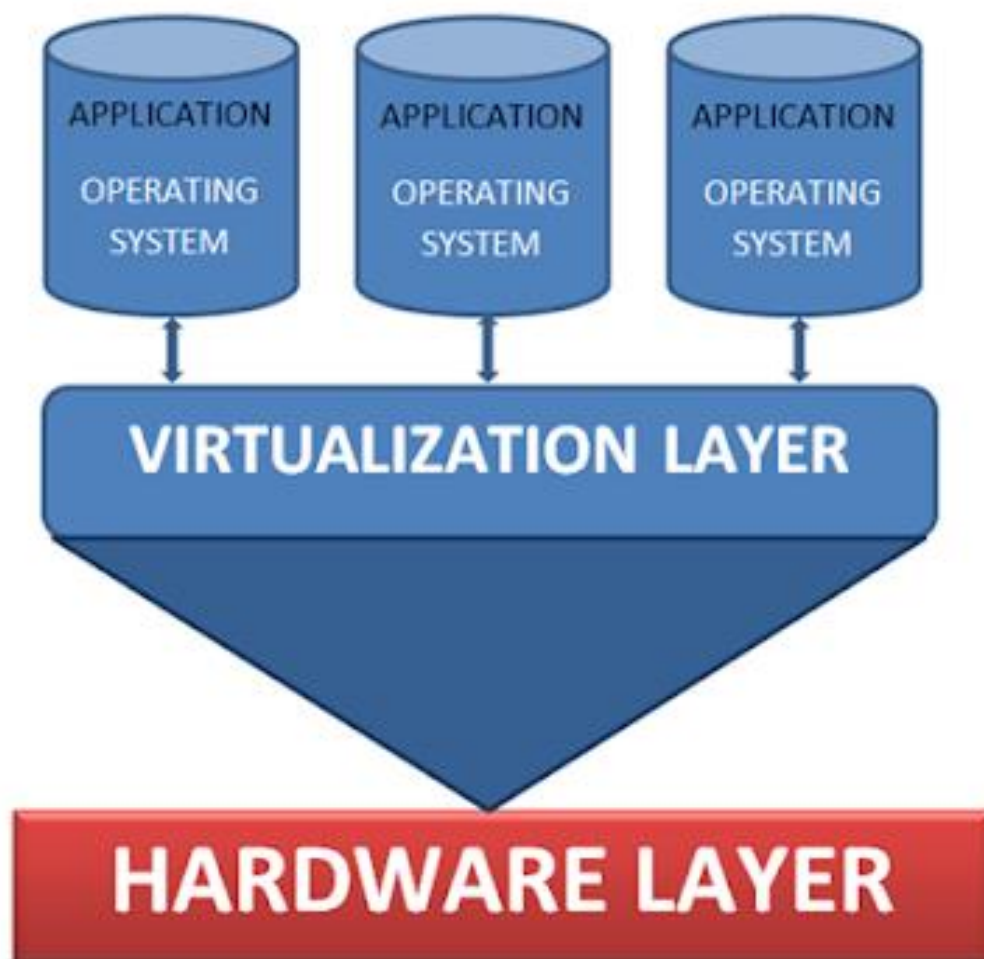
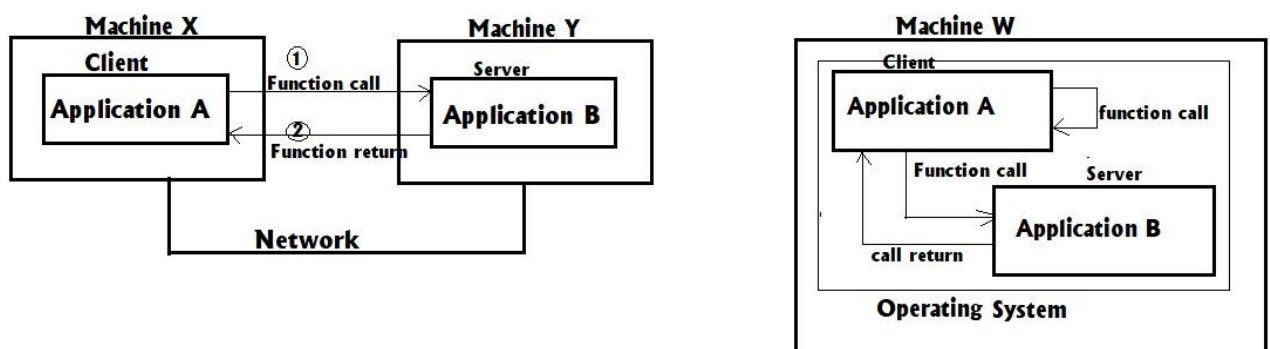


Figure 2-10: A picture by cloudcomputingat.com, shows the architecture of hardware virtualisation.

2.3.2 What is Service Oriented Architecture?

Ray (2010) defines Service Oriented Architecture (SOA) as a design paradigm that seeks to combine reusable, coarse-grained, business processes, packaged as automated Web services, into new applications. SOA integration promotes interoperability, platform-independence and language independence among integrated applications. It further promote reusability of services offered by applications in the enterprise in order to avoid redundancy. “a service is simply a functionality or data that is offered by one application to the other applications in the enterprise.” (Roshen, 2009). The program that offer/avail service is referred to as service provider or server, while the program consuming or invoking the service is called client of service consumer.

The client and server may reside in the same machine or in different machine and be connected by network.



In both diagrams Application a is a Client, invoking a service/function from Application B, which may be on the same machine or over the network. Application A can also invoke a function from itself. This functionality called is the service. SOA's objective is for the services to be reusable.

Figure 2-11: summarises the service invocation procedure

SOA basic building blocks are its preceding integration technologies, RPC, Asynchronous Messaging, CORBA and other distributed objects like Java's RMI and Microsoft DCOM.

2.3.3 Web Services

As Roshen (2009) asserted these Web services are standards composed of a collection of specifications, rules, and guidelines formulated and accepted by the leading market participants and are independent of implementation details.

“Normally, this standard-based approach (SOA) uses Web Services as building block to support particular business tasks. Web Services are published with Web Services Description Language (WSDL) interface and they use Simple Object Access Protocol (SOAP) as a communication protocol.” (Kalantari *et al*, 2012). Beside the two Web services mentioned above, there other two, namely Extensible Markup Language (XML) and Universal Description, Discovery, and Integration (UDDI).

Together with Enterprise Service Bus, these Web services enable SOA to solve the heterogeneity problems, including transport protocol, data format, synchrony, interface declaration and others, which make SOA to be interoperable, agile, have increased reusability, platform independent, language independent and protocol independent.

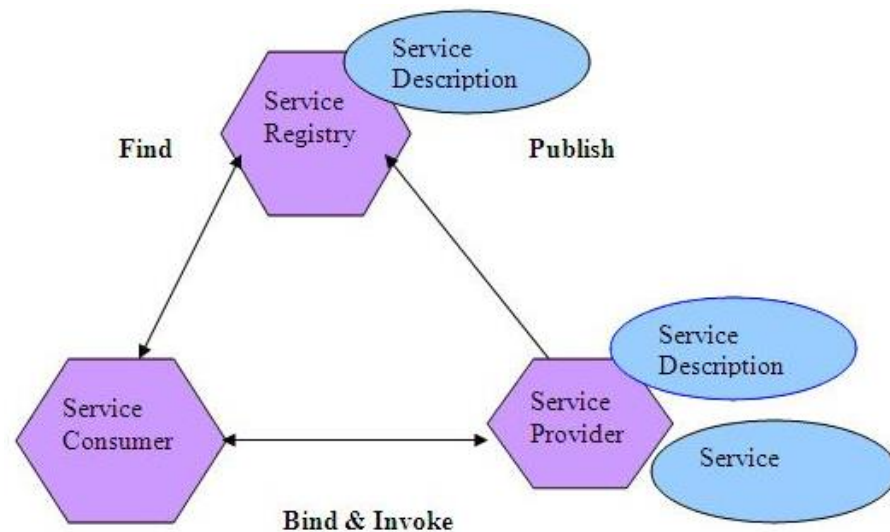


Figure 2-12: A picture by bethorough.wordpress.com showing architecture of SOA

2.3.4 Cluster Computing and Grid Computing

Cluster is a set up whereby several almost identical servers/nodes are connected together, and work together as a single unity with the intention of achieving high processing speeds and faster retrieval and storage of data. In a cluster, every node has its own storage and processing resources. The task to be processed is broken down into smaller chunks and simultaneously processed by nodes in the cluster. Clusters increase data storage space, and offer reliability, since a failure of one node doesn't hinder data retrieval, as the replicated data can be accessed from another node.



Figure 2-13: Cluster of servers. Picture by usna.edu

Another Distributed Computing technology, Grid computing, represented by Figure 2-14, below already described in in Section 2.2

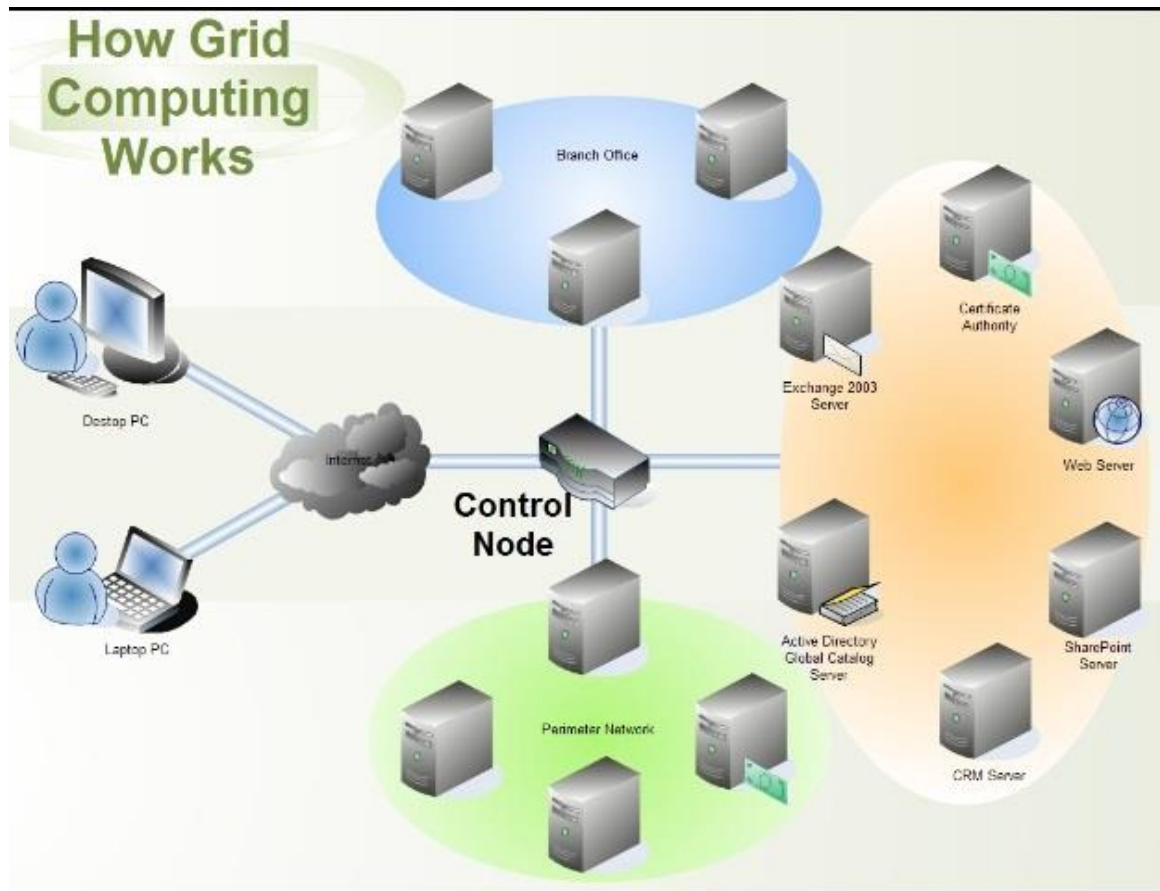


Figure 2-14: A picture by edrawsoft.com showing grid illustrating Grid Computing

2.3.5 2.3.5 What is Autonomic Computing?

Autonomic Computing is a paradigm with the vision for producing self-managing systems (configuring, healing, optimising, protecting) that are self-aware, environment-aware, can automatically adjust and monitor themselves. These systems should be able to protect themselves from malicious attack and heal themselves in case the attack was successful. When need arises in autonomic computing systems must be able to reconfigure themselves should when need arises. The systems should too be able to monitor and readjust to optimise performance. "...with little or no human interventions to tackle the complexity of systems integration and management, and total cost of ownership (TCO)." (Muhammad, 2015). He further reiterated that, the autonomic computing is enabled by monitored probes and sensors, and some form of automated management function.

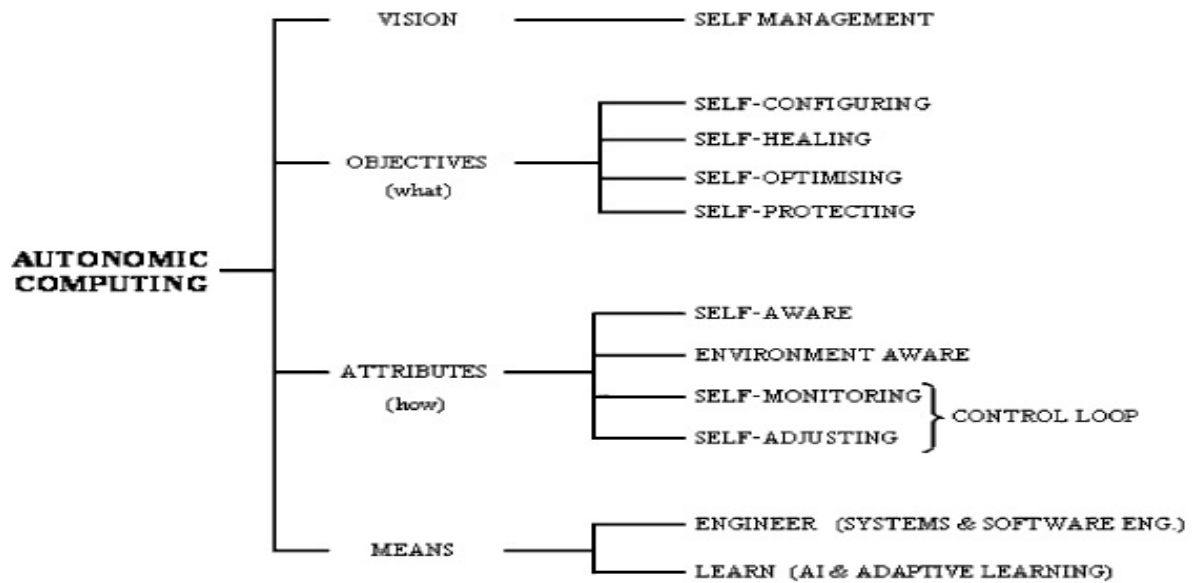


Figure 2-15: A picture extracted from *Autonomic Computing* (Sterritt, 2005), showing autonomic properties tree

2.3.6 Web 2.0 and Mashup

What is Web 2.0?

Wilson et al (2011) defines the second generation of the Web, wherein interoperable, user centered web applications and services promote social connectedness, media and information sharing, user-created content, and collaboration among individuals and organizations. The latest evolution of the Web, and successor of Web 1.0. A paradigm that may lead to extinction of dot com, where more information is created by the general public/users of the internet, than in Web 1.0, where most content was from the websites.

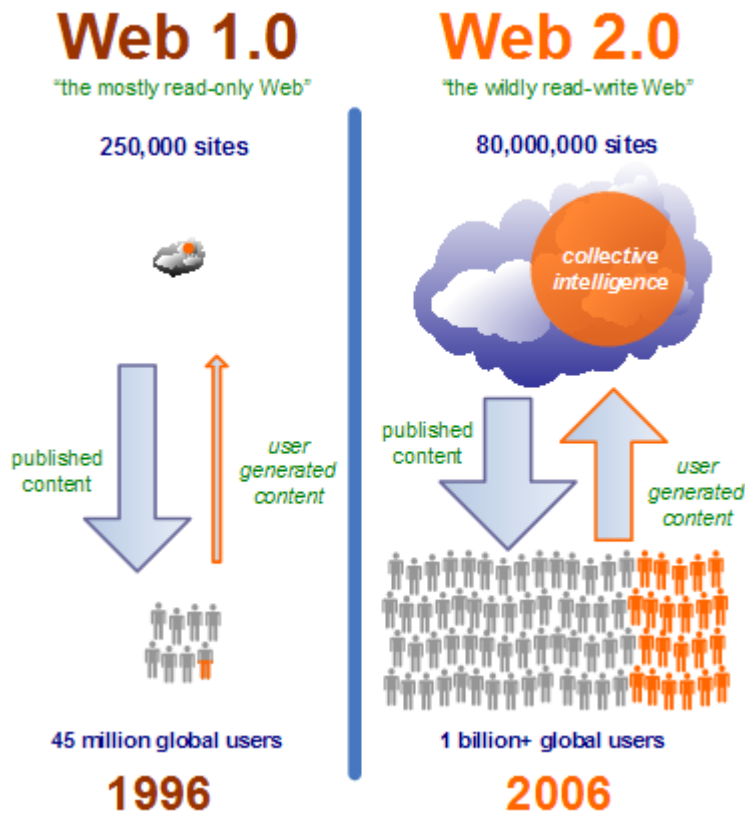


Figure 2-16: Picture by dionhinchcliffe.com, illustrating transition from Web 1.0 to Web 2.0, where content is generated through collective effort of users all over the world.

Web 2.0 is characterised by several technology that enable creation and publication of content by the users. These technology includes, Blogs, Social networking sites, Wikki sites etc. as shown in Figure 2-17 below

What is Web 2.0?

- Technologies – Facilitating technologies
 - Blogs
 - Wikis
 - Social networking technologies
 - Predictive markets
 - Virtual worlds
 - RSS
 - Ajax
 - Web Services and Service Oriented Architectures
- Techniques – Prompting and leveraging voluntary social activity
 - Social tagging, bookmarking, and filtering
 - Mashups, aggregation, and recombination
 - Social network analysis
 - Referrals, sharing, and word-of-mouth
 - Crowdsourcing & Human Computation
- Communities - High profile examples
 - Wikipedia
 - MySpace, Orkut, LinkedIn
 - Flickr, Fotolog
 - Second Life
 - Google Maps
 - YouTube



PITTBUSINESS Joseph M. Katz
Graduate School of Business

Figure 2-17: Picture by slideshare.net illustrating Web 2.0 concepts

What is Mashup?

“Web 2.0 mashups have emerged as a trend in website design that focuses on synthesizing new content by combining data and information from multiple sources in a unique way.” (Beemer and Gregg, 2009). Content is been created from all corners of the world, and they can be a need to create new content from various sources like Facebook, Twitter, Google, Wikipedia and others. Such technology is Web 2.0 Mashup.

Mobile Web 2.0 - Meshup

- Creating a new service
- Combining services
- Use Open API
 - Satellite pics from Google maps
 - Book Info. from Amazon
 - News from Bing
 - ...

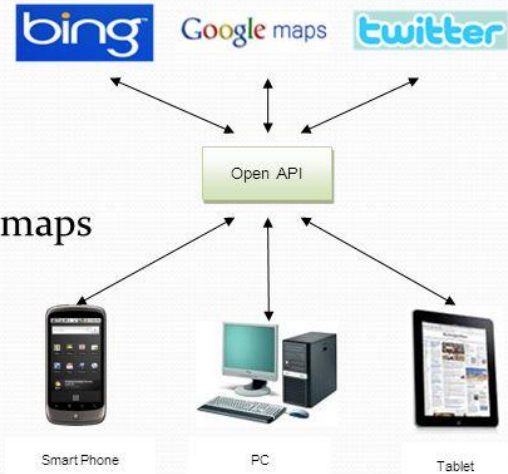


Fig. 2 Data sharing by using Open API

Figure 2-18: A picture by Slideshare.net illustrating Mashup

Phase 6.0 Cloud Computing

The definition and description of cloud computing have already been given in Chapter 1 Introduction and Section 2.1 in this chapter.

2.4 Properties of Cloud computing

Several publications, including Furht and Escalante (2010), Babbar (2017) and Muhammad (2016) summarises properties of cloud computing as: 1) On-Demand self-service, 2) Measured service, 3) Broad network service, 4) Rapid Elasticity and Resource pooling. Furht and Escalante (2010) also adding Quality of Service (QoS) to the five characteristics

On-demand Self-service

Without any human-interaction with the cloud-service provider, users can access cloud computing resources (server, hard-drive, network etc.) anytime they need to, wherever they are. The cloud service is automated, and it can handle consumers' varying needs as per their specifications without any human control.

Measured Service

A pay-per-use service, where consumers are charged only for the services they consumed. Once more an automated control meant to optimise resource, ensuring that consumers pay only for what they consumed, and only resources they need are allocated to them.

Broad-Network Service

Cloud service resources (applications) can be accessed using readily available and heterogeneous types of computers including desktop computers, laptops, portable digital assistants (PDAs), tablets, Smartphones etc. as they are all equipped with web browsers and other web content access controls.

Rapid Elasticity

Cloud is meant to be flexible and easily scalable. It allows the consumers to scale up or down the resources as need arises, without any interaction with the cloud service provider. Anytime the user want to add or remove features, like applications, network broadband, memory and others, they do it on their own without consultation or involvement of the cloud service provider.

Resource Pooling

Multi-tenant system where a pool of computing resources are shared by the consumers. The system dynamically assign and reassign resources based on consumers' needs. Without even

be aware of the location of the computing resources, consumers share the pool of these resources as per their needs. Once a consumer no longer need a resource, it is assigned to those who need resource.

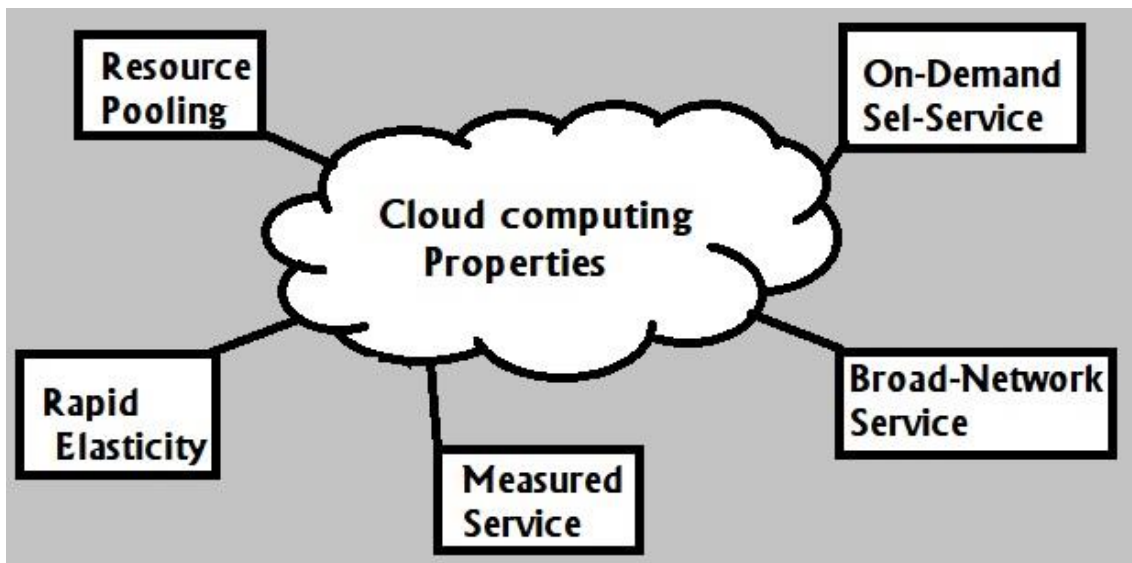


Figure 2-19: It shows 5 properties of cloud computing.

2.5 Cloud Computing Service Models

Multinational companies like Microsoft, Right Scale, Force.com and Cisco avail cloud services to clients in the form of three main service models, known as, Software-as-a-Service (SaaS), Platform-as-a-Service (PaaS) and Infrastructure-as-a-Service (IaaS). The three services are shown in the picture below.



Figure 2-20: A. Picture by smart-cloud-computing.blogspot.com, showing three cloud services and companies offering them.

Infrastructure as a Service (IaaS)

Rajendran (2016) states that the entire process of providing physical components as service is termed as Infrastructure as a Service. In this service, the service provider allows users to rent hard drive and other hardware and network infrastructure per demand. Consumers are not bothered with expensive upfront buying, setting-up servers, and maintaining servers, network facilities and hardware resources. Cloud service providers use virtualisation of hardware to enable provision and sharing of hardware resources as per needs of consumers. However, installing, configuring, maintaining and protecting OS and applications is the responsibility of the consumers.

Examples of such services are Microsoft Azure, Google Drive and Amazon Web Services.

Platform as a Service (PaaS)

“(PaaS) is a cloud computing offering that provides users with a cloud environment in which they can develop, manage and deliver applications” IBM.com. This is a service model that allows developers to develop applications, collaborate on projects and test applications, without having to buy or maintain infrastructure. Consumers do not have to buy or install operating system and platforms like C, C++ or .Net framework. That is the package managed by the cloud provider.

Examples include Google App Engine, MATLAB, and Microsoft Azure.

Software as a Service (SaaS)

“Software-as-a-Service is a software distribution model in which applications are hosted by a vendor or service provider and made available to customers over a network, typically the internet.” (Mujinga and Chipangura, 2011). With this service, customers are able to use applications which are not installed in their local hard-drives, but virtualised versions like online version of Microsoft Office, which is called Microsoft Office 365. Other popular examples include, IBM Lotus Live, Google Docs and Salesforce.com. “Service provider controls entire infrastructure such as servers, software etc. and provide facility to use applications to consumers and possibly application configuration settings.” (Islam, 2010). Consumers are not worried by buying, ownership, installation and maintenance of the applications they use. They just need a browser and their computers and access the applications online. Their whole infrastructure, from hard drives, RAM, CPU, Operating system (OS) are controlled and managed by the cloud service provider.

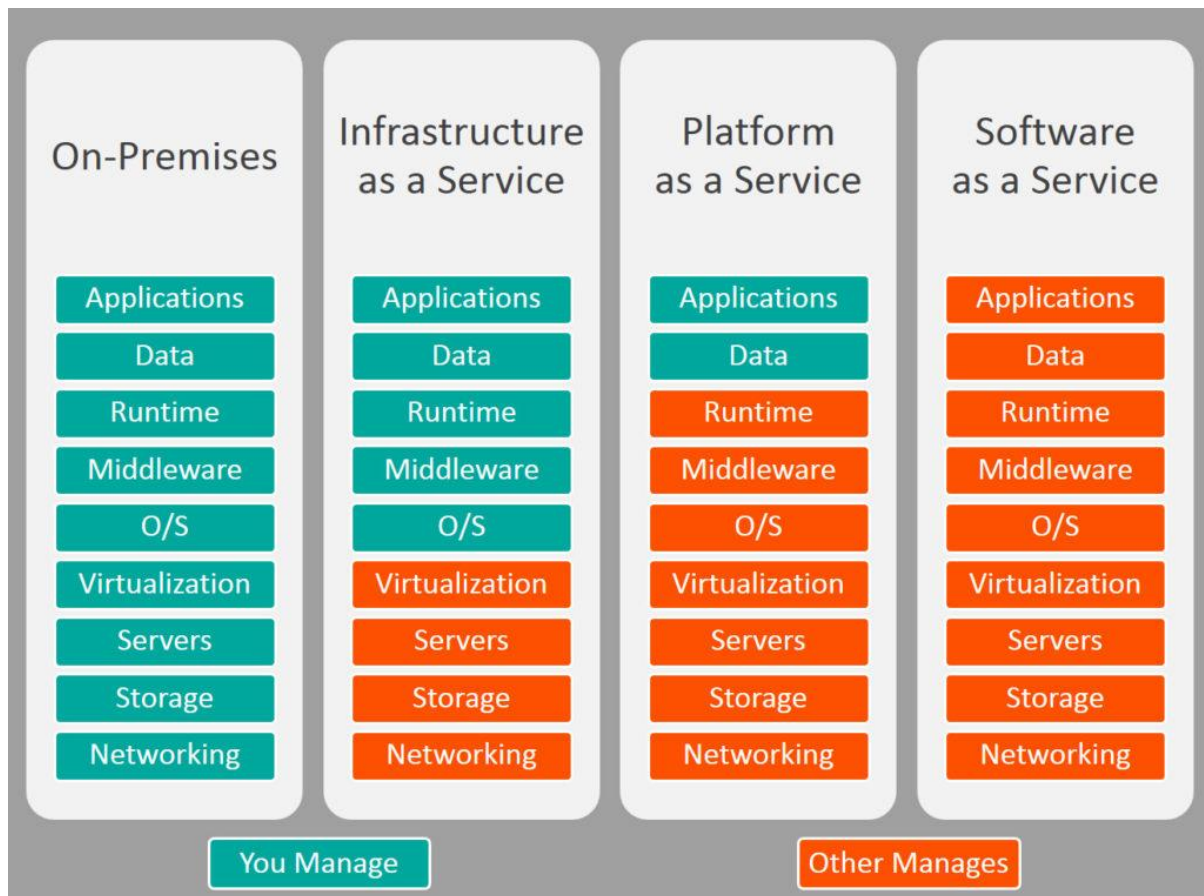


Figure 2-21: A picture by bmc.com, comparing the three service models in terms of the resources user manages and those managed by cloud provider manages in each model

2.6 Cloud Computing Deployment Models

Cloud Computing services are offered in 4 deployment models, namely Private Cloud, Public Cloud, Community Cloud and Hybrid Cloud.

Private Cloud

This model is developed and implemented exclusively for a certain enterprise. It is only visible and accessible to the intended users and doesn't share infrastructure with other customers. The main goal of this model is data security. However it is scalable like other models, and the company hosting it incur part of infrastructure maintenance.

Public Cloud

Public clouds are open to the public. They are operated and managed by third-party company, where customers share infrastructure offered by the service provider. “The cloud infrastructure is owned, managed, and operated by an external organization, that may be a company or a government organization, that hosts the infrastructure in its premises” (Carretero and Blas, 2014). This model is less secure than Private cloud but more scalable and suited for larger companies. It uses attractive and cheap “pay-as-you-go” payment method.

Community Cloud

This deployment is more like Public cloud, except that it is accessible to only a certain community of cloud users. It is managed or administers by that group of organisations forming a community. Usually it is a cloud limited to a community with a common interest.

Hybrid Cloud

The third model which is the combination of the other two or three of the above-described deployment models. For example, a bank may implement a private cloud for their confidential and sensitive financial activities so that it is accessible and run within their premises by the bank itself. Then run a public cloud accessible to their clients, to log on to the system to manage their accounts, make transfers and other transactions.

Table 2.6.1 below summarises the four models described above.

Cloud Computing Deployment Models				
Model	Private	Public	Community	Hybrid
Ownership	Single Organisation	Third party or group of third party cloud providers	Group of organisations with common interests	Organisation or group of organisations
Location	On-premises or internal cloud	Off-premises or external cloud	Off-premises	Both internal and external
Control	Third party or organisation	Third party	Third party or organisation	Third party or organisation
Visibility	Single organisation	General public	Only organisations owning it	Depends on combinations used

Examples	Amazon VPC (Virtual Private Cloud), Ubuntu Enterprise Cloud-UEC	Google App Engine		
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Table 2.6.1

Figure 2-22 below shows a summary of cloud computing deployment models

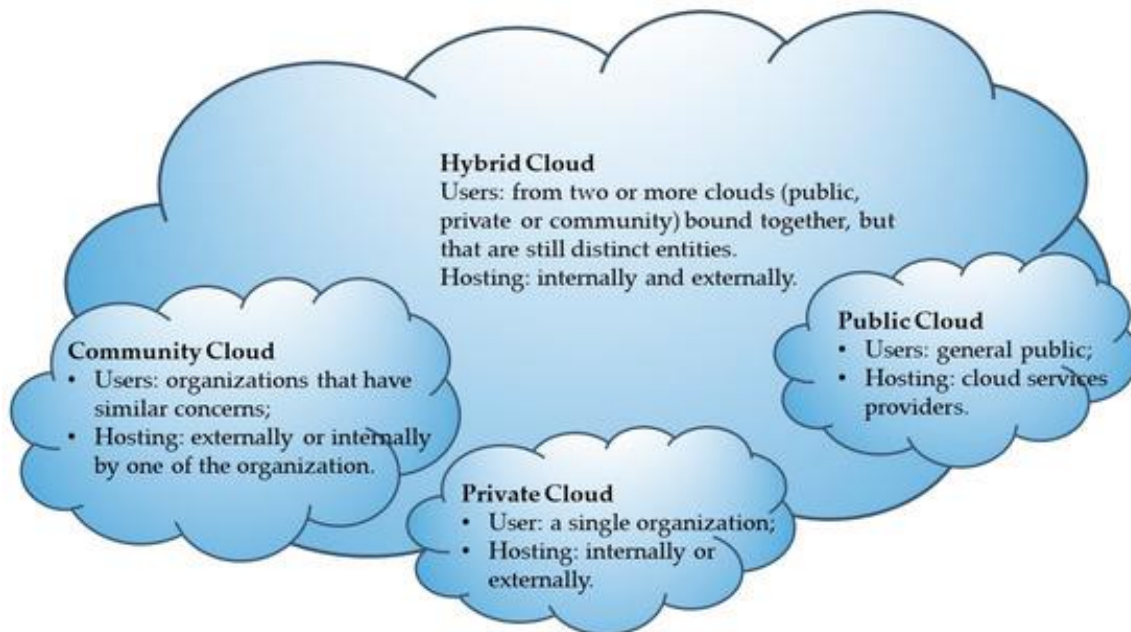


Figure 2-22: Picture by mdpi.com summarising cloud deployment models

2.7 Benefits of Cloud Computing

Ting Si Xue (2016) points out that Cloud computing is able to provide improved new capabilities which the traditional IT solution cannot provide. “As cloud computing can provide infrastructure as a service, it provides a variety of advantages over traditional systems” (Karim and Rampersad, 2017). As a new and immature technology, cloud computing do have couple of challenges, but it brings with it benefits that enable users to access and enjoy IT infrastructure that they would possibly never dream of , with traditional IT solutions. Some of these benefits are listed and explained below.

Reduction of Costs

Hashemi *et al* (2013) and Ting Xi Xue and Wee Xin (2016) identify reduction on initial costs as one of the main advantages of cloud computing. The users do not have to be stressed by capital costs on buying, installing, maintaining and upgrading expensive servers, licensed software, datasets, networking hardware etc., of which some they may not need any more in the near future. In cloud computing, users only pay for what they need to use, without ownership costs, and can scale up or down the computing resources as per need in the future.

Scalability

Muhammad (2015) and Islam (2017) are some of dozens of researchers who list scalability as one of the advantages brought by cloud computing. Even without huge budget, users can start by renting only few resources they need as trial, then increase (scale up) at later stages. The users can also scale down resources they rent at later stages. Cloud computing allows users to even use extra resources during peak time, and then scale down after that time. This flexibility in scaling up and down the resources, without incurring ownership and management costs isn't possibly with traditional IT solutions.

Luxury of Latest Software Versions and Hardware Products

Islam (2017), and Ting Xi Xue and Wee Xin (2017) mention this as another benefit of cloud computing. Cloud service providers are huge multinational companies IBM, Microsoft, Amazon, Force.com and others, which can purchase and avail any latest release of software or hardware product on its release day. As a result, the users of cloud service always have advantage of latest and possibly better IT products.

Flexible or Mobile Access

Islam (2016) and Hashemi (2013) mention flexible and mobile access as one of the benefits of adopting cloud computing. With abundance of mobile computers like PDAs, tablet, laptops and smartphones, employees can access their documents or files even when they are outside company/organisation's premises, as long as they have internet connection or within vicinity of the company's private network. Users can work even when at home or away on trips. No need of risking by saving documents on removable storage media like compact disks (CDs), Memory cards, USB flash drive or the same portable and mobile computers, which can easily get lost.

Backup and Disaster Recovery

"In case of disasters, an offsite backup is always helpful. Keeping crucial data backed up using cloud storage services is the need of the hour for most of the organizations." (Jadeja, 2012). Cloud computing service providers are big multinational organisations that have several servers in different regions, and thus backup data easily. They also have better disaster recovery system in case a disaster struck. Therefore, with cloud computing adoption there is a less risk of business continuity being affected.

Big and Elastic Storage

In cloud computing users have access to larger and elastic storage. A cloud service consumer can rent a large storage relatively cheap and increase that storage any time there is a need, without even consulting the cloud service provider. The same storage can be scale down, to avoid paying for unused storage resource.

Green Technology

Hashemi *et al* (2013): "Cloud computing is relatively good in energy consumption and provides eco-systems through virtual services." The more machines used the more carbon dioxide emitted together with other air pollutants, as fossil fuels are main energy providers currently. But in cloud computing, there are more virtual machines used than real machines. As a result there is less damage to the ecosystem with cloud computing paradigm.

2.8 Challenges of Cloud Computing

Cloud computing may have brought lot of benefits that can't be ignored in the field of IT, but like any new technology, there are lot of associated challenges and risks. In their publications, Ting Xi Xee (2016), Avram (2013), Jadija and Modi (2012), Islam (2017) and Alsolami (2018), identify the following challenges among others as the major ones:

1) *Data Privacy*

Potential users' major concern is the privacy of data in cloud computing servers. The cloud multi-tenant system, where data from different entities are stored in shared storage make one curious that data may be corrupted easily. Confidentiality of data stored in shared storage is at risk. Cloud potential users also can be worried about the fact that they data will not be stored inside their premises and thus no longer in charge of keeping even confidential and sensitive data private. If data from different entities are sharing storage, any successful vulnerability exploit in one dataset may make the other datasets prone to attack and exposure to unauthorised users. The users can also be curious about location of their data, as cloud providers may not reveal the exact storage location.

2) *Data Security*

In cloud system, storage are shared, lot of virtualised machines dominated and operation take place in distributed network. The whole setup isn't easy to secure data, and ensure its integrity and confidentiality. With data in continuous transmission between cloud providers' servers and the users' computers, the strength of encryption procedures will be tested time and again. Hackers will be tempted to launch attacks that may compromise integrity and confidentiality of sensitive data. Another concern is the fact data can be accessed anywhere, even outside users' premises through unsecure and open public network, the internet. Successful attack on website hosted in a server may give attackers opportunity to bypass login system, which can expose data, a risk for disclosure, destruction or modification.

3) *Malware Attack*

In cloud computing, the access to data for day to day consumer's operation is through web browsers and other cloud interface controls. This means that consumer has to login time and again, and work online most of their time. These tempt attacks like phishing,

spoofing and Denial of Service (DoS). Successful attacker's phishing or spoofing will definitely trick consumer into revealing their credentials and confidential information. Equipped with these attacker can hack consumer's account, impersonate them and launch more attacks on the system, or even steal or modify data. Denial of Service attack on cloud provider's server is another tempting attack, and its success mean data may not be available for consumer's critical day to day operations.

4) *Data Remanence*

When dealing with company (organisation)'s sensitive and confidential, which may be patients' records or financial records, it should be destroyed at the end of its lifecycle. However, the fact that unless disks are completely wiped out or destroyed, the data isn't completely wiped out. This may be a concern by cloud consumers, as they may not be certain about cloud providers' data destruction procedures' effectiveness.

5) *Transmission of data*

"Most of the time data is transferred without encryption due to lot of time is required for encryption and decryption for each operation upon data." (Islam, 2017)

Once data is stored in cloud servers, there will be frequent transfer between these servers and the customer machines. Encryption and decryption taking place at both ends as the main data-in-transmission protection measure. However as Islam (2017) attested, data may transmitted without encryption, thus making it vulnerable to attacks.

6) *Interoperability*

Cloud computing service offered by various leading companies Microsoft, IBM. Salesforce.com, Amazon etc. may not be compatible. This becomes a problem if a consumer has rented services from different incompatible services and integration has to be carried out.

2.9 Related Studies

This kind of study is definitely not the first, in context of cloud adoption in developing countries and in government. There are couple of publication I reviewed, to give me a better picture and inside into the progress of cloud computing adoption in developing countries, especially in government. The brief opinions of such publication are given in the next paragraph here.

Tweneboah-Kodua et al (2014) asserted “The three key benefits government agencies could derive from well implemented cloud models include (but not limited to): increase productivity, ease scalability and overall cost cutting (figure 2).” This is from the study they carried out in Ghana. They claim that government can cut cost by opting for SaaS, which cut costs of buying, licencing and managing software. The government can also scale up or down the resources rented, to cut costs or meet increased demand. Productivity can also be increased, since government services (including data) can be accessed everywhere over the internet by private entities. This helps them to make better and research informed decision, with data and services easily accessible. The paper also found out, from literature it reviewed, that most governments adopt and use cloud computing solutions in productivity and project management. Improving quality and innovation in services is another area where governments are using cloud technologies. Gradual increase of cloud technologies in areas like transport, health and education is another point they found from reviewed literature.

From the participants in this survey, the paper found out that, cost of migrating to cloud, security and data sovereignty, privacy of data, internet availability, institutional readiness, business continuity and service availability, and Standardization, Legal, Compliance and Audit are the main concerns about adopting cloud computing in Ghanaian government. More or less the same general cloud computing challenges as described in Section 2.8 earlier.

The paper suggest solutions or way forward for the government, if they are to adopt cloud computing. They include: educating and training servants and IT staff on cloud computing technology. They should attend workshops, seminars, training courses and visit/contact companies/organisation already using cloud solutions. The universities and other higher education institutions should be encouraged to review their curriculum and include cloud computing courses, in order to educate people more about cloud computing, This will too

increase number of graduates specialising and understating better about cloud computing. The paper further suggested that a more faster and reliable broadband internet connection should be used to supply offices all over the country. The government can engage the internet service providers or even international donors to help fund the infrastructure improvement to ensure a more reliable and faster internet supply across board.

Security assessment risk by IT departments and cloud piloting in certain sections of government are other solutions suggested by the paper.

“Nowadays the cloud computing is considered a new technology that can improve the function of the government” Mosa *et al* (2015). In their publication they assess possible models for migration from E-government to cloud computing. They discuss benefits that can be brought by cloud computing in E-Government. The benefits in generally include elasticity, reliability, scalability and cost-saving that can be brought by cloud computing in E-government. The paper listed security and privacy, hard to integrate, availability that depends of internet, no laws regulating cloud computing in some countries, higher cost for first time transition, no enough major suppliers as some of the major concern of adopting cloud computing in E-Government.

“Proposed model to move from e-governance to the cloud by using technology transfer model for 6 stages: learning, Requirement specification, Cloud prototype Development, Data and application migration, cloud Rollout, Cloud advancement.” (Singh, 2012). This is one of many models they reviewed from literature. The migration/adoption models can be generally classified as either step-based model, component-based model or layered-based model. However, they pointed out that the models are conceptual and they can be experimented or new models put in practice.

Khanda and Doss (2018) carried out a similar study of adoption of cloud computing in developing country like this paper is aiming to. Their paper is on Small to Business Enterprises in Botswana. Their study touched on the efforts and success of Botswana government in improving IT infrastructure so that organisations and businesses can find conducive conditions to adopt cloud computing among other latest trending paradigms. The study recognise Botswana’s government Maitlamo Policy (2012) and later Botswana National e-Government Strategy (2012) as major progresses aimed at improving IT infrastructure in Botswana, which led to Botswana Fiber Networks (BOFINET) enterprise. BOFINET’s main objective is provide reliable network (internet) to remote and rural areas

of Botswana. The study further shows that Botswana, through universities, the government and private sector is fast adopting cloud solutions. In addition to that, their review acknowledge the efforts made by African countries like Nigeria , South Africa and Ghana, through universities, government and private sector in improving their IT infrastructure for better success of cloud computing adoption.

“Cloud Computing too has a number of challenges like deployment issues, data migration, security, privacy, regulation and cyber-attacks.” (Khanda and Doss, 2018). From their reviews, on top of these challenges above, they identified Regulatory compliance concerns/user control, Cloud Service Provider Lock-in, Data security and Unsolicited Advertising as major concerns on adopting cloud computing.

3 METHODOLOGY

3.1 Research Type

My study is a Descriptive Research. Primary data were collected from various related populations using Survey data collection methods. Walliman (2011) describes descriptive research as follows; “This design relies on observation as a means of collecting data. It attempts to examine situations in order to establish what is the norm, i.e. what can be predicted to happen again under the same circumstances.” He further pointed that observation can take a form of interviews, questionnaires or (visual, audio or smell) recordings. Depending on my objectives, aims, funds and time constraints, descriptive research, using questionnaires and interviews to collect for my survey were the most feasible tools. I wanted to collect data directly from the sources, because besides being exactly the data I was looking for, carrying out survey within that population was cost-effective. The next section therefore explain the design I opted for and the factors influenced my choice.

3.2 Research Design

As already pointed out in the first section of this chapter, the design I opted for is a **Survey**.

What is a survey?

“A systematic method for gathering information from (a sample of) individuals for the purposes of describing the attributes of the larger population of which the individuals are members.” (Enanoria, 2005). This is exactly how I wanted to collect data from Government of Lesotho civil servants and IT personnel. However, I would never be able to collect it from all of them, because of; my funds and time constraints, respondents’ schedule, motivation and commitments. I therefore needed a design and tools which could help me find representative of the whole. Survey was the most suitable design.

Ajayi (2017) describe **Survey** as “a method is one of the primary sources of data which is used to collect quantitative information about items in a population. Surveys are used in different areas for collecting the data even in public and private sectors.” My goal was to collect primary data, as Ajayi (2017) further mentioned the high accuracy, currency and relevancy of primary data.

3.2.1 Benefits of Survey

“The attractions of a survey lie in its appeal to generalizability or universality within given parameters, its ability to make statements which are supported by large data banks and its ability to establish the degree of confidence which can be placed in a set of findings.” (Cohen et al, 2000). The goal here was to make a generalising conclusion about viability of cloud computing, supported by data collected from the original resources.

Ajayi (2017) and Morrison (1993) claim that surveys produce accurate data cheaply and efficiently.

As per Showkat and Parveen (2017), survey is a research strategy proved to be instrumental in systematically gathering the quantitative data from fairly a large sample of the population. Thus if one was intending to gather information from 50 or more, survey is the most reliable and efficient strategy, using cheaper questionnaires and interviews. He further explains that surveys are flexible in that, it allows the use of various tools like questionnaires (hand-delivered, internet or mail) and interviews (telephonically or face-to-face). This says that researcher has luxury of trying tools in order to increase response rate.

In addition to that, “Surveys can also elicit information about attitudes that are otherwise difficult to measure using observational techniques” (McIntyre, 1999). In case like this study, where opinions, attitudes, views, judgements and knowledge of civil servants on cloud computing and ICT infrastructure were needed, survey is the best tool for gathering such information.

3.2.2 Shortcomings of Survey

As much as survey is a strategy that has so many attractive benefits, it also has pitfalls. Glasow (2005) observes that respondents may have difficulty assessing their own behaviour or have poor recall of the circumstances surrounding their behaviour. Survey through interviews and questionnaire depends on data gathered from people. It gathers that opinions, feelings, experiences, attitudes, judgements and knowledge. The reliability of survey data depends almost entirely on how reliable those people are. People may forget or intentionally hide some information or give false information.

Furthermore, survey is time-consuming. The survey data is gathered from many people, a reasonable sample. A researcher first have to take time designing data collection tools (interview or questionnaire), edit it, pilot them, re-edit them and then distribute them to

masses in his/her sample frame. Be it questionnaire distribution through hand-delivery, email, post or interview through telephone, focus groups or face-to-face, the researcher spends lot of time collecting data. With questionnaire one may even spend time convincing respondents to participate or guiding them on how to fill in the questionnaire.

Survey data reliability and accuracy dependent of researchers' questionnaire and interview design skills. Poorly worded and organised questionnaire, with unclear instructions on how to fill it, is difficult to fill and respondents may end up not filling it accurately or leave out some questions. Some omitted questions may make survey data difficult to analyse.

3.3 Survey Concepts and Process

In this section a detailed explanation of how the data collection or the survey itself was carried out is given.

3.3.1 *Cross-sectional survey*

Surveys can either be longitudinal or cross-sectional.

Mathers *et al* (2009) defined them as follows:

“Surveys that are carried out at a just one point in time are known as a **cross-sectional** in design.” They give a situation or snapshot in a group at given point in time.

“A **longitudinal survey** rather than taking a snap-shot, paints a picture of events or attitudes over time.” This type of survey may take place over months, years or more, on the same or different groups.

My study was a Master's degree dissertation that I had to complete within 6 months, which means I had to collect data and analyse it within that period. On top of that, the time of data I needed was just a snap-shot of the situation of ICT infrastructure and personnel at Government of Lesotho offices at Thaba-Tseka. I therefore opted for a cross-sectional survey. The period during which I carried out this survey was March to April 2019.

3.3.2 *Population*

Walliman (2000) describe **population** (survey) as a collective term used to describe the total quantity of things (or cases) of the type which are the subject of your study.

Rahi (2017) defines population as all people or items that one wishes to understand while sampling is the process of selecting segment of the population for investigation. For this study, population was the Government of Lesotho employees working in offices at Thaba-Tseka town, together with IT personnel supporting them, whether deployed at the same town or in headquarters, Maseru.

3.3.3 *Sampling*

When carrying out survey, a researcher do not necessarily have to obtain data from the whole population, since the population may be too large, too spread out in geographical area or researcher be restricted by time and money factors. A smaller group or a subset of population from which data that can reasonably represent the whole population is selected. This population subset selected to be representative of the whole is referred to as **sample**. The process of selecting a sample is called **sampling**. In this study too the sample was selected from the target population, due to some of the reasons given above. The sampling methods and size selected for this study are explained and given in the next sections.

3.3.4 *Probability Sampling*

Sampling can either be probability (random) sampling or non-probability (non-random) sampling. “**Probability sampling** is sampling approach in which each unit has an equal chance of probability to be selected.” Rahi (2017)

I chose Probability Sampling since it reduces sampling bias and systematic error. It also has higher reliability level and increased accuracy of sampling error accuracy.

Probability Sampling can further be categorise into five categories, namely Simple Random Sampling, Stratified Random Sampling, Systematic Random Sampling, Multistage Random Sampling and Cluster Sampling. I wanted all employees working at Government offices and IT personnel to stand to stand the same chance of being selected, as they are almost uniform. I therefore opted for Simple Random Sampling. The survey tools (questionnaires) were hand-delivered to Government of Lesotho offices (Thaba-Tseka) and all those willing to fill them after I explained to them the

rationale of the research were given a chance. I went to all offices (work places) where they have computers and/or access to Internet. The electronic questionnaires were already designed for IT personnel in case they are deployed at headquarters only. Phone call was used to contact the headquarters to request permission to collect data from IT personnel. The electronic questionnaire was then sent by email to IT personnel. Even with email, the sampling was simple random, all those who were willing and convinced to fill the questionnaire were picked.

3.3.5 Sample and Sampling Frame

All the population items that have non-zero chance of being selected. I consulted various Government of Lesotho administrative offices at Thaba-Tseka to find the number of officers using computers. I wasn't successful. I end up counting offices they have per workplace or ministry. Then from there I decided to pick at least one person office for data collection questionnaire. This strategy gave me a range of 75 to 100 offices. I therefore printed 70 questionnaires. The number was also restricted by the funds I had. That 70 was the maximum I could afford, and I targeted at least 50% of the population.

3.4 Survey Tools

As Cohen et al (2000) asserted ... the collection of information (survey) typically involves one or more of the following data-gathering techniques: structured or semi-structured interviews, self-completion or postal questionnaires, standardized tests of attainment or performance, and attitude scales. I therefore, for the reasons and considerations I outlined in this sections and in Section 3.2, I chose interview (online) and questionnaires (email and face-to-face) as my data collections tools for this survey. The next two sub-section explains how; this tools were designed, administered, their benefits and limitations.

3.4.1 Questionnaire

Lavrakas (2008) defines questionnaire as a set of standardized questions, often called items, which follow a fixed scheme in order to collect individual data about one or more specific topics. Questionnaires are meant to collect primary data from people (respondents). The questionnaire consists of related questions, about a topic or concept

of interest to the researcher, which have coherence and logical. A respondent is expected to fill in the questionnaire by choosing option from list of answers given (multiple-choice), or by writing in order to express their opinions or understandings.

Why did I choose Questionnaire?

Questionnaire was chosen as one of the tools for collecting data because of its benefits, which are:

a) Questionnaires are cost effective

“Especially self-administered questionnaires, where you don’t have to hire surveyors to perform face-to-face interviews, (questionnaires) are a cost-efficient way to quickly collect massive amounts of information from a large number of people in a relatively short period of time” (Debois, 2019). As a self-sponsored student with a low budget, I had to opt for a cheaper but still effective and appropriate tool for collecting my data from my sample frame. Also time was another factor, and questionnaire meets that with relatively low costs. Mathers et al (2009) attest to this, “They (questionnaires) can be cheaper than personal interviewing and quicker if the sample is large and widely dispersed.”

b) Debois (2019) further claims that questionnaires are practical or flexible. They allow a researcher to ask close-ended or open ended questions, based on the needs or information required or level of literacy of the target population. Questionnaires can further be also be distributed through various means; hand-delivered, email or post. They therefore allow researcher to leverage on resources and options available and suitable for different situations where data is to be collected. Nicole (2011) too claims that the questionnaire is a very flexible tool, that has the advantages of having a structured format, is easy and convenient for respondents.

c) Questionnaire data is easy to analyse and virtualise

Debois (2019) explains that questionnaire results are easy to analyse with common software, even without a background in statistics or scientific research. The goal was to analyse my data using Microsoft Excel and visualise them using charts, so that they can be understood better. This is easily achieved when using questionnaire,

with standardised questions, which can be quantified even if they are qualitative in their nature.

- d) Questionnaire enable researcher to get data from respondents without personal contact

“Using a questionnaire enables you to organize the questions and receive replies without actually having to talk to every respondent.” (Nicole, 2011). Based on my population, time and costs constraints, I couldn’t complete data collection process if I was to meet them in person, as they were too many and some too far from where I stay. Most if not all IT personnel are based in Maseru and I stay in Thaba-Tseka. Even at Thaba-Tseka, my population were spread out in different offices. With questionnaire I could even get responses even from people I couldn’t meet in person but explained through covering letter, introduction or to recipients at the offices.

- e) Questionnaire can also be distributed effectively and cheaply to a larger population using email.

In their survey, Stevanov et al (2015) explains that, the e-mails were sent to them in October 2014 containing a short explanation and the questionnaire. Beside already been one of the most suitable tools for survey, I wanted a tool that will enable me to collect data from IT personnel in Maseru, as I am staying Thaba-Tseka, which is over 170 kilometres from Maseru. Email cut the costs of transport and printing. Once digital questionnaire has been designed, piloted and edited for errors and corrections, it can be sent to large population as possible without additional printing and transport costs.

Pitfalls of Questionnaires

Questionnaire may have all these and many other benefits, but it also has some pitfalls worth mentioning. Some of which did really contributed to limitation of this study.

These drawbacks are given and explained below.

a) Questionnaires design and development are time consuming

Nicole (2011) asserted that, “...they (questionnaires) do require a lot of time and skill to design and develop.” He further claimed that not everyone can design question. The process that starts from; selecting questions suitable for meeting aims and objectives of the research, arranging them in order they flow logically and smoothly, typing them, piloting and editing can be tedious. Bearing in mind that wording must be considered to meet literacy level and research ethics. Poorly worded and organised questionnaire can be difficult to understand and flow by respondents, and as a result they may give incorrect data or lead to low response rate, especially if they are self-administered.

b) Data collected using questionnaires are as reliable and correct as how respondents decide to be honest

Debois (2019) claims that respondents may not always be honest, influenced by factors like social desirability bias and protecting privacy. As much as a researcher may assure respondents about confidentiality and protection of data, some may still feel not comfortable with disclosing some of the information, and thus lie. Some may just decide to be dishonest or not understand the questions.

c) Questionnaires distribution is time-consuming

Whether distributed by email, post or hand-delivered, distribution of questionnaire is time-consuming.

Hand-delivered: if researcher opts for hand-delivery, he/she has to go in person to each and every target respondent. Imagine if they are 200 or 3 000 or 10 000. That can take days, weeks or months to complete.

Email-delivered: No travelling for email-delivery, but a researcher first have to find the emails or the targeted population, either through phone-call or searching through the internet or any means. Stressing, costly and time-consuming. Imagine having to find emails of 100 people. Still, before sending email, one still has to first communicate (call or any means) with respondents to explain himself or herself to the respondents, as what the questionnaire is about. Still after delivering, a researcher has to remind the respondents time to time about filling in and returning questionnaire.

Post-delivery: Just like with email-delivery, one has to first take weeks finding emails, contacting respondents through call or other means to explain the questionnaire they will receive through post.

Planning and Designing of Questionnaires

In designing the questionnaire, I considered the following factors:

- a) *The ethical issues; Research ethics.* As I was going to deal with people, I had to consider ethical issues like, confidentiality, privacy, honesty and many others as shown in consent form in APPENDIX A. I therefore designed and printed a consent form, for respondents to read it and sign before engaging in the research.
- b) *Type of information and its sources:* I reviewed my aims and objectives, as guide to the type of information and the possible sources of that information. Then I identified Government of Lesotho civil servants at Thaba-Tseka, IT personnel in government and Econet Telecom as my sources of information.
- c) *Accessibility of target population:* then I considered the distribution of questionnaire. Whether they will be hand-delivered or sent through email. The civil servants at Thaba-Tseka could easily be all reached within a week, as offices are roughly with one town or with a radius of 1 kilometre. Therefore the planned to hand-deliver them. The other questionnaire was for IT personnel, which would be sent through email.
- d) *Level of literacy:* The target population are civil servants with at least secondary school certificate, with most being tertiary graduates. English was medium of communication at their schools and compulsory requirement for civil servants working in offices. I therefore designed question papers which they can fill on

their own, without my guidance. My contact numbers were also included in consent form, in case a respondent need clarification or guidance.

- e) *Identification and Objectives*: Introduction of the research and questionnaire itself was included at the beginning, so that respondents understand and are clear how the information they provide is going to be used. I included my names, institution are I am enrolled with and the programme of study.
- f) *Types of questions (open-ended or closed-ended questions)*: I opted for closed-ended and pre-coded questions. Beside the benefits of closed-ended questions, including being easily analysed, I used my personnel experience when I was carrying out survey on behalf of Lesotho College of Education in 2015 and 2016. Most of civil servants do like writing and expressing their opinion. They prefer question papers with options, where they just select most suitable option. The last time I included open-ended question, most were left unanswered. Therefore, I believed even with this study, if I included open-ended question, they wouldn't fill them. Most questions were dichotomous, ranking (Likert scale) and multiple choice. These say that I had to consider/anticipate all possible responses from the respondents for each question and cater for them.
- g) *Readability of questions*: I drafted the questions, based on what I want to find, but also I considered that, not all or most of respondents would not understand Computer Science and/or Cloud computing jargon. Therefore, I toned down the jargon of my field as much as possible, and used normal English language words, so that they could understand the question better. In addition to that, questions were kept as short as possible, in order to make them clear and easy to understand and readable.
- h) *Common Pitfalls of questionnaire*: Colosi (2006) in the article "Designing Effective Questionnaire" listed the following common pitfalls, leading questions, double barrelled questions, ambiguous questions and personal questions. I reviewed and redesigned the questions to avoid these pitfalls.
- i) *Grouping questions*: Questions which are close-related or question falling under the same or similar concepts were grouped under one section. This was done to also make respondents easily realise the type of information required.

- j) *Logic and smooth flow of questions*: The questions in each section were sorted in the order in which they can be logically and flow smoothly. The questioned were branched or structured in such a manner they can cater for all possible preferences and condition. For example, dichotomous question were included to give respondent options, based on experiences and preferences.
- k) *Instructions*: The intention was for respondents to fill questions, without my close guidance, therefore instructions were included at the beginning to guide the respondents on how they fill the questionnaires. More instructions were included throughout questionnaire sections, to guide respondents on which questions to skip, in case their choice need them to do so.
- l) *Time*: Respondents are people, who for this case, are workers. They have to serve public and do other job duties. They can't spend the whole day or their valuable time filling in a questionnaire that has to do with their job description. They would be doing me favour. As a result the questionnaire should cater for that, and be as short as possible, while still gathering as much information as possible. The questionnaire was timed in the interval 10 minutes to 20 minutes.
- m) *Title*: The questionnaire bear the title of the study itself.

The guidelines on designing the questionnaires were taken from these publications: Cohen *et al* (2000) Research Methods in Education, Page 245-265; Rowley(2014) Design and using Research Questions(journal); Colosi (2006), Designing Effective Question (article); and Skinner(20017), Survey Research: Designing Instrument. The Questionnaire is shown in APPENDIX B.

Digital/Electronic Questionnaire Design

The questionnaire for IT personnel still followed the guidelines above, designed using Microsoft Word. However for this digital, the digital form feature of Word, under Developer Tab was used. Using this feature and saving the design as Word Template, enable the questionnaire to be interactive and easily distributed as a template.

Pilot Testing

Mathers et al (2009) suggest that you should never use a questionnaire which has not been piloted, particularly if the questionnaire is designed for self-completion and there will be nobody around to clear up misunderstandings. Pilot Testing involves testing a draft of questionnaire on a smaller scale compared to sample frame, with respondents not different from target sample frame.

The aims as Mathers et al (2009) and Permani (2014) claim are;

- To check and correct wording. To check spelling and jargon or words that may not be clear or confusing to respondents,
- To check if the time taken is close to what the interviewer intended the respondents to take filling the questionnaire.
- To identify questions that are ambiguous and possibly leading.
- To be certain that question flow logically as intended and can easily be followed.

Pilot Testing is that part that I didn't do as thoroughly as I wanted to. I piloted questionnaire for Government of Lesotho Civil Servants on 5 people, who are working in government currently and my colleagues at Lesotho College of Education, who once worked in Government. The questionnaire for IT personnel was tested only on three colleagues who are in IT Section of Lesotho College of Education. Though numbers were too low, they still helped me rectify spelling mistakes, wording, and ambiguity and included some points that I left out initially.

Distribution and Collection of Questionnaires

The questionnaires for civil servants at Thaba-Tseka were hand-delivered and hand-picked on dates agreed with respondents. In all offices, I introduced myself, the intention of my visit and brief description of my study. In some ministries, they let me leave them at reception, with promise that, with such educational study they will definitely distribute to employees. In some ministries, they let me distribute them to various offices. In every office, I introduced myself, described my study and its goals and humbly persuaded them to participate in my study. I gave brief guidelines on how questionnaires are filled. However I still did this ethically as explained in Section 3.5.

The electronic/digital questionnaire were distributed using email. I used Econet Telecom Lesotho Telephone Directory 2019 and <https://www.gov.ls/> to gather telephone numbers and email addresses of various target government ministries. The telephone numbers and email addresses were used to contact the ministries and request permission to collect information from their IT Sections. Once agreements were made, I sent questionnaires and negotiated on dates of return for filled question papers. Just like with hand-delivery, I introduce myself, briefly introduce my study and its goals and humbly persuaded them to fill the questionnaires.

3.4.2 Interview

Schostak (2006) defines interview as an extendable conversation between partners that aims at having an ‘in-depth information’ about a certain topic or subject, and through which a phenomenon could be interpreted in terms of the meanings interviewees bring to it. Interview is one of survey data collection tools where an interviewer (researcher) asks the interviewee (respondent) questions, in attempt to get the information about their understandings, opinions, experiences and beliefs. The interview may be two people or between one interviewer and group of interviewees or group of interviewers and interviewee (s). Interview can either be face-to-face or over the telephone. Depending on agreement, the interview can be voice or video recorded or the interviewer write down the responses from interviewee(s).

“Though suitable for quantitative data collection, interviews are particularly useful when qualitative data are required.” Nicole (2011). I therefore selected interview as one of my data collection tools for my survey, because I wanted both quantitative and qualitative data from ISP, which is Econet Telecom Lesotho.

Type of Interview

Abawi (2013) list three types of interview as, structured, semi-structured and unstructured. I chose semi-structured interview. “In a semi-structured interview, the interviewer uses a set of predetermined questions and the respondents answer in their own words.” (Easwaramoorthy and Zarinpoush, 2006). I wanted the ISP to explain their views, opinions and understandings in their own words, as I wanted them to go deeper

where possible. Ryan *et al* (2009) argues that the flexibility of semi-standardised interview allows the interviewer to pursue a series of less structured questioning and also permits the exploration of spontaneous issues raised by the interviewee to be explored. This is exactly how I wanted my interview to be like. That flexibility, where I could even explore and allow the interview freedom to question and thus reveal more information.

Means of conduct: Telephone

“Different types of interviews can be used in the same study, individual interviews combined with focus groups, face-to-face with telephone or email interviews” (Edwards and Holland, 2013). The intention was to use telephone interview. This is the interview contacted over the telephone, either landline, cellular phone, Voice over Internet Protocol or Video Conferencing (Skype), where researcher and participant schedule a time during which the call will be made to contact interview.

Some of the benefits of telephone interview include; rapid gathering of information and allowing personal contact between interviewer and respondent, as claimed by Valenzuela and Shrivastava (2014). Nicole (2011) too attest that telephone interview cuts transport costs and time spend travelling to respondents and can be carried fast than face-to-face. In case of this study, the target interviewee (Econet Telecom Lesotho) consultant was based in Maseru, which is over 170 kilometres from where I am based. On the other hand, telephone interview like any other data collection method has some flaws. Valenzuela and Shrivastava (2014) gave imperfections of telephone interview as: Many people don't have their telephones listed publicly, interview has to be short or else respondent may feel imposed on. “Disadvantages include the lack of face-to-face contact and so lack of information about the other from their appearance, non-verbal communication in the interaction and the physical context” Edwards and Holland (2013).

However, the telephone interview failed after several attempts, and I ended up using WhatsApp, which is one of the most popular Instant Messaging platforms.

After we exchanged the cellular phone numbers, we agreed to contact interview over WhatsApp. I saved the Microsoft Word interview document as PDF, and sent it to him using WhatsApp. He read the questions, and a day later provided answers to the questions I asked. He also gave me opportunity to contact him anytime I want clarification or have more questions. The Interview questions are shown in APPENDIX C and the WhatsApp conversation is shown on APPENDIX D.

Benefits of interview

Interview as data collection method, whether contacted over the telephone, face-to-face or focus groups, has several attractive benefits.

Abawi (2013) mentions the following benefits: researcher collects information with better understanding. Contrary to questionnaire, interview is more personal and thus lead to high response rate. Interview allows a researcher to have more control over the order and flow of questions. According to Alshenqeeti (2014), other advantages of interview are fewer incomplete answers and relatively flexible. Since with interview, respondents can ask for clarification in case they don't understand the question, they can ask for rephrasing or more explanation of what the question needs and therefore most answers will be complete. The interviewer has opportunity to even add more question or explore more if need be.

Drawbacks of Interview

When contacting a research interview, one should know that it goes with some unavoidable shortcomings. Interviews are time-consuming and tiring. The process of finding the telephone numbers of the respondents, calling them, scheduling a dates and time for interviews and finally contacting the interview consumes lot of time and is definitely tiring. Imagine if one has to interview 100 respondents in two months. One of the problematic feature of interview mentioned by Cicourel (1964) is that the respondent may well feel uneasy and adopt avoidance tactics if the questioning is too deep. As much as probing is one advantage of interview, it may prove to also be a drawback, where respondent may try to avoid revealing more information and possibly feel uneasy with the questions. Ryan *et al* (2009) and Alshenqeeti (2014) claim that interview has another weakness of bias, through use of inadequate questioning. "Risk of bias is high due to fatigue and to becoming too involved with interviewees" (Abawi,

2013). Analysis of interview data can be tricky and difficult when there is lot of qualitative data.

Interview Execution Plan Design

The interview execution procedure followed the interview guideline by: Cohen *et al* (2000), Research Methods in Education (p.274-279), Valenzuela and Shrivastava(2014), *Interviewing as a Method for Qualitative Research* (Lecture), Easwaramoorthy & Zarinpoush(2014) *Interviewing for Research* (article) and Pernami (2014) *Sampling questionnaire and interview design* (Lecture).

I follows seven main basic stages, namely; Thematising, Designing, Interviewing, Transcribing, Analysing, Verifying and Reporting.

Thematising

Cohen et al (2000) describe this stage as where researcher formulate the purpose of an investigation and describe the concept of the topic to be investigated before the interviews start. The interview was intended for Government of Lesotho ISP, which is Econet Telecom Lesotho. The goal was to the internet service they offer to the Government of Lesotho (Thaba-Tseka), the state of their infrastructure, the problems they encounter and future projections at Thaba-Tseka town. They would help the study to evaluate how ready the ISP infrastructure is for cloud computing adoption, at Thaba-Tseka Town.

Designing

“When designing an interview schedule it is imperative to ask questions that are likely to yield as much information about the study phenomenon as possible and also be able to address the aims and objectives of the research.” (Gill *et al*, 2008). The questions were designed so that they cover the following variables: type of broadband, bandwidth, future projections, problems encountered, customers already using cloud services, optical fiber supply and challenges faced by ISP at Thaba-Tseka town.

Interviewing

Easwaramoorthy & Zarinpoush (2014) explain that a researcher should choose the appropriate respondents. Depending on the type of interview, decide on the characteristics of interviewees and the number of interviews required. Decide how you will conduct the interviews. Consider telephone or face-to face interviews. The Econet Telecom Lesotho agents in charge or working on Government of Lesotho accounts was identified respondent. There was no need for many, as the data collected was not to be compared with other ISPs. Econet Telecom Lesotho is the sole ISP to Government of Lesotho at Thaba-Tseka. Telephone interview was identified as the most suitable as per justification given in sub-sub-section (***Means of conduct: Telephone***). The telephone number was searched from Econet Telecom Lesotho 2019 Directory and their website. The intention was to schedule the date and time for the interview, with estimated time for interview. The ethical issues like their rights, confidentiality and aim of the research were to be explained to the respondent. However, it proved to be a fruitless effort. However after trying other options, I finally found their General Manager Business Enterprise, who was willing to do interview, only through WhatsApp, because of his unpredictable schedule. I sent the interview PDF document through WhatsApp and the responses were sent through WhatsApp too. The Interview document on APPENDIX C and WhatsApp responses on APPENDIX D.

“WhatsApp Messenger is a freeware, cross-platform messaging and Voice over Internet Protocol service owned by Facebook. It allows the sending of text messages and voice calls, as well as video calls, images and other media, documents, and user location. The WhatsApp client application runs on mobile devices but also accessible from desktop computers while the mobile device is connected to the Internet.”
www.wikipedia.org

Transcribing

“Prepare the interview material for analysis, which commonly includes a transcription from oral speech to written text.”(Cohen et al, 2000). The data (both quantitative and qualitative) collected for Econet Telecom Lesotho were separated in variables that can be analysed. The variables were extracted from interviewee’s responses. The extraction was based on the aims and objectives of the interview, that is, what the interview was intended to find.

Analysing

“Decide on the purpose, the topic, the nature and methods of analysis that are appropriate.” (Valenzuela and Shrivastava, 2014)

3.5 Research Ethics

Ethics are about knowing what is right and what is wrong, be it in life generally or in any profession or field, Fouka and Mantzorou (2011) claimed “It is said that ethics is the branch of philosophy which deals with the dynamics of decision making concerning what is right and wrong.” . As research involves subjects (human beings) and other academics’ publication, with its results expected to contribute to new knowledge or betterment of life, it is vital that a researcher know how to conduct themselves. There are norms and values expected from anyone conducting a research.

Research ethics give guidelines as to how a research should be conducted. What is right and what is wrong, when one is conducting a research. “Researchers are professionals hence, research ethics as a branch of applied ethics has well established rules and guidelines that defines their conduct” (Akaranga and Makau, 2016). They are meant to help researchers maintain their dignity, avoid plagiarism, biasness and harming the participants in a research among others.

The research ethics issues to consider are as follows:

HONESTY

A researcher must avoid, at all costs, deceiving the fellow academics and the public in their research findings, interpretation and analysis, so as to maintain trustworthy. “Honestly report data, results, methods and procedures, and publication status. Do not fabricate, falsify, or misrepresent data. Do not deceive colleagues, research sponsors, or the public.” (Resnik, 2015).

Researchers must avoid misconduct, which includes plagiarism, fabrication and falsification, during the research process cycle, starting with proposal, reviewing, collecting data, presenting data and reporting the results.

Office of Research Integrity, US Department of Health and Human Services defines falsification as; manipulating research materials, equipment, or processes, or changing or

omitting data or results such that the research is not accurately represented in the research record.

Fabrication is making up data or results intentionally and report them.

Walliman (2011) defines plagiarism as directly copying someone else's work into your report, thesis etc. and letting it be assumed that it is your own. It is the worst academic crime to copy people's work, ideas and thoughts without citing them correctly. It is unethical and should be avoided at all costs, even trying to paraphrasing in effort to make them appear as yours isn't allowed.

It is not a crime to include the work or findings by fellow researchers and academics in reviewing or supporting the argument, but the source and origin of such work must be acknowledged. It should be in the form of referencing at the end of the research report and within the body of the research, where such extracts were included: citation.

The researcher should never omit some of the results or data collected, thus being bias, in order to fake the report so that it favours his/her hypotheses, assumptions and believes. It is the researcher responsibility to respect the fellow researchers, academics and public and general.

I tried my level best never to be bias, avoid plagiarism and not to fabricate results. All the data I presented and analysed were collected from the sources in my population and other reliable sources. I never lied to the respondents in order to entice them to participate in my study. I told them exactly what the study was about, as the introduction of my questionnaires and interview on APPENDIX A and APPENDIX B shows.

INFORMED CONSENT

Nijhawan et al (2013) describes informed consent as the process where a participant is informed about all aspects of the trial, which are important for the participant to make a decision and after studying all aspects of the trial the participant voluntarily confirms his or her willingness to participate in a particular clinical trial and significance of the research for advancement of medical knowledge and social welfare. Whenever people are to participate in a research, they must be do that willingly and voluntarily. They must be made aware that, they have a right to withdraw at any time during the process, be it interview or any means of data collection. The researcher must be honest with them and clearly state the objectives of the research. Right from the beginning they should know where and how the information they provided is going to be used.

Should they demand anonymity, confidentiality and privacy, they should be granted that and the researcher keep his/her word.

In case of vulnerable people like children, disabled, ill or elderly people, the parents, guardian or people looking after them must be the ones giving consent.

I download a consent form template from www...., edited it to suit my study and gave all my respondents to read and understand it and their rights before they participated in my study. We both (respondents and me) signed the consent form. The consent form is shown on APPENDIX A.

BENEFICENCE AND DECEPTION

Cohen et al(2005) state that, in social psychological research, the term(deception) is applied to that kind of experimental situation where the researcher knowingly conceals the true purpose and conditions of the research, or else positively misinforms the subjects, or exposes them to unduly painful, stressful or embarrassing experiences, without the subjects having knowledge of what is going on. Deception goes hand in hand with beneficence. With beneficence, the researcher must explain clearly the benefits of the research, and should not exaggerate the benefits. In desperation to get data, the researcher should make false promises to entice the participant to have hope of benefiting from the research. Deception must be avoided by telling the participant the whole truth, not part of the truth, about the consequences and risks of participating in the research.

It clearly stipulated on my survey tools on APPENDIX B, C and D the aims and objectives of the research. Not even once did I tried desperate measures of promising the respondents any incentive or lied about the aims and objectives of the research. I humbly requested their time and told them that my study was pure post-graduate dissertation, and data collected is intended for that.

NON-MALEFICENCE

The welfare of human beings is more important than the results or findings of the research. This implies that, a research must consider and priorities the safety of participants and thus minimises chances of harm to the participants. The harm may be physical or emotional.

The researcher must avoid been too aggressive or asking embarrassing questions during the interviews. Knowing the background of the participants, so that the researcher knows what they went through in order to avoid asking too sensitive or emotional depressing question, is very important.

I might have been limited by questioning skills but, I tried the best I can to ask questions that could embarrass and invade privacy of the participants. No sensitive questions were asked. The questions were general information and participants were not forced to answer even questions they do not feel comfortable answering.

DATA HANDLING

Data and information collected from participants may be sensitive and need confidentiality and privacy. The researcher must have a clear strategy and plan for handling such data, when to disseminate and dispose records. There must be safe and secure storage for saving such data/information during and after the research process. The agreement must be made with participants, with their written consent, about where the data is going to be disseminated. It should be clear if it is going to be a journal, article, dissertation, website or any publication.

When disposing data records, any attributes or information that can compromise anonymity must be removed and thus protecting the participants.

The consent form Appendix A shows clearly how data collected from participant will be handled until it is disposed or destroyed. All respondents were aware that the data they provided are to be used only for the study indicated.

4 RESULTS AND ANALYSIS

INTRODUCTION

As shown in the last chapter, questionnaires were hand-delivered to civil servants at various Government of Lesotho Offices at Thaba-Tseka town. A total of 60 questionnaires were distributed, 45 of them were filled, though some not complete. The results of those questionnaire are shown and analysed in Section 4.1.

During the data collection at these Government of Lesotho offices, I discovered that almost all offices gets IT support from head-quarters in Maseru. Therefore the questionnaires intended for IT personnel were then send through email. The results and analysis for this second questionnaire are in Section 4.2.

The last data collection was through interview at ISP, which is Econet Lesotho. Its results and analysis are in Section 4.3.

The results were almost all analysed using Microsoft Excel 2013 charts.

4.1 Government Civil Servants Questionnaire

4.1.1 Government Civil Servants Computer Literacy

The respondents were asked whether they ever enrolled for any computer literacy course. The bar chart in Figure 4-1 below shows the responses of 45 civil servants who answered the question.

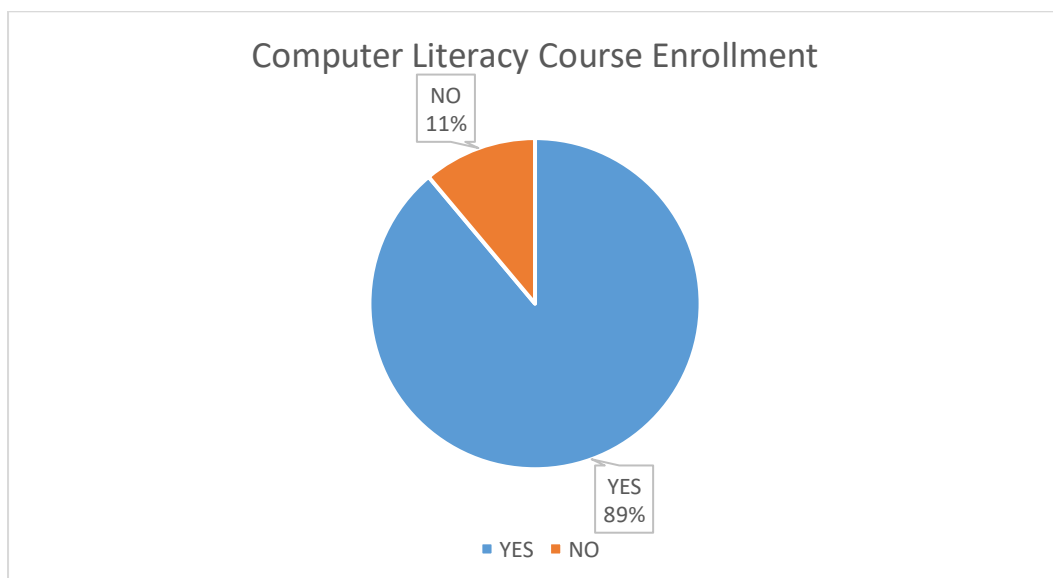


Figure 4-1: Bar-chart showing the results on computer literacy course enrolment.

With 89% of civil servants already computer literate, it leads me to believing that the task of training or introducing them to cloud computing world will not be the hectic task. It is only a low percentage, 11%, which will need computer literacy training. That percentage may be even lower and mostly employees who are closer to retirement, because since the late 1990s, almost all Lesotho tertiary institutes introduced computer literacy courses. The government in recent years has been employing mostly tertiary graduates for office position. This will also be proven by results of the next question.

4.1.2 *The level at which computer literacy skills were acquired.*

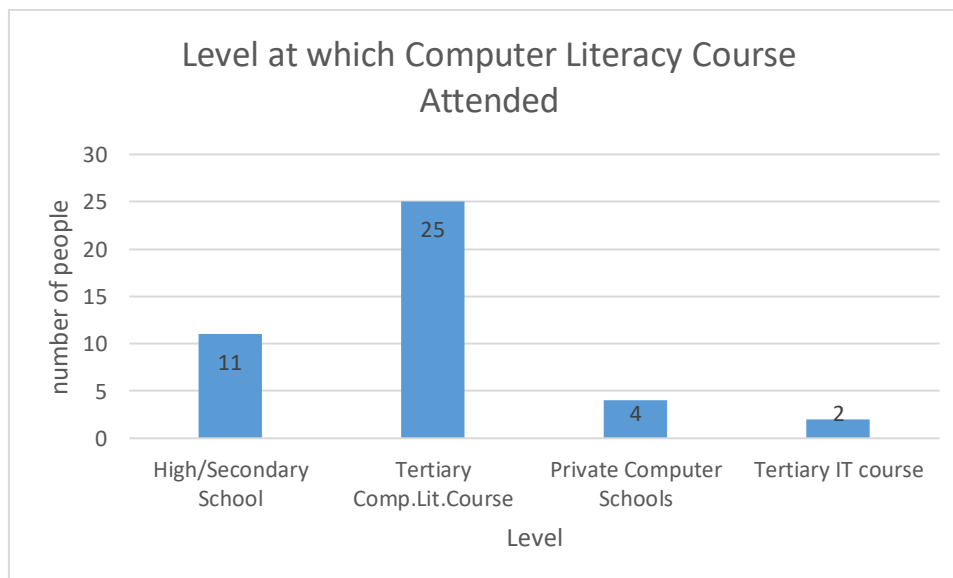


Figure 4-2: Bar chart showing level at which computer literacy was acquired

The bar-chart in 4-2 shows a high number, 25 (which is 59%), of respondents having acquired computer literacy skills at highest level of education in Lesotho. That is encouraging figure, especially if 5% of those who learned IT at tertiary is included. These figures may mean that, with computer literacy, the government is 60% plus ready to try cloud computing solutions, since users will not have to be trained from scratch.

4.1.3 Readiness for future computer literacy course

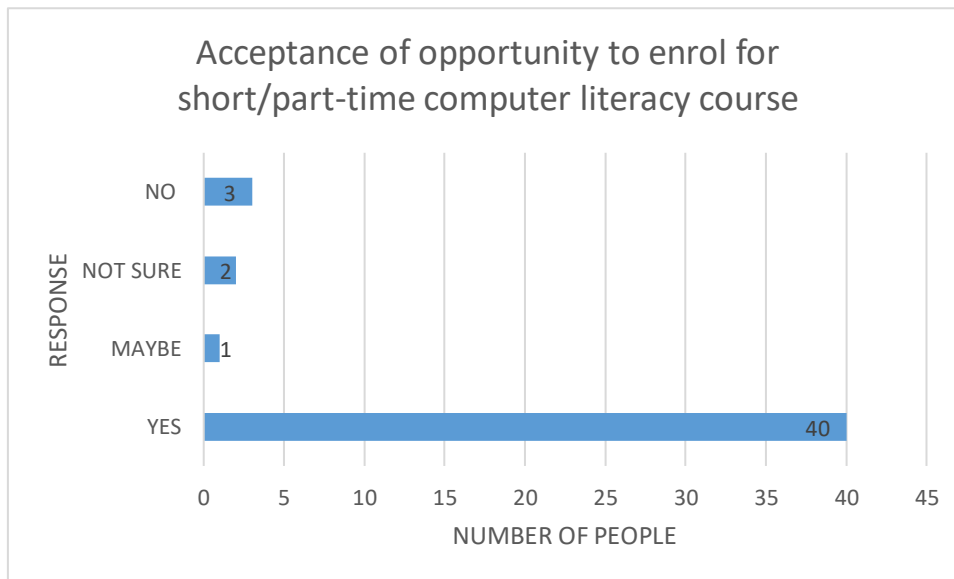


Figure 4-3: Bar Chart showing Acceptance to enrol for short/part-time computer literacy course.

The results in Figure 4-3 lead me to believe that a very high percentage of civil servants are ready to even nurture their computer literacy skills further. A good sign that training them for cloud computing adoption is unlikely to face resistance. The results say that 40 (87%) of the 46 respondents are willing to take further computer literacy courses.

4.1.4 Significance of computer literacy in the position occupied

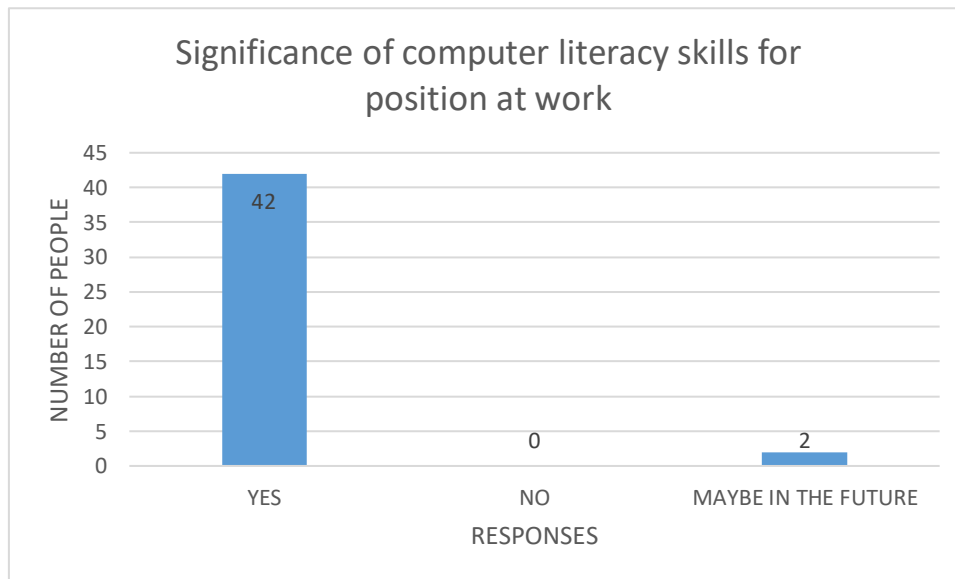


Figure 4-4: Bar chart showing significance of computer literacy skills for position at work

Almost all the respondents believe that computer literacy skills are important in their positions at work. That may say that, they believe that computers are the future of their daily work at office. This may lead me to believe that introducing a new paradigm of cloud computing will not be that difficult task, if they already believe in traditional IT solutions. 42 of 44 respondents believe that, their jobs need one to be equipped with computer literacy skills.

4.1.5 Number of computers per office and Number of users per computer

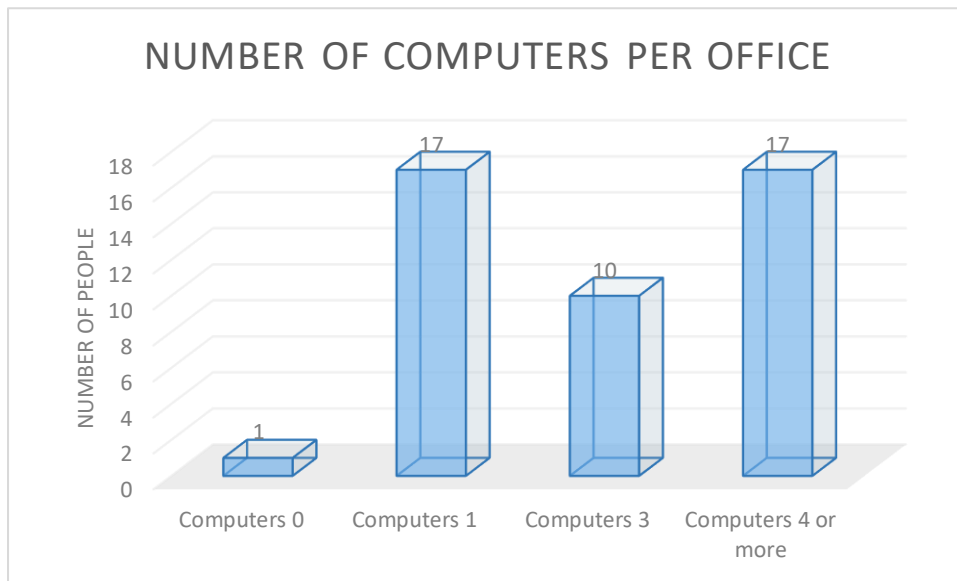


Figure 4-5: Bar Chart showing number of computers per office

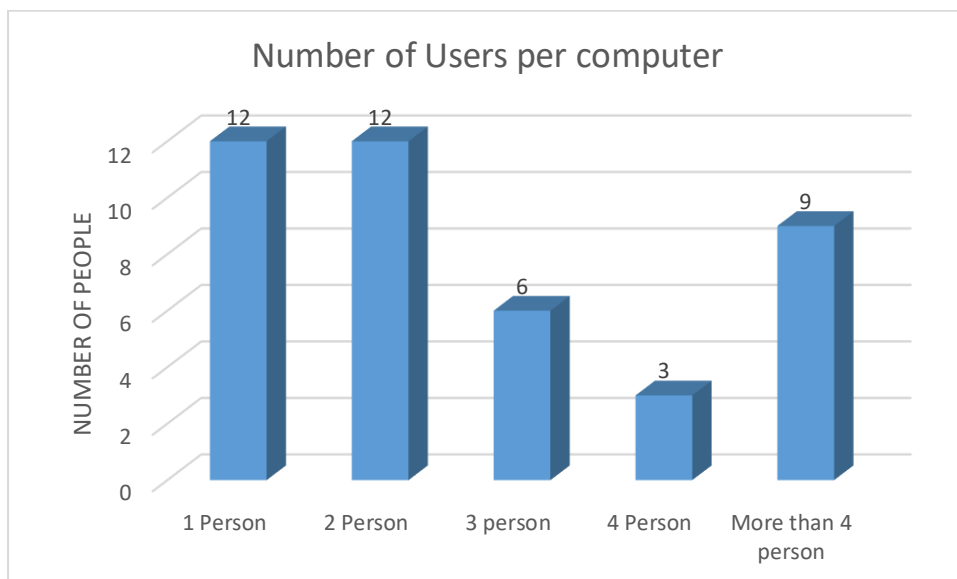


Figure 4-6: Bar-Chart showing number of users per computer

The results of Figure 4-5 and Figure 4-6 give a promising picture, in terms of IT infrastructure (especially computers) at government offices. Figure 4.1.E tells us that almost all office have at least one computer, which is the basic necessity, should government opt for cloud adoption in the future. The results further encourage when Figure 4-6 is considered, as in most offices there at most 2 users per computer. 24 (57%) of the office there are 2 or 1 users per computer. There is still a worrying statistics of 4

or more users per computer in 29% of offices, which is what the government has to work on, if cloud computing is to be adopted in the future.

4.1.6 Daily work done using computers and time spend using computers

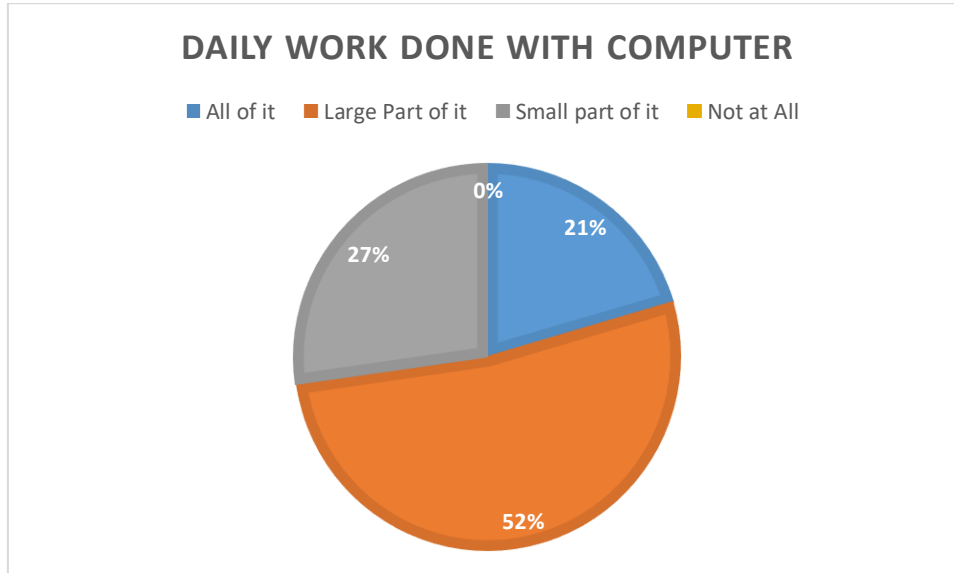


Figure 4-7: Pie-Chart showing work done with computer

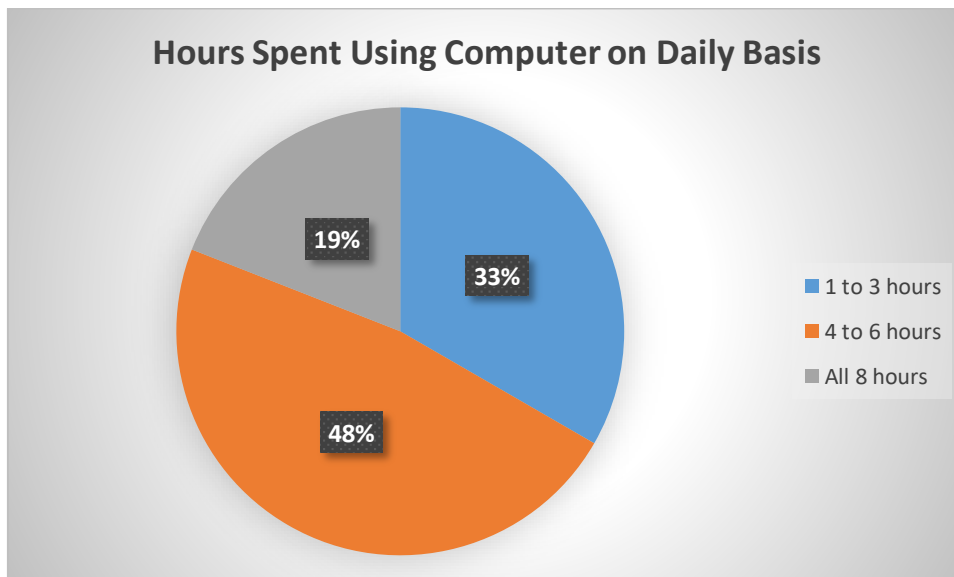


Figure 4-8: Pie-Chart showing number of hours spent using computers on daily basis

The civil servants already spent most of their time using computers at work. The results on Figure 4-7 and Figure 4-8 lead me to believe that, 67% of respondents already spent 4 hours to all their hours at work on computers. From Figure 4-8 shows that 63% of employees do most or all their daily duties with computer. One fact that one may not

ignore is that, part of that time may be spend on social media. However, that can be a blessing in disguise, since social media involves storing and sharing lot of personal information online. That may increase their trust on cloud, as it involves storing and sharing data online.

4.1.7 Number and Accessibility of Computers at Work in other Offices

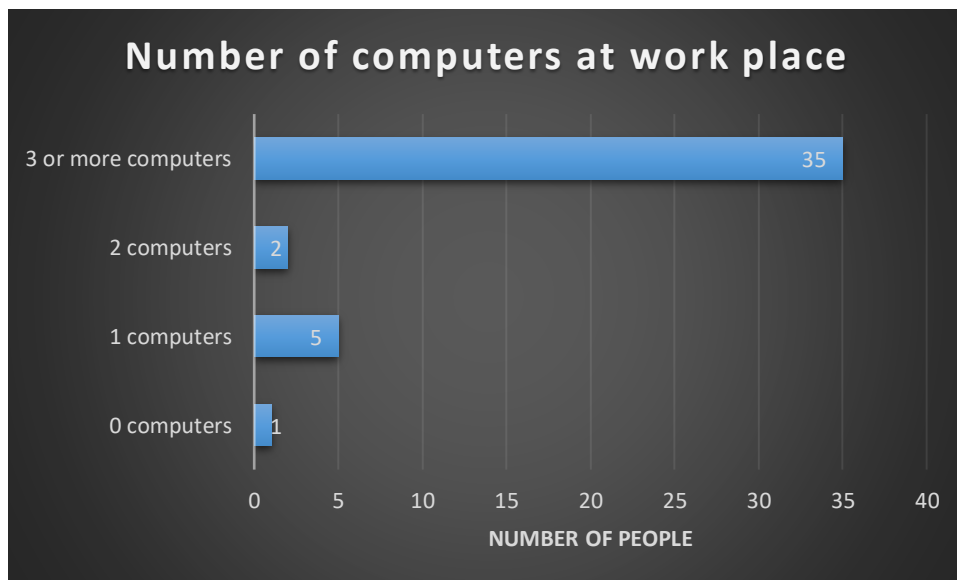


Figure 4-9: Bar-chart showing number of computers at work place.

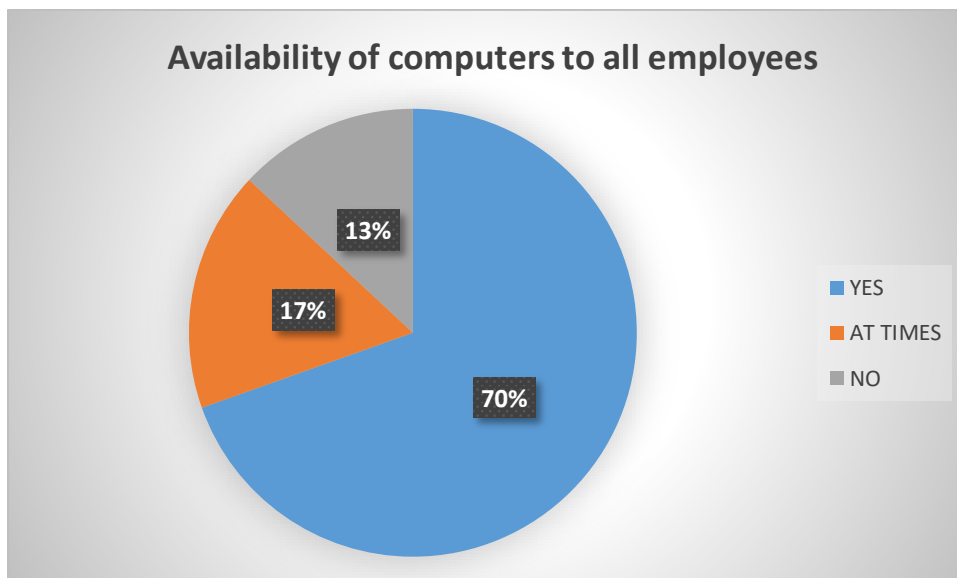


Figure 4-10: Bar-Chart showing Availability of Computers to all workers

Figure 4-9 results are very promising, since beside the respondents' offices, there are computers in other office, with 81% saying that, there are 3 or more computers in other

office, beside their own office. It is even encouraging more when these results are combined with Figure 4-5 and Figure 4-6, where almost all office have computers are low ratio of computer : users. Figure 4-10 further show that 70% of respondents say that computers in other offices are available when they need to use them. That may say that, the computers generally are not crowded, which may further prove a low number of users per each computer. For cloud computing, it may say that, in terms of computers, basic units, the government is better position for adoption.

4.1.8 Availability of Internet and Ratio of computers connected

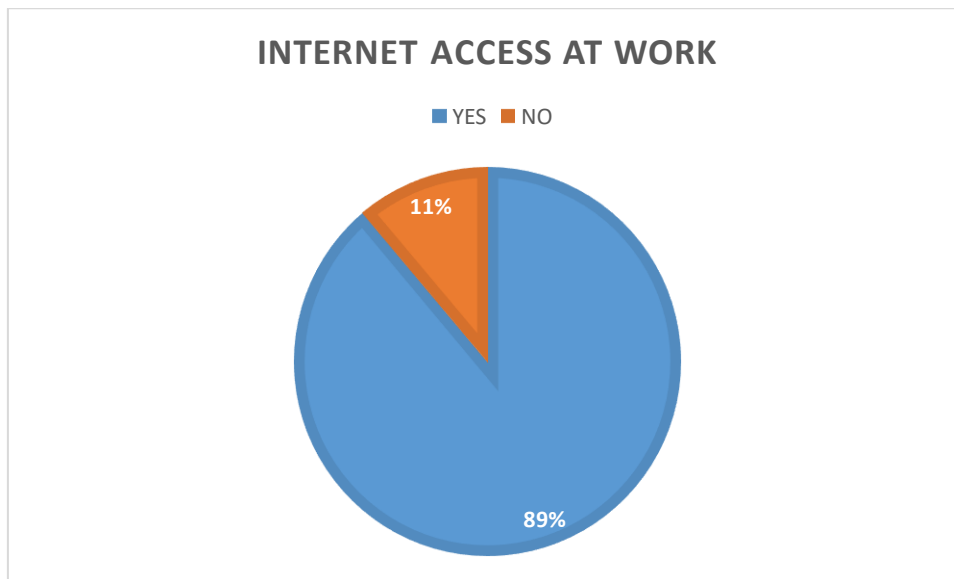


Figure 4-11: Pie-Chart showing availability of internet at work

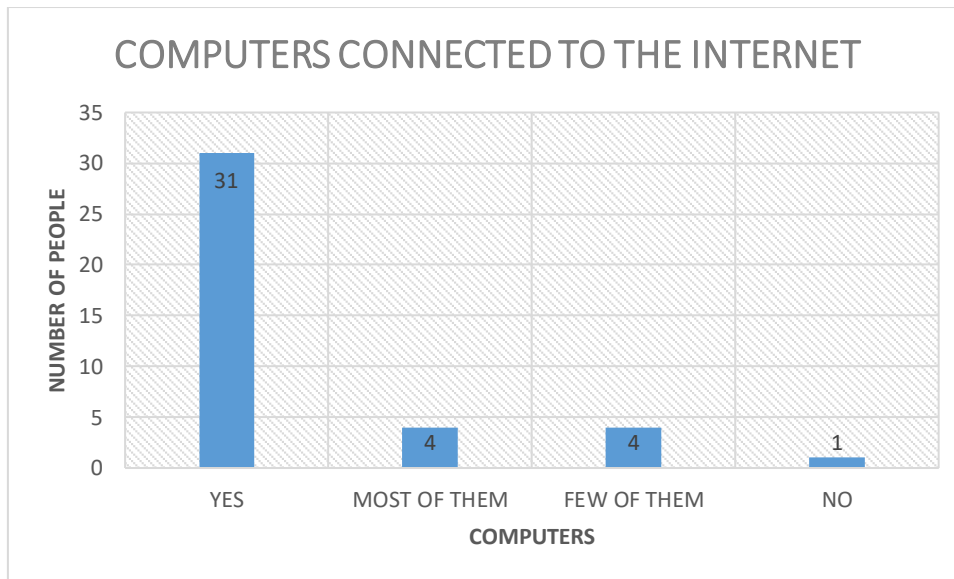


Figure 4-12: Bar-Chart showing computers connected to the internet

From Figure 4-11, 89% respondents say that they have internet connection at their work or office. That's encouraging figure for cloud computing, because with this paradigm almost everything is done through the internet. Data stored, software used, virtual machines and hardware resources are accessed through the internet. Figure 4-12 further add on encouraging figures in Figure 4-11, since 31 of 40 respondents said that all the computers at work are connected to the internet. 87.5% of respondents said that almost all or all computers are connected to the internet. Therefore these statistics mean that the government has a little left to reach 100% connection, if it is to adopt cloud computing.

4.1.9 Reliability and Speed of Internet

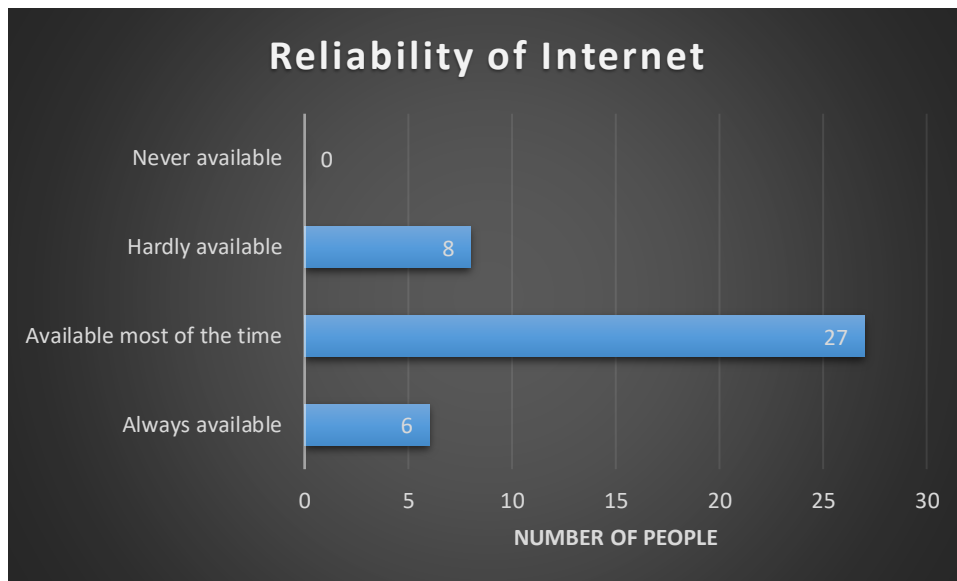


Figure 4-13: Bar-Chart showing Reliability of Internet

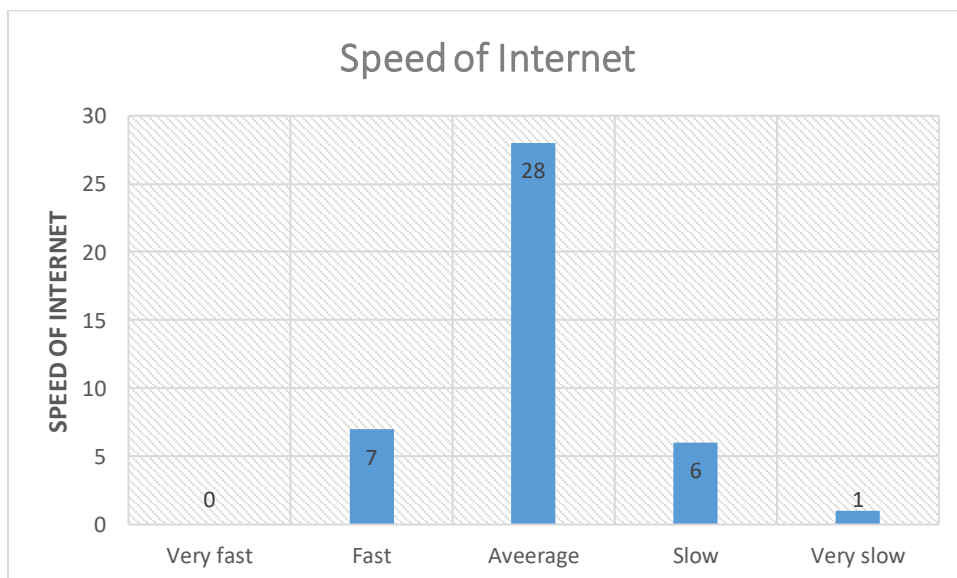


Figure 4-14: Bar-Chart showing the speed of the Internet

Figure 4-13 lead me to believe that the ISP for Government of Lesotho is reliable or close to being reliable. 27 (66%) of respondents say that internet is available most of the time, with further 6(15%) saying it is available all the time. The worrying factor is the speed, as shown in Figure 4-14 where 67% of respondents consider it average, not fast for that matter. With cloud solutions, there is a need for a fast internet as almost all services and data are online.

4.1.10 Cloud and Email Usage

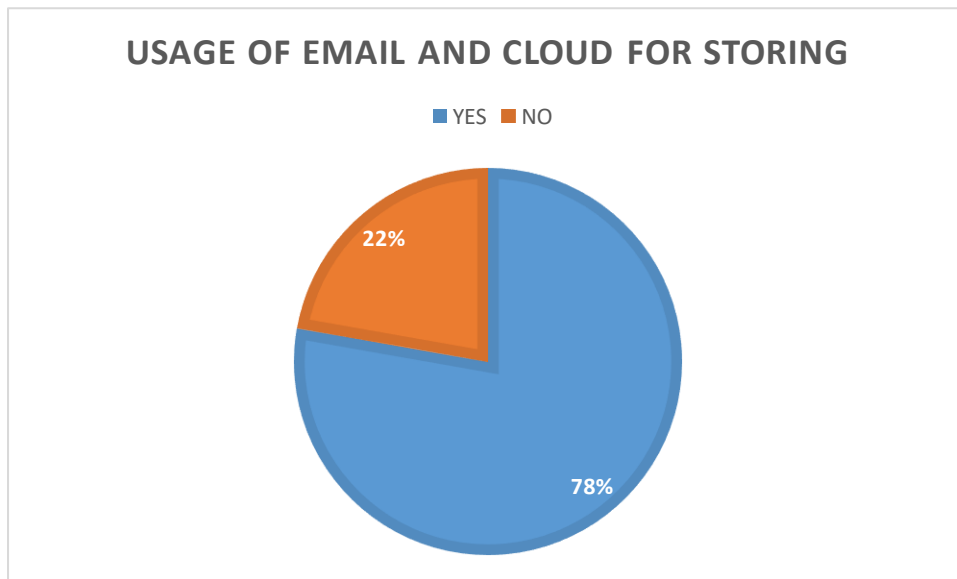


Figure 4-15: Pie-Chart showing usage of cloud computing for storing

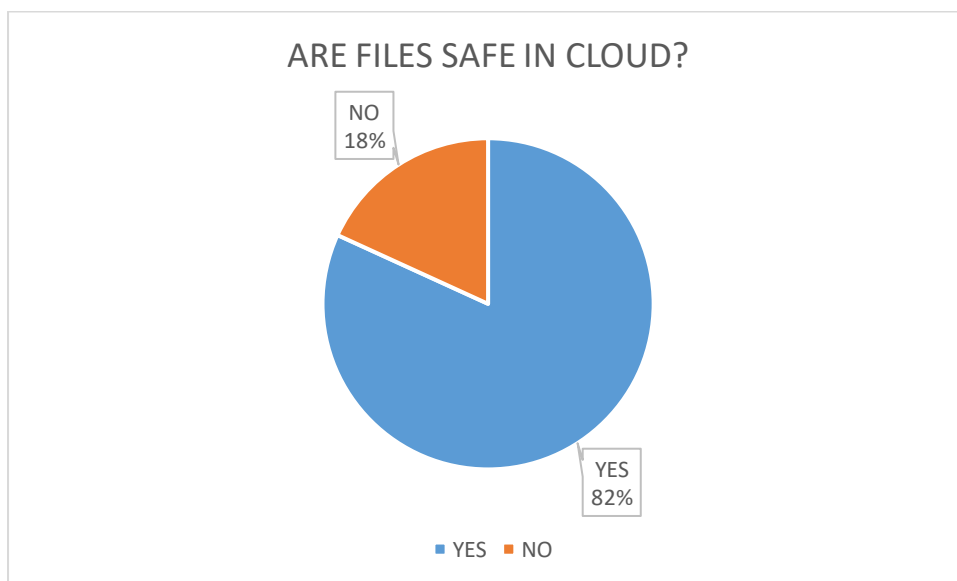


Figure 4-16: Pie-Chart illustrating Trust on Cloud by Civil Servants

Figure 4-15 are the results of a question, where respondents were asked whether they have ever used email, Dropbox or other online means to store and transfer files. 78% of the respondents have ever or already using public cloud for storing and transferring files. Encouraging fact, if civil servants are already using cloud services.

From Figure 4-16, it is encouraging when 82% of respondents consider cloud safe/secure for data storage. Cloud security is one of the major concerns by organisation

and company considering adoption of cloud. The results here may lead me to believe that, for these employees it may not be the concern, unless they may respond differently if it is government information not their private information to be transferred or stored in cloud permanently.

4.1.11 Computer System Security

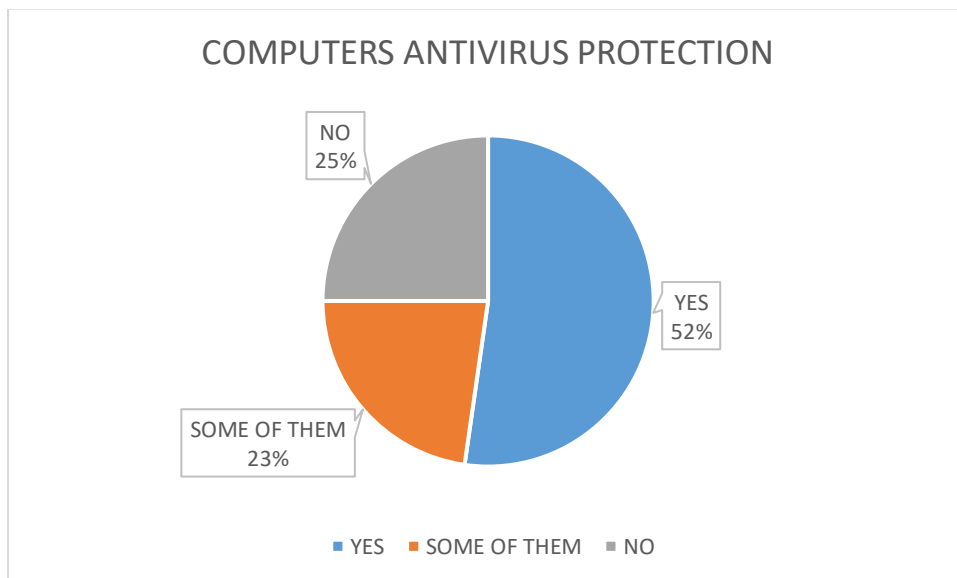


Figure 4-17: Pie-Chart showing computers antivirus protection

This is where the government has to improve a lot. That figure of 25% of respondents who say that computers are not protected with antivirus is a great concern. Government keeps very sensitive and confidential information about people. That can be a temptation for hackers or other attackers. Without antivirus protection, then the systems are vulnerable and prone to attacks like denial of service, spyware, virus, ransomware and other attacks. Adopting cloud solutions with that 25% of computers unprotected can lead to confidentiality, availability and integrity of information being compromised.

4.1.12 Workshops for Secure use of Computers

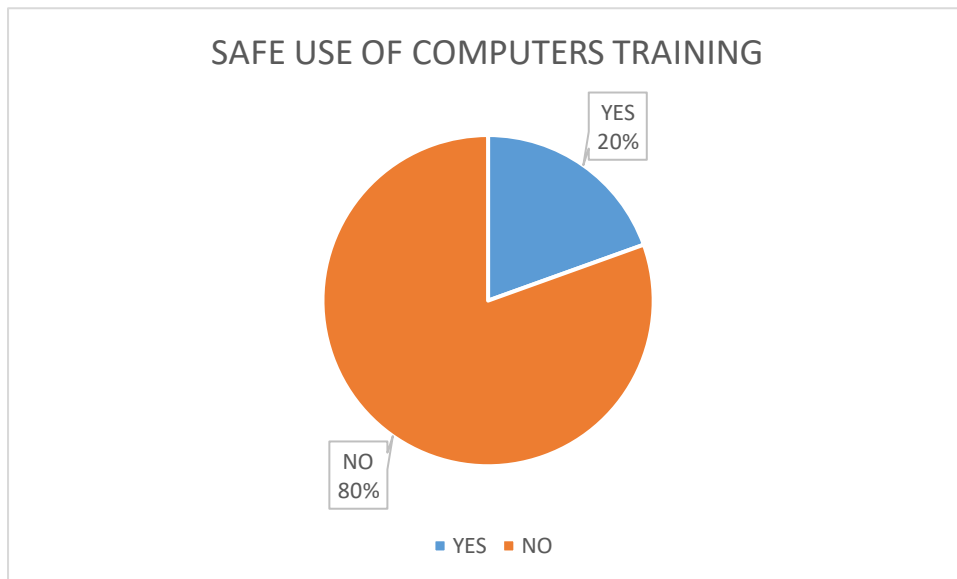


Figure 4-18: Pie-Chart showing Safe use of computers training

The respondents were asked if they ever attend workshops on computer security of safe use of computers, and 80% of them said NO. They never attended such workshops. Human beings or users can be the weakest link in the network or computer system, if they are not equipped with enough computer security skills. Their innocent or careless behaviour or practices when using computers or network may make network or system vulnerable to malicious attacks like spyware, Trojan horse, virus, phishing, adware and many others. This is a worrying fact if the government is to adopt cloud computing, where confidential and sensitive data will be stored in cloud, and always accessed through internet.

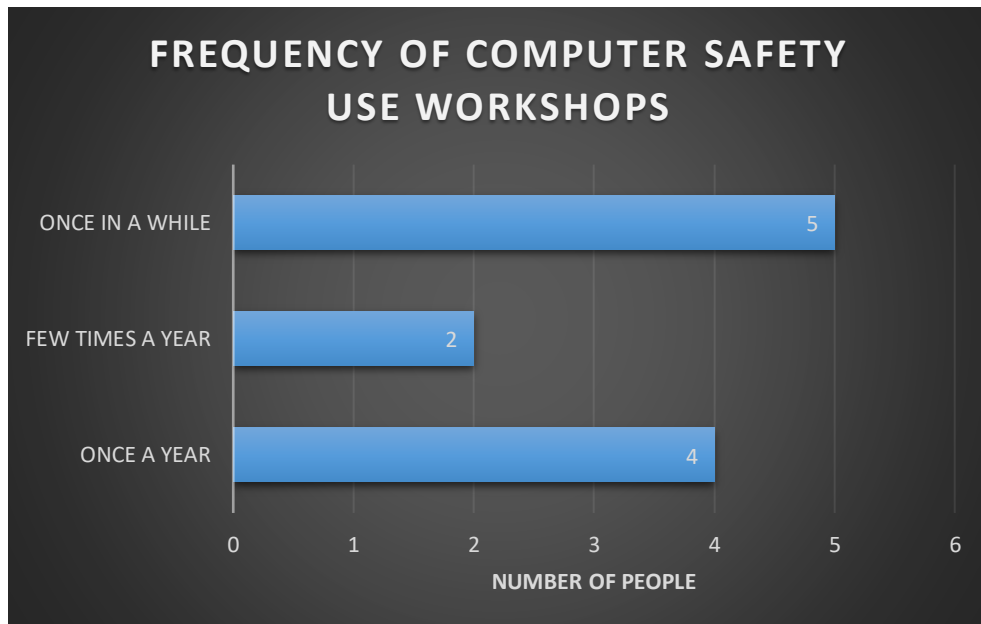


Figure 4-19: Bar-Chart showing the frequency of computer safety workshops

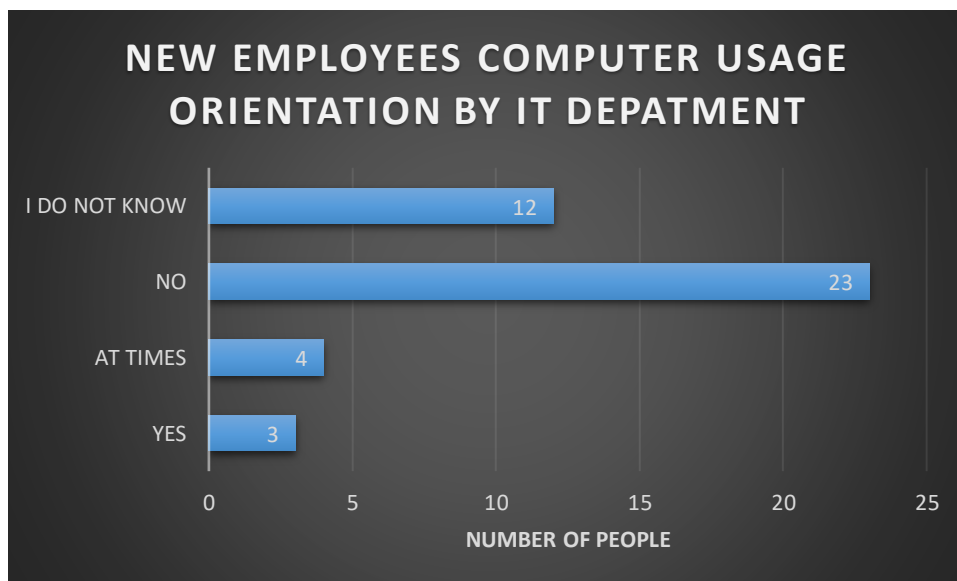


Figure 4-20: Bar-Chart showing new employees computer system usage orientation by IT department

Figure 4-19 shows us that, even the 20% (from Figure 4-18) that ever attended the workshops, the frequency is low, with most of them attending computer security workshops once in a while or once a year.

Figure 4-20: 23 of 42 (55%) of respondents say that new employees are never given orientation about using the software or computer system or network at work. This too

make the system vulnerable, if users are not trained on how to effectively and safely use it.

4.1.13 IT Support at Work

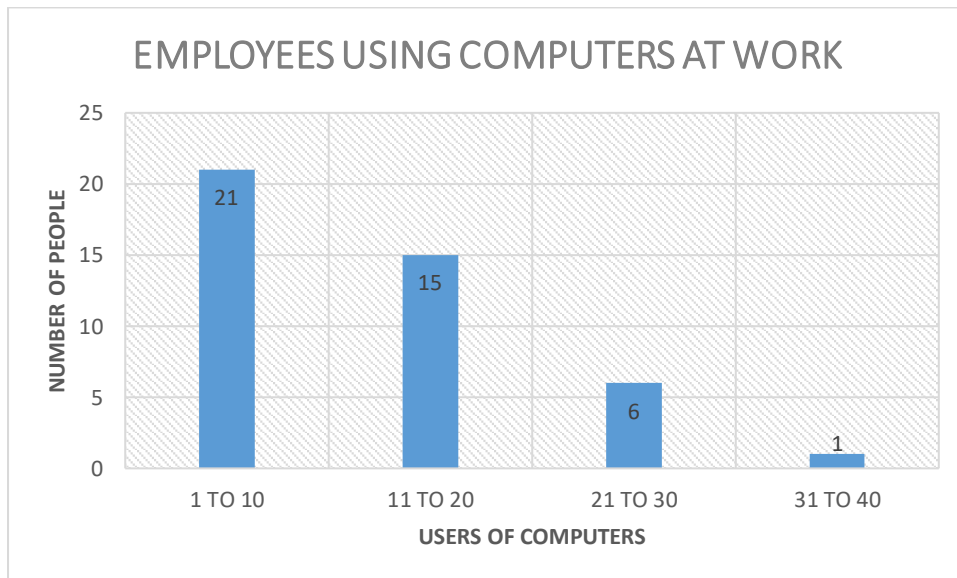


Figure 4-21: Bar-Chart showing employees using computers at work

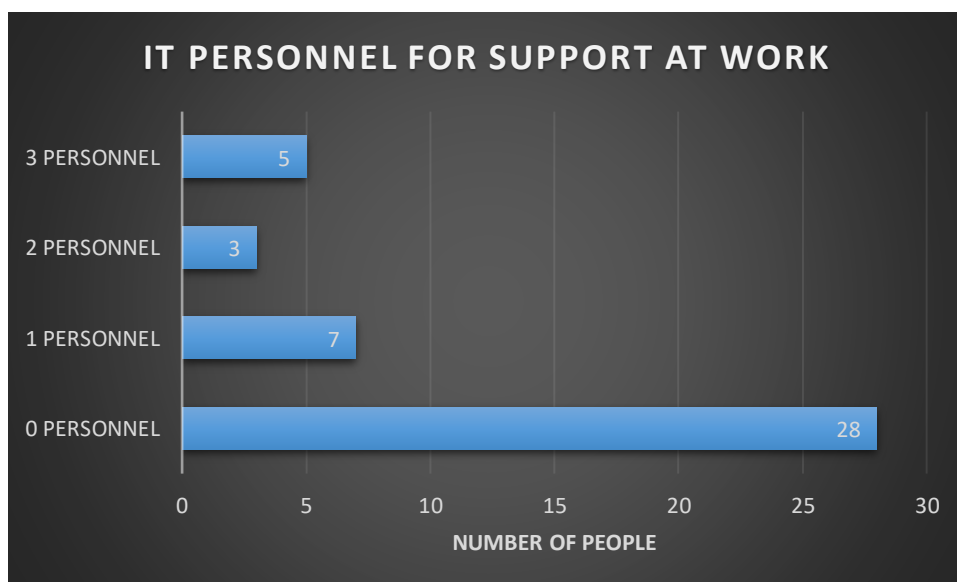


Figure 4-22: Bar-Chart showing number of IT personnel for support

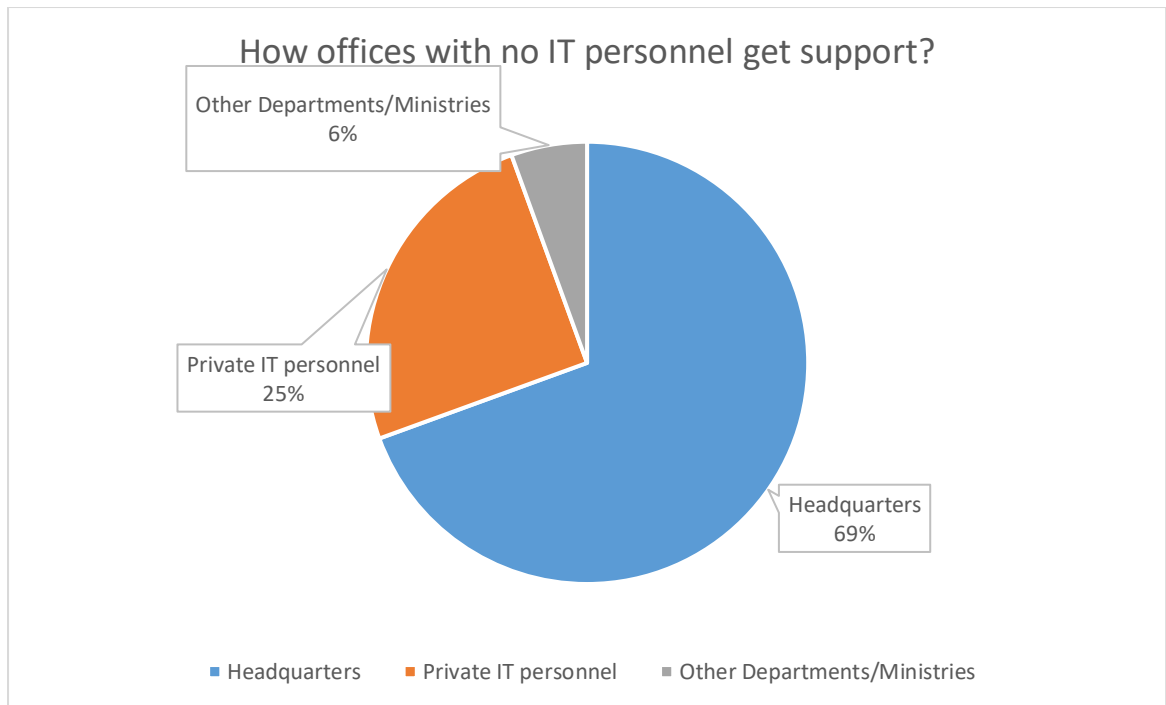


Figure 4-23: Pie-Chart show how offices get system support

From the 3 charts above (Figure 4-21, Figure 4-22 and Figure 4-23), 87% of respondents say that at their workplace they have 1 to 20 users of computers, with 62% of them without a IT personnel to support the system/users on daily basis. 69% of respondents say that they get support from IT personnel at headquarters in Maseru, through phone call. Should the government decide to adopt cloud computing, this situation should change and offices in districts (branches) be assigned permanent IT personnel to support and guide users on daily basis.

4.2 Internet Service Provider

4.2.1 *Broadband Connections and Bandwidth*

Econet Telecom Lesotho confirmed that they supply Government of Lesotho offices at Thaba-Tseka with Internet. They supply using various broadband bandwidths, namely ADSL, Optical Fibre Cable, HDSL, XDSL, LTE and Microwaves. The choice depends on demand and location of the office supplied.

“Most offices are supplied through fibre (optical fibre cable) via government data network-government WAN” the agent added. Broadband is the high bandwidth internet supply to homes and businesses using various means like telephone lines, satellites and microwaves. The fastest of these broadband is optical fibre cable, which transmits data at the speed of light. These means that, in terms of highest bandwidth that cloud computing adoption may need, Econet Telecom Lesotho as ISP is almost ready. SDSL (Symmetrical Digital Subscriber Line) is another a broadband that is typically by businesses for services such as video conferencing, which need significant bandwidth both upstream and downstream. Though not as fast as optical fibre cable, is a promising factor as cloud computing adoption means lot of upstreaming by the clients, on top of downstreaming that is definitely a necessity.

“LTE where is used provides speeds of up to 80 Mbps and average of 20Mbps. ADSL speed of up to 20Mbps and average of 8Mbps. On fibre, depending on requirement per instance, (speeds ranges) from 10Mbps to 1000Mbps” further explained the Agent.

The agent also explained that Thaba-Tseka current maximum optical fibre cable bandwidth for Internet supplied to banks, government and private businesses is 10Mbps, with range from 1Mbps to 10Mbps.

According to World Broadband Speed League (ceoworld.biz) 2018, the top 20 countries with fastest Internet speed, range from 20.86 (USA) to 60.39 (Singapore). If Thaba-Tseka was to be compared to these top 20 countries, than it is not that bad, at optical fibre maximum of 10Mbps. The encouraging fact here is that, Econet Telecom Lesotho is already able to supply at the speeds exceeding the top country in the world, Singapore, as they the agent stated that they connect at speeds ranging from 10Mbps to 1000Mbps at some places in Lesotho.

Moyo (2018) through www.itweb.co.za puts RSA on Internet speed average of 6.38Mbps, which is third in Africa below Madagascar and Kenya. This speed falls within Thaba-Tseka speed that ranges from 1Mbps to 10Mbps, and encouraging figure considering that RSA is one of the countries already adopting cloud computing. This statistic further puts Thaba-Tseka at good position to adopt cloud computing, given the fact that Econet Telecom Lesotho through various broadband connections is already averaging 20Mbps (just below USA average of 20.86Mbps), 10Mbps and 8Mbps at some places in Lesotho.

2018 BSA GLOBAL CLOUD COMPUTING SCORECARD puts Mexico, South Africa, Turkey, India and Russia among the top 25 countries on cloud computing adoption preparedness. Their bandwidths were 5.69Mbps, 6.38Mbps, 4.90Mbps, 5.29Mbps and 13.51Mbps in 2018 according to 2018 [World Broadband Speed League](#). Although 2018 BSA GLOBAL CLOUD COMPUTING SCORECARD ranking considered not only bandwidth but factors like; Ensuring privacy, Promoting security, Establishing necessary IT infrastructure, Battling cybercrime etc., it is a positive fact to find that, Thaba-Tseka bandwidth speed that of 10Mbps is among the bandwidths of countries considered to be among 25 most prepared for cloud computing.

4.2.2 Internet Supply Challenges in Thaba-Tseka

The Econet Telecom Lesotho Agent pointed out vandalism of cables by villagers and herd-boys in order to use the cables to build kraals and fences, or a mere sabotage by some as the main challenge they are facing at the moment in Thaba-Tseka. Another challenge is mountainous nature of Thaba-Tseka, which forces them to Econet Telecom Lesotho to rely on Microwaves as backhaul links between certain areas and lowlands

(Maseru), where the head offices are. The unavoidable challenge in winter is snow. During this season clients suffer from instability of service, since wireless technology is affected. In addition to that, snowfall deny them access to sites whether there is no electricity supply and they have to refuel diesel which is used as backup to solar energy.



Figure 4-24: Showing the mountains around and at where Thaba-Tseka town is located.

Figure 4-24 is a testimony to what the Agent pointed out as problems brought by mountainous of Thaba-Tseka.

These challenges mentioned above hinder the preparedness of Thaba-Tseka town for cloud computing adoption by Government of Lesotho. Once the government decides to host their data online, civil servants and other clients of the government will not tolerate the service continuity that will be affected for such long winter snow periods and unavailability due to vandalism. Cloud computing needs stable and ever-present internet connection during service hours, since data and files are hosted in servers online, not in premises.

The other challenge they face with Government offices internet supply, is the connection that is cut by employees who have tendency to turn off modems and switches in their offices, which affects other employees connected via those networking devices.

4.2.3 Future Projections and Solutions to Challenges

“We are working with LEC to build a fibre over their power lines and we are relying from them for protection” explains the Econet Telecom Lesotho Agent, when answering the question on their future projections in Thaba-Tseka. Once they manage to get protection from LEC, it means the challenges brought by vandalism will be sorted out.

Another plan is to take advantage of LHDA Phase 2 and build back up links that are not vulnerable to vandalism. Currently they rely on backup from Mokhotlong district, which North-East of Thaba-Tseka.

Econet Telecom Lesotho is currently working hand in hand with Ministry of Communications, Science and Technology to ensure that modem and switches are placed where they are protected and not any employee will have access to them.

Should they succeed in these future plans, Econet Telecom Lesotho is confident that Internet connection will be stable, reliable and available 24/7.

With these plans mentioned above, and possibly other infrastructure upgrades, Thaba-Tseka government IT infrastructure on the side of ISP will possible be ready for cloud computing adoption.

5 DISCUSSIONS

This chapter discusses the findings and analysis of this study, from the two successful data collection tools, namely interview and questionnaire. In the previous chapter, the results were analysed and briefly interpreted separately. The holistic view of the results and findings of the results presented in Chapter 5 is the core of this chapter. Chapter 5 is organised into 6 sections, with section covering a certain concept that was investigated during data collection.

5.1 Computer Literacy

The results shown on Figure 4.1.A to Figure 4.1.D lead me to believe that, in general the civil servants are computer literate, and learned computer basic skills at highest level possibly, which is tertiary level. There are few who learned acquired the skills at secondary/high school level and private computer schools, but majority are individuals that have required basic computer literacy from tertiary institute. Basically the file management and use of the internet are covered in tertiary introductory computer literacy courses. Internet topics usually covers concepts like downloading, uploading, creating and using accounts like email accounts and social media accounts, cyber threats like virus, spyware, spoofing and many others. With that level of computer literacy of majority of civil servants, the migration to cloud computing will likely not be a hectic task. Possibly short trainings or workshops on cloud environment and mandatory introduction to the cloud system that will be used will be enough. The results say that civil servants at Lesotho government have enough computer basic skills for introduction of cloud computing. The respondents are also ready to enrol for further computer literacy course should the opportunity come by, and majority of them believe that computer literacy skills are integral part of their daily duties. Very promising finding of this study. With these mentality and attitude towards computers, it is very likely that training for transition to cloud will not face resistance from the civil servants.

5.2 Computers Availability and E-Governance

The results present in Figure 4.1.E to Figure.4.1.J put me in position to believe that Government of Lesotho offices at Thaba-Tseka general have at least one computer per office, with most of them used by at most two civil servants. Most of civil servants also have access to computers in other offices. Most of these civil servants already spend most of their

time using computers at work. Though some civil servants may be spending part of that time on entertainment or non-work related activities, it is a positive finding that the usage of computers and transition to E-governance is already at advanced stage. “Electronic Governance (E-Governance) is the application of Information and Communication Technologies (ICTs) for delivering government services through integration of various stand-alone systems between Government-to-Citizens (G2C), Government-to-Business (G2B) and Government-to-Government (G2G) services.” Igi-global.com. The Government of Lesotho infrastructure is already at advanced stage, but for cloud computing adoption there should be at least one computer per civil servant in the office, as a computer is the obligatory device for anyone to access the internet service like cloud computing.

5.3 Internet and Its Reliability

Figure 4.1.K to Figure 4.1 N gives me a picture that, in terms of Internet connection, which is a necessity for cloud computing adoption, the Government of Lesotho is almost prepared. Majority of computers are already connected to the Internet and the supply is almost always available. The only concern is the speed of the Internet as large percentage of respondents consider it average. However, the speed may be affected by factors that can be sorted out. Malware infections (virus, worms etc.), downloading or viewing videos are some of factors that affect internet speed and can be sorted out through policy implementation and putting computer security measures in place. Still, the speed of internet is the area that needs improvement. In general, all these lead me to believe that ICT infrastructure in terms of Internet supply, the Government of Lesotho is almost prepared for cloud computing adoption at Thaba-Tseka.

5.4 Usage and Attitude towards Public Clouds

The results on Figure 4.1.O. and Figure 4.1.P lead me to believe that civil servants are already into cloud and believe that their documents in are safe in cloud storage. Most of them are already using free public clouds like Dropbox and Google drive (through use of email like Gmail). With this attitude and little experience they are already getting through this exposure to free cloud, one is in position to believe that the civil servants computer literate skills in cloud are already honed, and thus it will not take a long time to train and workshop them on full-time usage of cloud at work. However, they will still need intensive

training should cloud be adopted, as they will then be dealing with sensitive and confidential information, not their personal information and few documents transferred through email or DropBox.

5.5 Computer Security

The results shown on Figure 4.1.Q to Figure 4.1.S lead me to believe that computer system security is one of the areas where the Government of Lesotho (Thaba-Tseka) has a huge task to deal with, if they are to adopt cloud computing. Yes, most computers are protected with antivirus, but generally there isn't that much done to equip the staff with skills and techniques to ensure that their computer systems are secure or less vulnerable to attack. Besides already having no IT staff at these branches, there are hardly ever workshops or training on safety of computer systems. There have been few workshops but are also irregular and far apart. Most new employees are not orientated on safe use of the systems. Human security vulnerabilities can be exploited by attackers through spoofing, social engineering, phishing, password cracking and other forms of cyber-attacks. Successful attacks may lead to users unintentionally revealing their credentials, providing a leak for attackers to access critical information, stealing of information and funds. Since the government keeps critical and confidential civilians and other entities, it is likely to attract more attacks in order to compromise confidentiality, integrity and availability of information once it is in cloud. There are dozens of cyber threats in recent years, including the most trending and latest which are denial-of-service and ransomware. The civil servants must be trained enough to protect themselves and the system against such threats which compromise the system and affect services that are offered by the government.

5.6 IT System Support

Computer System usage support by IT staff is where the Government of Lesotho is not prepared for cloud adoption at Thaba-Tseka, and Figure 4.1.U to Figure 4.1.W are testimony to this. According to the results shown on these 3 figures, on average ministries at Thaba-Tseka have between 1 and 20 civil servants, with almost all of them without IT staff to support them on daily basis. They servants get support from head-quarters in Maseru or private companies or individuals. This is not ideal situation for cloud computing adoption. The ministries branches at Thaba-Tseka are not just understaffed but not staffed at all in IT departments. In the scenario where confidential and sensitive information is hosted in cloud,

and had to be frequently transferred between government computers and cloud servers, the support by qualified IT staff is mandatory.

5.7 Limitations

The study would be completed would be complete if the collection from IT departments in Maseru was successful. The data analysed in Chapter 4, Section 4.1 and Section 4.2 are from civil servants who are not specialists in IT field. The opinion from the very specialist in the field would give the study even a clearer picture of preparedness of Government of Lesotho (Thaba-Tseka) for cloud adoption. The digital questionnaire was prepared and sent through email to various ministries, but despite several reminders through phone calls, not even one department responded. I went to the ministries in person, met the IT staff bosses, and explained to them the intention of the study and how the questionnaire is to be filled. They seemed positive, gave me their blessing to conduct the research. I was given email addresses where I sent messages with questionnaire document attached. They even gave me their cell-phone numbers so that I could remind them. However, 3 weeks later, despite several reminders there was still no response. The questionnaire is on APPENDIX E. The study intended to collect almost the same data as collected from Thaba-Tseka civil servants, but from IT specialists perspective. The study also wanted to investigate more about understanding and preparedness of IT staff for cloud computing, a more technical perspective. I am not in position to give the reason for failure as being digital format of questionnaire of lack of interest, because when I explained face-to-face and phoned as reminder they never mentioned any difficulties.

6 CONCLUSION AND RECOMMENDATIONS

This chapter consists of two sections. The first section focused on conclusion or summary of the findings and answers the questions in Section 1.3 (Aims and Objectives). The second section deals with recommendations, which are proposed future studies and improvement that can be done to prepare Government of Lesotho (Thaba-Tseka) for cloud computing adoption.

6.1 Conclusion

The Internet connection bandwidth at Thaba-Tseka is at the world average of 10Mbps, as Moyo(2018) put it at that figure. That bandwidth is higher than average bandwidth of some of the African countries already adopting cloud computing. The ISP has infrastructure capable of supplying even at the average speeds of 80Mbps, which is above average speeds of leading countries with internet speeds in the world. Then one can conclude that, the bandwidth is high enough for adoption of cloud computing.

Based on challenges faced by ISP and opinions of the respondents, the Internet connection at Thaba-Tseka is not stable enough for adoption of cloud computing, where e-governance will be 100% online.

In terms of IT personnel skillset at Thaba-Tseka, the Government of Lesotho is lacking and far behind if cloud computing is to be adopted. There is virtually no such personnel at Thaba-Tseka. However the computer literacy level and exposure to the internet and free public cloud, the civil servants at Thaba-Tseka are almost 100% ready, though there are few who need to enrol for computer literacy courses to acquire necessary skills. These civil servants again showed that they have confidence in and trust cloud computing to handle their data.

The other major concern is the security of computer systems. This is another field where the government of Lesotho needs and improvement and are not prepared for security challenges in cloud environment.

In general, Government of Lesotho at Thaba-Tseka can be rated as maybe over 50% ready for cloud computing, in terms of factors investigated, with need for improvement on few of those factors considered for study.

6.2 Recommendations

Failure to acquire data from Government of Lesotho IT departments is one of the drawbacks of this study. I therefore recommend that interested researchers in cloud computing, investigate the preparedness of the government IT departments for cloud computing.

The BSSA Policy Blueprint (2018) rate cloud preparedness of countries on 7 areas including, (1) Ensuring privacy, (2) Promoting security, (3) Ensuring data portability and the harmonization of international rules and (4) Battling cybercrime. I suggest that further studies are carried out on preparedness of government of Lesotho on these 4 areas given above.

I urge researcher to carry out more studies on creation and implementation of policies that will govern the cloud computing in government and private sectors in Lesotho, in order to provide a conducive environment for the this new computing paradigm in Lesotho.

Any field is run smoothly if there are specialists who guides other noble users of services and products of such field. The government should first ensure that all departments in all branches have IT staff residing there permanently, to provide computer system support. Then more staff should be enrolled for cloud computing courses, to equip them with necessary advanced skills in this new field. The civil servants too should attend short course and workshops on cloud computing, in order to familiarise them with the concepts of this new field.

If cloud computing is to be adopted as new IT solution in the Government of Lesotho, then even tertiary institutions in Lesotho should review their curriculums, in order to incorporate cloud computing courses, in order to produce enough specialists in that field for the smooth migration and implementation of this paradigm.

The Government of Lesotho should work hand in hand with the ISP, Econet Telecom Lesotho, and other organisations like LHDA, as Econet Telecom Lesotho agent suggested, to implement the measures to protect networking infrastructure from vandalism, as this will ensure that Internet connection is stable and reliable at Thaba-Tseka.

Computers are integral components in cloud computing. To access Internet, one needs a computer, and cloud services are accessed through the Internet. Should Government of Lesotho decide to adopt cloud solutions at Thaba-Tseka, then each and every servant should have their computers, which they don't share with other servants. Therefore the government should work towards ensuring that, there are enough computers for all civil servants working in offices.

As explained in Section 2.6 in Chapter 2, cloud computing is offered in 4 deployment models, namely private cloud, community cloud, public cloud and hybrid cloud. I would recommend a hybrid cloud, consisting of private and public cloud. Private cloud be deployed for sensitive, mission-critical and classified information, and be hosted inside government premises. Public cloud be deployed for information that is accessible to all civilians.

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APPENDIX A

Research Project Title: Viability of Cloud Computing Adoption by Government of Lesotho at Thaba-Tseka Town

Consent to take part in research

- ☐ I..... voluntarily agree to participate in this research study.
- ☐ I understand that even if I agree to participate now, I can withdraw at any time or refuse to answer any question without any consequences of any kind.
- ☐ I understand that I can withdraw permission to use data from my interview within two weeks after the interview, in which case the material will be deleted.
- ☐ I have had the purpose and nature of the study explained to me in writing and I have had the opportunity to ask questions about the study.
- ☐ I understand that participation involves sharing and giving information and statistics on internet usage in Lesotho through our company, including Big Data and Cloud Computing.
- ☐ I understand that I will not benefit directly from participating in this research.
- ☐ I agree to my interview being audio-recorded.
- ☐ I understand that all information I provide for this study will be treated confidentially.
- ☐ I understand that in any report on the results of this research my identity will remain anonymous.
- ☐ I understand that disguised extracts from my interview may be quoted in dissertation.
- ☐ I understand that if I inform the researcher that myself or someone else is at risk of harm they may have to report this to the relevant authorities - they will discuss this with me first but may be required to report with or without my permission.

- ☐ I understand that signed consent forms will be retained in Mr Makhoabenyane's Dropbox until Botho University confirms the results of their dissertation].
- ☐ I understand that a transcript of my interview in which all identifying information has been removed will be retained for 2 years from the date dissertation is confirmed.
- ☐ I understand that under freedom of information legalisation I am entitled to access the information I have provided at any time while it is in storage as specified above.
- ☐ I understand that I am free to contact any of the people involved in the research to seek further clarification and information.

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Signature of research participant

Signature of participant

Date

Signature of researcher

I believe the participant is giving informed consent to participate in this study

Signature of researcher

Date

APPENDIX B

NAME (Student Researcher) : Kopano Makhoabenyane
UNIVERSITY : Botho University
PROGRAMME : MSC Computer Information Systems

INTRODUCTION

The main objective of this questionnaire is to gather information about computer literacy of employees, information and communication technology [ICT] infrastructure, internet supply and the usage of computers and ICT tools at Government of Lesotho offices in Thaba-Tseka. The information gathered is intended to be used for Masters of Science Dissertation. The information may also be useful to Information Technology Department of Government of Lesotho and researchers in Cloud Computing in the future.

All the questions are NOT compulsory. You can answer as much as you can, although your effort to answer all of them will be appreciated. You can skip any question that you don't feel comfortable answering, or feel that it is invading your privacy.

QUESTIONS

Guide: Place a tick (✓) or a cross (×) the box or circle beside the option you choose in each question.

SECTION A

QUESTION 1

Have you ever studied any computer literacy course?

Yes ☐

No ☐

*Skip **QUESTION2**, if your answer to **QUESTION 1** is No.*

QUESTION 2

At which level did you study the computer literacy course?

[A] High School /Secondary school. ☐

[B] College / University Computer literacy/skills course ☐

[C] Private computer schools ☐

[D] Tertiary Information Technology/Computer Science course ☐

QUESTION 3

Will you accept opportunity to enrol for any short/part-time computer literacy course in the future, in order to improve your computer literacy?

Yes ☐ Maybe ☐ Not sure ☐ No ☐

QUESTION 4

Do you consider computer literacy skills basic necessity for your position?

Yes ☐ No ☐ Maybe in the Future ☐

SECTION B**QUESTION 1**

How many working computers (laptop, desktop, tablet) do you have in your office?

0 ☐ 1 ☐ 3 ☐ 4 or more ☐

If your answer to QUESTION 1 is 0, skip QUESTION 2 – QUESTION 4 AND jump to Question 5

.

QUESTION 2

What is the number people (employees) per each computer?

1 ☐2 ☐3 ☐4 ☐more than 4 ☐**QUESTION 3**

How much of your daily work is done using a computer?

[A] All of it ☐

[B] Small part of it ☐

[C] Large part of it ☐

[D] Not at all ☐

QUESTION 4

How many (rough estimation) of your daily 8.00am to 4.30pm hours are spent using computer?

[A] 1- 3 hours ☐

[B] 4-6 hours ☐

[C] All of them ☐

QUESTION 5

How many computers are at your work place (meaning, beside your office)?

0 ☐1 ☐2 ☐3 or more ☐

If your answer to QUESTION 5 is 0, skip QUESTION 6.

QUESTION 6

Do you ever have access to any of these computers when you need to use them?

[A] Yes ☐

[B] At some times ☐

[C] No ☐

SECTION C**QUESTION 1**

Do you have internet access (wifi/cable) at your work place?

Yes ☐

No ☐

*If your answer to **QUESTION 1** is No, Skip **QUESTION 2 - QUESTION 4** and jump to **QUESTION 5**.*

QUESTION 2

Are all computers connected to the internet?

[A] Yes ☐

[B] Most of them ☐

[C] Few of them ☐

[D] None ☐

QUESTION 3

How reliable is the internet connection at your work?

[A] Always available ☐

[B] Available most of the time ☐

[C] Hardly ever available ☐

[D] Almost never available ☐

QUESTION 4

Rate the speed of the internet at work out of 5.

[5] Very Fast ☐ [4] Fast ☐ [3] Average ☐ [2] Slow ☐ [1] Very slow ☐

QUESTION 5

Do you ever store, send or receive any of work files (documents) using either email, Dropbox or any means through internet?

Yes ☐

No ☐

QUESTION 6

Do you feel the files (documents) are safe when stored/send/received through email, Dropbox or any mean through the internet?

Yes

No

SECTION D (Internet and Computer Security)

NB: Answer questions in this section if there are computers at your work place.

QUESTION 1

To your knowledge, are computers at work protected with antivirus?

Yes ☐

Some of them ☐

No ☐

QUESTION 2

Have you ever had training/workshops about protecting computers with passwords, antivirus or other means?

Yes ☐

No ☐

*If the answer to **QUESTION 2** is No, Skip **QUESTION 3**.*

QUESTION 3

How often do you have training/workshops about protecting computers with passwords, antivirus or other means?

[A] Once a year ☐

[B] Few times a Year ☐

[C] Once in a while

QUESTION 4

Do the Information Technology (IT) Department at your ministry give new employee orientation about safe use of the computers?

[A] Yes ☐

[B] At times ☐

[C] No ☐

[D] I do not know ☐

SECTION E**QUESTION 1**

How many (even estimation) employees at your workplace use computers?

[_____]

QUESTION 2

How many IT personnel are available at your work to support you with usage of computers and the internet?

0 ☐

1 ☐

2 ☐

3 ☐

other number, mention it [____]

QUESTION 3

If the answer is 0 in **QUESTION 2**, how do you get IT system support on computers and internet on daily basis?

[A] IT personnel from headquarters, through phone call

☐

[B] Private (non-government employees) IT personnel

☐

[C] IT personnel from other government ministries/departments

☐

*****END*****



Thank you for your
participation.

APPENDIX C

NAME (Student Researcher) : Kopano Makhoabenyane
 UNIVERSITY : Botho University
 PROGRAMME : MSC Computer Information Systems

INTRODUCTION

The main objective of this interview is to gather information about the state of the infrastructure your company uses to supply internet to you use at Government of Lesotho offices in Thaba-Tseka. I also intend to find about the means of internet you provide to the clients. In addition to that, I want to find more about future projection on internet supply to clients. The information gathered is intended to be used for Masters of Science Dissertation. The information may also be useful to Information Technology Department of Government of Lesotho and researchers in Cloud Computing in the future.

All the questions are NOT compulsory. You can answer as much as you can, although your effort to answer all of them will be appreciated. You can skip any question that you don't feel comfortable answering, or feel that it is invading your privacy.

Company (ISP) Name : _____
 Position : _____

QUESTIONS

1. Do you supply internet to government offices at Thaba-Tseka?
2. Which broadband do you connect the government offices at Thaba-Tseka?
3. Can you give me the bandwidth you use to supply government offices at Thaba-Tseka?
4. Are there any government offices (Thaba-Tseka) or private companies/institutions/organisations that you connected them using optical fibre cable? Bandwidth (maximum, minimum or average)?

5. Are there any common complains about your internet connections at Thaba-Tseka?
6. Please give me the types /names / models of cables you use to supply (i) optical fibre cable and (ii) broadband (ADSL, VDSL etc).
7. What are the current challenges internet connection challenges you are currently facing at Thaba-Tseka? Elaborate more
8. Briefly explain your future plans to improve your internet connection infrastructure at Thaba-Tseka, if there are any.
9. Is your internet at Thaba-Tseka currently available 24/7?
10. Do you currently have customers who store their files, documents or information in remote places and rely on your network to access them?

APPENDIX D

[05/04 06:30] Econet Telecom Lesotho Agent: Abuti just remember that I owed you, I had to travel on Monday on emergency

[05/04 06:30] Econet Telecom Lesotho Agent: I am coming back today

[05/04 06:31] Econet Telecom Lesotho Agent: Unfortunately I left my machine home and don't have the questions

[05/04 06:31] Econet Telecom Lesotho Agent: Unless if you can call later and I give you answers verbally

[05/04 06:32] kopanom2: Nka e send hape. Li short ke tla copy ke li romele

[05/04 06:33] Econet Telecom Lesotho Agent: My mailbox is full and no longer receiving mails I need to fix it when I arrive

[05/04 06:33] Econet Telecom Lesotho Agent: Use what's up

[05/04 06:36] kopanom2: Ok

[05/04 07:01] Econet Telecom Lesotho Agent: 1. Yes.

2. We use a combinations of broadband technologies: ADSL, LTE and fiber and microwave. The choice of technology is influenced most by location of office and our coverage of fiber. Other solutions are used as alternative where we don't have fiber and occasionally as a backup by ministry to their fiber connection on the Lesotho Government Data Network. Most office are supplied thru fiber via the government data network -government WAN. Econet worked with Gov to construct this network which now serves most of Gov offices.

[05/04 07:01] Econet Telecom Lesotho Agent: 3. LTE where it's used provides speeds of up to 80Mbps and average 20Mbps. Adsl speeds of up 20Mbps and average 8Mbps. On fiber depending on requirement per Instance from 10Mbps to 1000Mbps

[05/04 07:01] Econet Telecom Lesotho Agent: In ThabaTseka max on fiber 10Mbps so far

[05/04 07:01] Econet Telecom Lesotho Agent: 4. Yes we supply all banks for instance.

[05/04 07:01] Econet Telecom Lesotho Agent: 4. B/w Ranges from 1Mbps to 10Mbps

[05/04 07:05] Econet Telecom Lesotho Agent: On 2. I left xdsl/hdsl

[05/04 07:18] Econet Telecom Lesotho Agent: 5. Because of the mountains Thaba Tseka backhaul links have areas that rely on microwave btwn the low lands Maseru where head offices are for most business. Most customers suffer from instability during snow season, which affects wireless technology and affect access to sites that rely on solar for electricity and in cases where our engineers are unable to reach the sites to attend sites fault or refuel generators deseil where it's used as alternative. The biggest challenges remains vandalism of econet cables

by herd boys and villagers who cut cables poles to build kraals, fences or simply sabotage. These are main pains for us resulting in customers services being affected

[05/04 07:18] Econet Telecom Lesotho Agent: We are working with LeC to build fiber over their power lines and we are rent from them for protection. Unfortunately their coverage is also limited in some areas including Thaba Tseka

[05/04 07:18] Econet Telecom Lesotho Agent: This is in their plans which, the other plan is to take advantage of LHDA phase two project to build backup links that are not vulnerable to vandalism

[05/04 07:18] Econet Telecom Lesotho Agent: At the moment we rely on our backup links coming from Mokhotlong

[05/04 07:18] Econet Telecom Lesotho Agent: Unless the below has affected the service our service is available 24hrs. Most cases customers who are less educated also contribute in causing downtime's by switching off modems and switches service their network. We work with ministry

APPENDIX E

NAME (Student Researcher) : Kopano Makhoabenyane
 UNIVERSITY : Botho University
 PROGRAMME : MSC Computer Information Systems

INTRODUCTION

The main objective of this questionnaire is to gather information about computer literacy of employees, information and communication technology [ICT] infrastructure, internet supply and the usage of computers and ICT tools at Government of Lesotho offices in Thaba-Tseka. The information gathered is intended to be used for Masters of Science Dissertation. The information may also be useful to Information Technology Department of Government of Lesotho and researchers in Cloud Computing in the future.

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INSTRUCTIONS: Fill in the questionnaire by; 1) clicking the Option box (circle) beside the most suitable answer, or 2) clicking Dropdown menu and select most suitable option, or 3) Type on space provided if it a question where you have to type.

WORK AND EDUCATION

Ministry :Click here to type Ministry.

Department/Section : Click here to type department/section.

Position :Click here to type position.

Highest Qualification : Choose an Qualification.

The questions in ALL sections are based on situation at Thaba-Tseka.

SECTION A

QUESTION 1

Are computers shared or each employee uses his/her computer?

☐ Shared ☐ Some Shared ☐ Not Shared

*If your answer to **QUESTION 1** is “Not Shared” skip **QUESTION 2**.*

QUESTION 2

Please give average number of employees / users per computer.

[Click here type number.]

QUESTION 3

Are you based at Thaba-Tseka or Maseru?

☐ Thaba-Tseka ☐ Maseru

*If your answer to **QUESTION 3** is “Thaba-Tseka”, skip **QUESTION 4**.*

QUESTION 4

How do you support employees at Thaba-Tseka? [Choose an item.]

QUESTION 5

How many (even rough estimation) employees do you support at Thaba-Tseka?

[Enter number here.]

QUESTION 6

Do you ever hold trainings or workshops or refresher courses for employees on computer literacy?

☐ YES ☐ NO

*If your answer to **QUESTION 6** is "NO", skip **QUESTION 7**.*

QUESTION 7

How frequently to hold trainings or workshops or refresher courses?

☐ Once a year ☐ Several times a year ☐ Once in few years

SECTION B**QUESTION 1**

How often do you get complains about slow internet? [Click Dropdown to Select.]

QUESTION 2

How often do you get complains about unavailable internet? [Click Dropdown to Select.]

QUESTION 3

How frequently do you have to support employees with malware attack?

[Click Dropdown to select.]

QUESTION 4

Rate the overall understanding or comfortability of employees using the internet.

- ☐ Very Poor
- ☐ Poor
- ☐ Average
- ☐ Good
- ☐ Very Good

QUESTION 5

Rate the overall understanding and application of internet security measures by employees.

- ☐ Very Poor
 - ☐ Poor
 - ☐ Average
 - ☐ Good
 - ☐ Very Good
-

SECTION C

QUESTION 1

Do you have dedicated email system at your ministry/government?

- ☐ YES ☐ NO

*If your answer to **QUESTION 1** is “NO”, skip **QUESTION 2**.*

QUESTION 2

Do the employees use this dedicated email to store, send and receive their documents?

- ☐ Most of them ☐ Few of them ☐ None of them

QUESTION 3

Do the employees use email (Google, Yahoo, etc) to store, send and receive their documents?

- ☐ Most of them ☐ Few of them ☐ None of them

QUESTION 3

Are there any employees who ever used any of the following: Google Drive, Microsoft OneDrive, Dropbox etc to store or transfer their documents?

- ☐ Several of them ☐ Few of them ☐ NO

QUESTION 4

Do the Government rules/regulations/policies allow employees to store documents in computers outside the work premises?

- ☐ YES ☐ NO ☐ Not Sure

SECTION D

QUESTION 1

Do you ever use email, Google Drive, Microsoft OneDrive or Dropbox to store your personal or work documents?

- ☐ YES ☐ NO

QUESTION 2

Rate the safety of document when stored in any or Google Drive, Microsoft OneDrive or Dropbox. [Click Dropdown to select Rating.]

QUESTION 3

Have you ever read about or studied or familiar with “Cloud Computing” or its concepts?

- ☐ YES ☐ NO

*If the answer to **QUESTION 3** is “NO” skip all the remaining questions in this SECTION.*

QUESTION 4

Do you believe Cloud Computing can be a cheaper solution for the government?

- ☐ YES ☐ NO ☐ Not sure

QUESTION 5

Do you believe Cloud Computing can bring more advantages than disadvantages for the government?

 YES

NO

☐ Not sure

QUESTION 6

Would you encourage the government to adopt Cloud Computing solutions?

- Maybe in the future

NO

QUESTION 7

How possible is it to save and access government files in “Cloud” based on current internet bandwidth and reliability? [Click Dropdown to select.]

^^^^^^^^^^^^^^^^^^^^END^^^^^^^^^^^^^^^^^^^^

Thank you for your participation.

