NCOMPUTING TECHNOLOGY AND MANAGEMENT OF COMPUTING RESOURCES: A CASE STUDY OF NYAMATA DISTRICT HOSPITAL, RWANDA

UWINGENEYE CONSOLEE

MIS/0002/11

A Research Project Submitted in Partial Fulfillment for the Award of the Degree of Master of Science in Information Science (Information and Communication Technology Option) of Mount Kenya University

FEBRUARY 2017

DECLARATION

This research project is my original work and has not been presented for a degree in any other University or for any other award

Student Name: Uwingeneye Consolee

Registration No: MIS/0002/11

Signature _____ Date _____

I confirm that the work reported in this research project was carried out by the candidate under my supervision.

Prof. Raymond Wafula Ongus, PhD

Signature _____ Date _____

DEDICATION

I dedicate this work to the Almighty God, my late father Patrice Ngarukiye, my mother Annonciate Mukabutera, my husband Jean Claude Ubonabenshi, my son Fraterne Ishimwe Ubonabenshi, my brothers and sisters, my friends and relatives.

ACKNOWLEDGEMENT

ABSTRACT

This study investigated the effect of Ncomputing technology on management of computing resources in Rwanda, by considering Nyamata District Hospital as a case study. Its findings would be significant to policy makers and other stakeholders who are involved in making vital decisions as far as computer resources are concerned. The study intended to investigate the usage of Ncomputing technology at Nyamata District Hospital, Rwanda , to determine how computing resources are managed at Nyamata District Hospital, Rwanda, and to determine how Ncomputing technology affects the management of computing resources at Nyamata District Hospital, Rwanda.The population of sixty five (65) employees were targeted as employees who have access on Ncomputing technology shared computers.The sample size was sixty five (65) employees of Nyamata District Hospital. The sampling technique in this study was census, due to the small population size considered. Questionnaires were administered to the staff of Nyamata District Hospital, while interviews were conducted with IT services in charge and Hospital Director. Data quality control was ensured by piloting instruments at CHUK and Rwamagana District Hospital .The study reviewed various documents to get secondary data about the topic. As far as methodology was concerned, the study used a case study design in which qualitative and quantitative approaches were used. Data was analysed using Statistical Package for Social Sciences (SPSS) version 20, where the findings were described using frequencies, percentages, weighted means, standard deviations and Pearson correlation. The Pearson correlation found that the correlation coefficients, R between independent variable (server virtualization) and dependent variables (device sharing, data back-up, centralized computing and security features) were 0.951, 0.914, 0.922 and 0.926 respectively. This indicated a strong positive correlations between independent variable (server virtualization) and dependent variables (device sharing, data back-up, centralized computing and security features). The correlation coefficients, R between independent variable (desktop virtualization) and dependent variables (device sharing, data back-up, centralized computing and security features) were 0.904, 0.817, 0.720 and 0.933 respectively. This indicated a strong positive correlations between the independent variable (desktop virtualization) and dependent variables (device sharing, data back-up, centralized computing and security features). The two interview guides were analysed qualitatively using content analysis where Ncomputing technology was said to provide cost saving benefits through the single license used. Ncomputing technology reduced costs of maintenance, data management and staff management though three challenges such as power failure, internet connectivity problem and staff attitude to ICT use were encountered. The study recommended Nyamata District Hospital to provide training to all staff about Ncomputing technology usage in order to use technology frequently and effectively. The study also recommended increasing the internet bandwidth such that network performance would be improved. In addition, an automatic power generator was also recommended.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS AND ABBREVIATIONS

ADEPR	*Association Des Eglises Pentecôte au Rwanda*
CHUK	*Centre Hospitalier Universtaire de Kigali*
CPU	Central Processing Unit
CVI	Content Validity Index
DVD	Digital Versatile Disk
EMI	Emergency Medical Initiative
FTP	File Transfer Protocol
FY	Financial Year
HDD	Hard Disk Drive
IBM	International Business Machines
ICT	Information and Communication Technology
IDC	International Data Corporation
IT	Information Technology
LAN	Local Area Network
MKU	Mount Kenya University
MLE	Maximum Likelihood Estimate
PC	Personal Computer
PMU	Pentecostal Mission Unlimited
PVT	Process Virtualization Theory
RAM	Random Access Memory
SPSS	Statistical Package for Social Sciences
TAM	Technology Acceptance Model
UMVUE	Uniformly Minimum Variance Unbiased Estimate
UPS	Uninterruptable Power Supply
USA	United States of America
USB	Universal Serial Bus
UTAUT	Unified Theory of Acceptance and Use of Technology

UTMA	Ultra-Thin Multi-Access
VDI	Virtualization Desktop Infrastructure
WWW	World Wide Web

OPERATIONAL DEFINITIONS OF KEY TERMS

Computing

It is the process of utilizing computer technology to complete tasks at Nyamata District Hospital.

Computing Resource

It is any physical or virtual component of limited availability within a computer system. Every device connected to a computer system is a resource at Nyamata District Hospital.

Desktop Virtualization

It is a software technology that separates the desktop environment and associated application software from the physical client device that is used to access it at Nyamata District Hospital.

Layering

This is a method of desktop virtualization that divides a disk image into logical parts to be managed individually. For example, if all members of a user group use the same operating system (OS), then the core operating system (OS) only needs to be backed up once for the entire environment who share this layer at Nyamata District Hospital.

Management

This is the function that coordinates the efforts of people to accomplish goals and objectives using available resources efficiently and effectively at Nyamata District Hospital.

N

It is a mathematical term which stands for indefinite number of additional users sharing a single computer.

Ncomputing Technology

It is a technology that enables a desktop personal computer or server to be shared by more than one hundred users with each user getting a full computing experience.

The solutions include both virtualization software (vSpace) which helps to create virtual sessions inside a personal computer (PC) or server, and thin client devices that connect the users monitor, keyboard and mouse to shared computer at Nyamata District Hospital.

Operating System

It is software that manages computer hardware and software resources and provides common services for computer programs at Nyamata District Hospital.

Terminal Services

It is capable of hosting compatible multi-user client desktops running on a variety of Windows-based and non-Windows-based computers directly at Nyamata District Hospital.

Thin Client

It is a computer or a computer program that depends heavily on another computer to fulfill its computational roles. Thin clients occur as components of a broader computer infrastructure, where many clients share their computations with the same server at Nyamata District Hospital.

User Virtualization

It refers to the independent management of all aspects of the user on the desktop environment at Nyamata District Hospital.

Virtualization Desktop

It is a technology that separates local desktop and remote computing (storage resources), which was initially derived from the remote desktop administration but with new business models and very different use cases at Nyamata District Hospital.

VSpace

This is virtualization software helps to create virtual sessions inside a personal computer (PC) or server at Nyamata District Hospital.

CHAPTER ONE: INTRODUCTION

1.0 Introduction

The study sought to investigate how Ncomputing technology affects the management of computing resources at Nyamata District Hospital, Rwanda. This chapter explains the background of the study, statement of the problem, objectives of the study, research questions, significance of the study, limitation of the study, scope of the study and organization of the study.

1.1 Background of the Study

The use of computers in hospitals, education institutions and business enterprises is a common occurrence globally. Zero Desktop (2015) Grupo EMI is one of the leading Latin American multinationals in the field of emergency medicine, and a dedicated user of NComputing technology companywide in Uruguay. The company provides assistance in emergency medical situations and helps people recover from accidents or illness, with the success of the deployment, Grupo EMI plan 2010 to increase the number of NComputing workstations from 140 to 200 in 2013. They also plan to implement the same technology in the other countries where Grupo (group) EMI operates (ZeroDesktop, 2015).

In Macedonia, NComputing's technology allows seven students to share one PC hard drive simultaneously. Each user station consists of a monitor, mouse, keyboard, and speakers that are connected to the hard-drive (Hosman, 2010).

Turkey's most widespread Non-Governmental Organization operating in the field of Education, assessed traditional thin clients and after investigation some virtualization technologies chosen NComputing's technology as revolutionizing the desktop virtualization platform. As a result, the increased utilization of Information and Communications Technology (ICT) in the activity centers and extracurricular learning centers was improving the quality of learning for all citizens in Turkey (Parlakkilic, 2015).

Couzens & Kurteva (2014), NComputing provider has worked with African educators and governments for many years. Among its African customers are South Africa's Western, Nkumba University in Uganda, Kenya's Institute of Advanced Technology, Cape Education

Department and the Ministry of Education in Ghana where these schools use Ncomputing Technology.

One of the key factors for the faster adoption of NComputing's technology in the region is the simplicity and affordability of its thin client devices and its vSpace platform (Couzens & Kurteva,2014).

Healthcare facilities have taken advantage of the computing power bestowed upon computers to try to improve the services they provide to their clients (Shortliffe & Blois, 2006). Continuous innovations have continued to refine the efficiency and effectiveness of healthcare services through the application of several computer applications. Among these include the power brought about by technologies such as Internet, computer networks, and several applications pooled in information system capabilities. These applications have helped in improving decision making processes through increased accessibility and availability of information according to Winkelman and Leonard (2004).

However, scholars observe that though computer utilization especially through Information system application has several benefits, there are equally great challenges it comes with and therefore planning stands right at the heart of any adoption endeavors else failure will be the frustrating outcome (Berg & Van, 2003).

The need to minimize the high cost barriers commonly associated with computing technologies has led to creative and innovative thinking in utilization of computing resources in many institutions. Common innovations include the use of Electronic health systems, adoption of applications that use open source technologies and most recently is the use of Ncomputing which is attracting great attention from business and government organizations for its ability to run many basic applications and at less than 10% of the computers capacity according to (Murray, 2007).

Ncomputing technology is a technology that enables a desktop Personal Computer to be shared by as many as one hundred users, with each user getting a full computing experience.

Ncomputing uses both virtualization software (v Space) which enables the creation of virtual sessions inside a PC or server, and thin client devices that connect the users monitor, keyboard and mouse to shared computer (Zedwiz, 2011).

Ncomputing basically utilizes desktop virtualization technology with the ability to support up to one hundred users on a single operating system, thereby reducing the number of physical host servers and radically improving configuration and management of computing environments (Pal, *et al.*, 2009). Security, locking down user configuration settings and protecting all corporate data in one centralized location, Data protection is an acclaimed benefit of Ncomputing technology.

NComputing technology allows one computer to be simultaneously shared by multiple students. The monitor, keyboard and mouse of each student are connected to a shared computer by means of a relatively inexpensive desktop access device (which has no central processing unit, memory or moving parts). In many schools in Andhra Pradesh (Netherlands), there is a computer lab with two personal computers that function as hosts running on Windows. Every other machine is plugged into the small device which connects to one of the host PCs and has access to all the functions that the host provides. Another significant advantage of NComputing devices is that they save very large amounts of electricity (Jeffrey, 2010).

Nyamata District Hospital was built in 2002 as a district hospital by the Pentecostal Church (ADEPR) in collaboration with Pentecostal Mission Unlimited (PMU) Inter Life and the Government of Rwanda. It is located in South East of Rwanda, Bugesera Disrtict in Nyamata Sector on 32 acre piece of land along the main road to Kigali from Bujumbura, via Kirundo. It provides health care services to the population of Bugesera District and other surrounding districts. The administrative structure of the Hospital is illustrated in the appendix One as Nyamata District Hospital organization structure (Nyamata District Hospital, 2014).

Nyamata District Hospital organization Structure is divided into top level management, middle unit management and the lower level management. The top level management comprises of Administrative council who oversees the entire administrative duties of the hospital, Management committee whose responsibility is to enforce administrative council's directives and the directorate who coordinates five hospital units of Information Technology (IT), Human Resources, Accounts, and Medical personnel who comprise the middle unit

(level 2) of management. The middle unit management is grouped into units called departments charged with the operational tasks in the hospital. These are categorized into In-patient units and onsite services (See Appendix VII).

In-patient units of the hospital include surgery, post-surgery care, maternity, obstetrics and gynecology, pediatrics, emergency care, internal medicine, and mental health. On-site services include pharmacy, out-patient consulting, physical services, imaging, laboratories, dentistry and optometrist, administration and support staff. The employee population at Nyamata District hospital is one hundred and seventy one.

1.1.1 ICT usage at Nyamata District Hospital

Nyamata District Hospital uses standalone desktop computers placed before vital personnel prior to the adoption of Ncomputing technology (Nyamata District Hospital, 2009). This caused a one-to-many Desktop-to-personnel situation because of the few available desktop computers. The hospital lacked a centralized and non-customized windows desktop environment where users are able to access computer resources without much movement.

Before the adoption of Ncomputing in 2011, Nyamata District Hospital utilized standalone computing Systems which included central processing units (CPUs), monitors, external hard disks, flash disks, uninterruptable power supplies (UPSs), digital versatile disks (DVDs), laptops and softwares such as operating systems Windows XP and Windows 7 Application software and Utility Softwares, storage media, network applications providing electronic mail, world wide web (WWW) browsing, and file transfer protocol (FTP) are the property of this hospital. These systems were used to serve the daily internal and external clientele of the hospital. Currently, Nyamata District Hospital is equipped with a wired and wireless local area Network with two racks, two switches and one router where every employee plugs to access Internet and other web based databases applications through a browser (see Appendix IX). It has two online databases such as Open Clinic (version 4.89.38) which is used in billing and recording patient data, Open Medical Record System that is used to make a follow up of patient for special treatment and one local database called sage used in finance service (Nyamata District Hospital,2014).

It has two Servers with Ncomputing software installed and eighty monitors with eighty accessible terminals where any required user can access data directly from the Server using Ncomputing technology devices, seventeen (17) laptops and five (5) network printers. The employees share any kind of information using the intranet and extranet (Nyamata District Hospital, 2014).

1.2 Problem Statement

Nowadays, many studies were conducted on the impact of Ncomputing technology. For example Pham (2010) conducted a research on improving energy and power efficiency using Ncomputing technology and approaches for predicting reliability of complex computing systems; He found that Ncomputing technology reduced power consumption and increase energy efficiency. In south Atlantic, Sugranes (2012) assessed telemedicine System in the South Atlantic including Ncomputing technology system, his study showed that Ncomputing technology enabled multiple users to simultaneously share a single operating system instance. In Tanzania, Renatus (2014) assessed the cost implication analysis of Ncomputing technology in education sector and in the same country, Renatus (2015) also assessed acceptance of desktop visualization technology where a case study was Ncomputing technology in Tanzania.

Nyamata District Hospital introduced Ncomputing technology as a technology to improve the management of computing resources. Subsequently, there were many positive witnesses at the hospital. Despite these interventions, complaint about data management still persisted. No research had been done previously to assess the effect of Ncomputing technology on management of computing resources.

Therefore the study sought to find out the effect of Ncomputing technology on management of computing resources in Rwanda, by considering Nyamata District Hospital as a case study.

1.3 Objectives of the Study

The study contains general objective and specific objectives

1.3.1. General Objective

The general objective of this study was to analyze the usage of Ncomputing technology in the management of computing resources at Nyamata District Hospital, Rwanda.

1.3.2. Specific Objectives

The following specific objectives were identified for the study:

i) To investigate the usage of Ncomputing technology at Nyamata District Hospital, Rwanda.

ii) To assess how computing resources were managed at Nyamata District Hospital, Rwanda.

iii) To determine how Ncomputing technology affects the management of computing resources at Nyamata District Hospital, Rwanda.

1.4 Research Questions

The study was guided by the following research questions:

i) To what level is Ncomputing technology used at Nyamata District Hospital, Rwanda?

i) To what extent are computing resources managed at Nyamata District Hospital, Rwanda?

ii) How does Ncomputing technology affect the management of computing resources at Nyamata District Hospital, Rwanda?

1.5 Significance of the Study

Findings of this study would be significant to the policy makers and other stakeholders who are involved in making vital decisions as far as computer resources are concerned. For instance the Ministry of Health and concerned Non-Governmental Organizations (NGO) would find the recommendations and the findings helpful in deciding how to improve quality of service through better and low cost computing alternative.

The findings also would be useful to Rwanda Revenue Authority (RRA), to Rwanda Social Security Board and help them to recommend all hospitals to access the technology which would help them to enhance control on revenues and health insurance daily situation.

In addition, Ncomputing is a technology that cuts across all disciplines. Therefore, not only would the findings of this study apply to health sector but also can be borrowed to influence computer resource management in other institutions such as Universities, Secondary schools, among others. This study would end by identifying key research areas that would require further intervention. Such information would be useful for researchers who have interest in Ncomputing technology.

1.6 Limitations of the Study

The most obvious limitation of the study was the availability of Nyamata District Hospital staff to be interviewed for this study due to their busy schedules and their service status. In order to address this challenge, the researcher booked appointments with the sampled staff and administered the questionnaire.

The study was also limited by knowledge of respondents especially Ncomputing technology terms. The researcher was able to explain the technical terms to ease them to provide their opinions.

1.7 Scope of the Study

This section contains the content scope and geographical scope.

1.7.1 Content Scope

The study focused on management of computing resources using NComputing technology in Nyamata District Hospital in Rwanda. In particular the study sought to determine how the constructs of the independent variable (Ncomputing technology) affected the construct of the dependent variable (Management of computing resources), according to the conceptual framework.

1.7.2   Geographical Scope

The study was restricted to Nyamata District Hospital. The study was limited only to headquarters of the hospital in Bugesera District, Eastern province of Rwanda.

This hospital is one of the hospitals that implemented Ncomputing technology before others and it has high performance on using technology. The map of Rwanda showing Bugesera District (see Appendix VIII).

1.7.3 Time scope

The study covered the period from 2008 to 2016, inclusive. The choice of this period of time was because Nyamata District Hospital started to use this technology in 2011.
This timeframe helped the study to assess the management of computing resources at Nyamata District Hospital before and after Ncomputing technology was introduced.

1.8 Organization of the Study

The study is organized into five chapters which are as follows:
Chapter one is composed of an introductory part, background of the research problem, statement of the problem, research objectives and research questions, significance of the study, scope of the study, the definitions of key terms and Organization of the study. Chapter two: This chapter covers a review of related literature of the topic of research. Chapter three covers the introductory part of the methodology; research methodology that was applied to the research and it also gave an explanation on sample size selection procedures, research strategy and type, research design framework, operationalization of variable and indicators, data analysis and methods/techniques of data collection. Chapter four: research findings and discussion and chapter five: summary, conclusions and recommendations.

CHAPTER TWO: REVIEW OF RELATED LITERATURE

2.0 Introduction

This chapter reviews the literatures available in the area of study, which reflects on number of studies by the previous researchers. This chapter begins with the past studies of Ncomputing technology globally, in Africa, East Africa and in Rwanda. The critical review will be discussed to bring out the gap that needed to be filled.

2.1 Theoretical Literature

This section contains theories about Ncomputing technology, Ncomputing technology history, Ncomputing technology technical factors and Ncomputing models.

2.1.1 Ncomputing Technology

According to Parlakkilic (2015) Ncomputing Technology is a modern take on the time-honored concept where multiple users share the processing power of a single computer. This approach has several advantages over the traditional personal computer model, including lower overall costs, better energy efficiency. The unique NComputing technology is composed of three primary components such as vSpace virtualization software, a user extension protocol, and access devices. By combining all three of these components into an integrated solution, NComputing delivers unmatched performance at an incredibly low cost.

2.1.2 Ncomputing Technology Historical Development

The virtualisation concept was first introduced in 1960s by Christopher Strachey, the first professor of Oxford University and leader of programming research group, to allow partitioning of large, mainframe hardware a scarce and expensive resource. Over time minicomputers and personal computers provided a more efficient and affordable to distribute processing power. By the 1980s, virtualisation was no longer employed, however in 1990s, researchers began to see how virtualisation could solve some of the problem with the proliferation of less expensive hardware, including underutilisation, escalating management costs and vulnerability (Williams, 2007).

NComputing was founded in 2003 and is a privately-held company established by Young Song, a former co-founder and executive of eMachines, and Klaus Maier, Chief Executive Officer of Hydrapark GmbH.36. The L100 Expanion product using a concept known as UTMA (Ultra-Thin Multi Access) which is the verbiage used to describe all of NComputing's multi-user products as depicted in Figure 2.1.

NComputing owns its own terminal server software, remote computing client related patent, and System on Chip architecture intellectual properties. In addition, they take advantage of under-used CPU processor horse power of the most common and available multi-user operating systems such as Microsoft Windows 2000, XP (Landry, 2006).
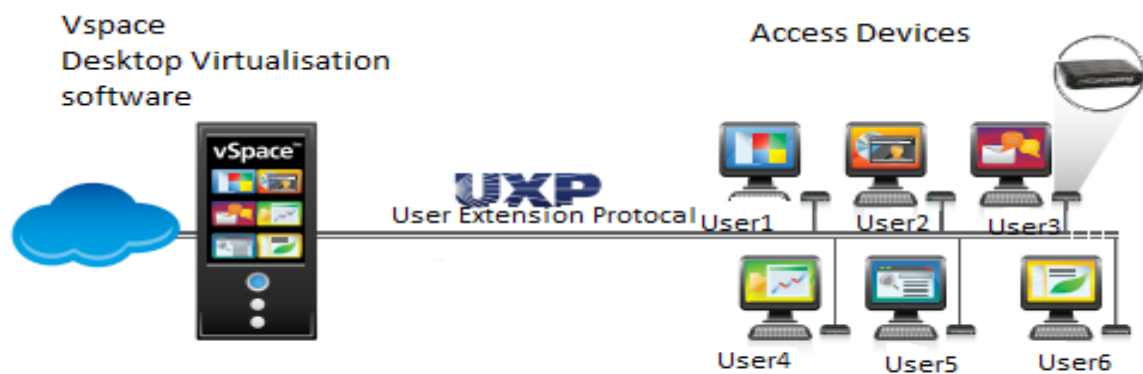
Figure 2. 1 Ncomputing technology Components.
 Source: Renatus (2014).

As depicted in Figure 2.1, NComputing solution has three components:

   i. Access devices that connect the user's monitor/peripherals to the host computer;
   ii. Virtualisation software (vSpace), which virtualizes the host computer to create multiple sessions;
   iii. User eXtension Protocol (UXP), which transmits the data and video signals between the user and the host computer;

NComputing is a leader in accelerating the adoption of desktop virtualization. Removing the barriers through a unique formula of simplicity, performance and value, Ncomputing's integrated solutions serve global enterprise and mid-market companies in key verticals such

as education, healthcare and government. With over twenty million daily users in 140 countries, the company is fueling the adoption of desktop virtualization faster than any other in the world (Hoang, 2010).

2.1.3 Ncomputing Technology Technical Factors

Ncomputing allows organizations to use a single desktop personal computer (PC). That does this mean, a significant reduction in hardware cost, software administration, power consumption and head production. Since today's microprocessors are far more powerful than most people ever use (Wingstrand, 2010).

NComputing systems are a major leap forward in green computing. More than fifteen thousand (15,000) organizations in over eighty (80) countries have used NComputing technology to slash their carbon footprint and electric consumption. The Ncomputing technology solution is based on a simple fact, today's personal computers are so powerful that the vast majority of applications only use a small fraction of the computer's capacity (Wingstrand, 2010).

NComputing's virtualization software and hardware tap this unused capacity so that it can be simultaneously shared by multiple users. An Ncomputing access device also has a much longer useful life than personal computers. When a shared personal computer is replaced with a newer one, the PC may go to a landfill, but the Ncomputing technology users can keep their access devices and enjoy the boost in performance from the new personal computer. So whereas personal computers might be upgraded every three years or so, access devices could easily last five years or more. With less frequent turnover, less equipment ends up in landfills (Sarwar, *et al., 2014)*.

2.1.4 Ncomputing Technology Models

Ncomputing Computing company has produced popular five (5) types of Ncomputing technology access devices:

1. The U-series

The U-series connects directly to the host PC's USB port. Up to 10 U-series devices can be connected to a host PC with a 10 meter (30 feet) distance limit.

USB repeaters can be used to further extend the user computing stations if needed. The simplest of all Ncomputing models to connect, because users connect into Universal Serial Bus (USB) ports on the host computer, and thus no network switches or Peripheral Component Interface (PCI) cards are required (Sugranes & Baqueró,2012), as depicted in Figure 2.2.

Figure 2.2 Ncomputing technology U-series
Source: Smith (2010).

2. The X-Series

The X-series connect directly to the host personal computer through a Peripheral Component Interface card (included) which is installed into the host PC. Up to 10 X-series devices can be connected to a host PC. There is a 10 meter (30 feet) distance limit between the X-series device and the host personal computer. X-series access devices connect via CAT 5 cable to a Peripheral Component Interface card that is installed in a shared personal computer. The technology supports up to two Peripheral Component Interface cards (Sugranes , 2012), as depicted in Figure 2.3.

Figure 2.3 Ncomputing technology X-series

Source: Smith (2010).

3. The M-series kit

It includes three access terminals (3-in-1) allowing 45 users to share the resources of one personal computer or server. The successor to the X series is the M series, which brings a new architecture and a new upper limit of 45 users per host personal computer. The M series uses the Numo 2 Advanced Risc Machines based System on a chip that provides hard drive video without excessive host-side processing (Sugranes, 2012) .

4. The L-Series

The L-series access devices connect through standard Ethernet networks and up to 30 virtual desktops can be connected to a host PC. Since they connect over standard Ethernet, the user can be practically any distance away from the host computer. Unlike the X-series, the NComputing L-series does not use a Peripheral Component Interface card. L-series access devices connect each user's keyboard, mouse, other USB devices and monitor back to the shared PC over standard Ethernet cables through a router or switch. An entry-level server supports approximately 30 users.The L-series comes in kits that include NComputing's vSpace software and one access device (Sugranes,2012), as depicted in Figure 2.4.

Figure 2.4 Ncomputing technology L-Series
Source: Smith (2010).

5. The N-series

These are devices are purpose built for organizations deploying the Citrix virtual desktop infrastructure in a Box solution and provide 100% of the benefits of the Citrix experience. N-sersies are only compatible with Citrix's XenApp, XenDesktop. For N-series devices, the price includes an Enterprise bundle of 1 device license for vSpace Management Center (Sugranes, 2012).

2.2. Theoretical Framework

Theoretical framework involves theories and concepts of Ncomputing technology

2.2.1 Process Virtualization Theory

Process Virtualization Theory (PVT) provides a general theoretical starting point for the investigation of factors that affect the virtualizability of a process from the customers' or users' perspective. A virtual process is a process in which physical interaction between people and/or objects has been removed; the transition from a physical process to a virtual process is referred to as process virtualization (Overby, 2012; Overby, 2008). The main enabler of most contemporary virtual processes is information technology, but virtual processes need not be based on information technology.

According to this definition, process virtualization occurs when a physical process is transitioned to a virtual environment. This characterizes an emerging paradigm in information systems research, such as the transition of education to distance learning environments, the transition of shopping to electronic commerce websites, or the transition of interpersonal relationships to online communities (Boughzala, *et al*., 2010).

PVT has been designed to explain and predict whether a process is amenable or resistant to being conducted virtually; it describes how suitable a process is to being conducted without physical interaction between people or between people and objects (Overby, 2008). According to PVT, some processes (such as shopping for books) are more amenable to virtualization than others.

The dependent variable in process virtualization theory is process virtualizability, which describes how amenable a process is to being conducted without physical interaction between people or between people and objects. Operationally, process virtualizability can be measured either as adoption of the virtual process, or the quality of the outcomes of the virtual process (Overby, 2008*)*.

The main constructs of process virtualization theory are sensory requirements, relationship requirements, synchronism requirements, and identification and control requirements (Overby, 2008).

Each of these constructs is posited to have a negative effect on process virtualizability. In other words, as each of these requirements increases, the process becomes less amenable to virtualization. This does not mean that a process with high sensory, relationship, synchronism, and/or identification and control requirements cannot be virtualized; rather, it means that it would be more amenable to being virtualized if these requirements are low. The dependent variable of process virtualizability is continuous, not discrete, and should be thought of as a question of degree, not of kind (Overby, 2008).

According to Overby (2008) advancements in the power and accessibility of information technology have led to a proliferation of new virtual processes in recent years. In order to investigate how and why IT has this effect, the theory explicitly considers the role of IT in process virtualization.

A key premise of the theory is that information technology can be used to make a process more amenable to virtualization. Put in propositional terms, IT has a positive moderating effect on the relations between the main constructs and process virtualizability.

The first construct proposed to affect process virtualizability is sensory requirements, which is defined as the need for process participants to be able to enjoy a full sensory experience of the process and the other process participants and objects. Process virtualization eliminates physical interaction between people and between people and objects from a process. The lack of physical interaction makes it difficult for a participant in a virtual process to establish a sensory connection to objects and/or other people, because they cannot directly taste, smell, or feel them. If a process is reliant on this, it will benefit from the physical context and resist virtualization, ceteris paribus (Boughzala, *et al*., 2010).

The second construct proposed to affect process virtualizability is relationship requirements, which is defined as the need for process participants to interact with one another in a social or professional context. Such interaction often leads to knowledge acquisition, trust development, and friendship development. Relationship requirements are posited to have a negative relation to process virtualizability (Boughzala, *et al*., 2010).

The third construct proposed to affect process virtualizability is synchronism requirements, which is defined as the degree to which the activities that make up a process need to occur quickly with minimal delay. Synchronism requirements are posited to have a negative relation to process virtualizability (Boughzala, *et al*., 2010).

The fourth construct proposed to affect process virtualizability is identification and control requirements, which is defined as the degree to which the process requires: unique identification of process participants, and the ability to exert control over influence their behavior. Identification and control requirements are posited to have a negative relation to process virtualizability (Boughzala, *et al*., 2010).

2.2.2 Unified Theory of Acceptance and Use of Technology (UTAUT)

According to Ayankunle *et al* (2013) explained that unified theory of acceptance and use of technology (UTAUT) proposes that performance expectancy, effort expectancy, and social influence predict behavioral intention towards the acceptance of information technology.

Venkatesh *et al* (2003) added that UTAUT has four key constructs such as performance expectancy, effort expectancy, social influence, and facilitating conditions that influence behavioral intention to use a technology or technology use. They adapt these constructs and definitions from UTAUT to the consumer technology acceptance and use context. Here, performance expectancy is defined as the degree to which using a technology will provide benefits to consumers in performing certain activities; effort expectancy is the degree of ease associated with consumers' use of technology; social influence is the extent to which consumers perceive that important others like family and friends believe they should use a particular technology; and facilitating conditions refer to consumers' perceptions of the resources and support available to perform a behavior (Venkatesh *et al.* ,2003). According to UTAUT, performance expectancy, effort expectancy, and social influence are theorized to influence behavioral intention to use a technology, while behavioral intention and facilitating conditions determine technology use as depicted by the Figure 2.5.
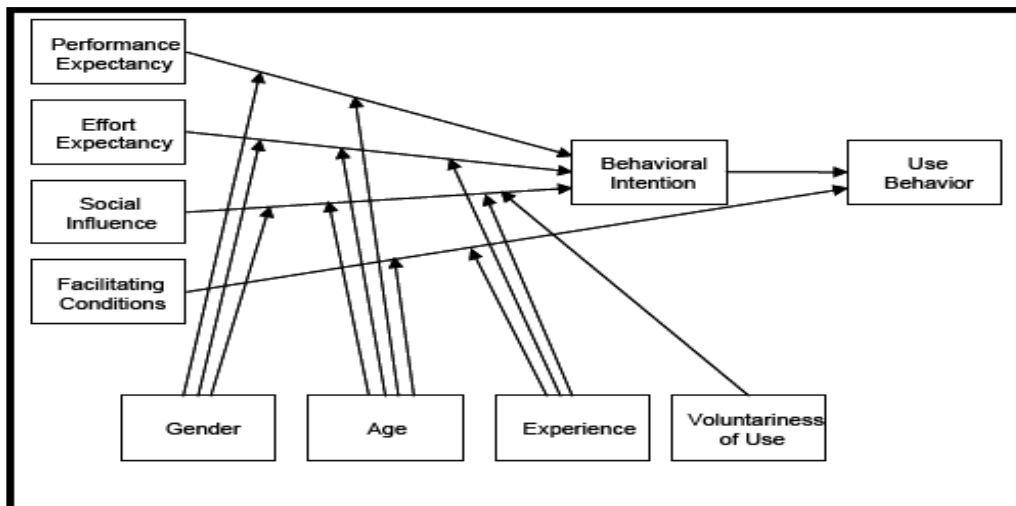
Figure 2.5 Unified Theory Of Acceptance and Use Of Technology (UTAUT)

Source: Venkatesh *et al.*(2003).

2.2.3 Technology Acceptance Model (TAM)

One of the well-known models related to technology acceptance and use is the technology acceptance model (TAM), proposed by Davis in 1986.

TAM has proven to be a theoretical model in helping to explain and predict user behavior of information technology (Legris, Ingham, & Collerette, 2003). TAM is considered an influential extension of theory of reasoned action (TRA), according to Ajzen and Fishbein (1980).

Davis, Bagozzi, and Warshaw (1989) proposed TAM to explain why a user accepts or rejects information technology by adapting theory of reasoned action. TAM provides a basis with which one traces how external variables influence belief, attitude, and intention to use. Two cognitive beliefs are posited by TAM: perceived usefulness and perceived ease of use.

According to TAM, one's actual use of a technology system is influenced directly or indirectly by the user's behavioral intentions, attitude, perceived usefulness of the system, and perceived ease of the system. TAM also proposes that external factors affect intention and actual use through mediated effects on perceived usefulness and perceived ease of use. Figure 2.6 depicts the TAM (Davis, 1989).
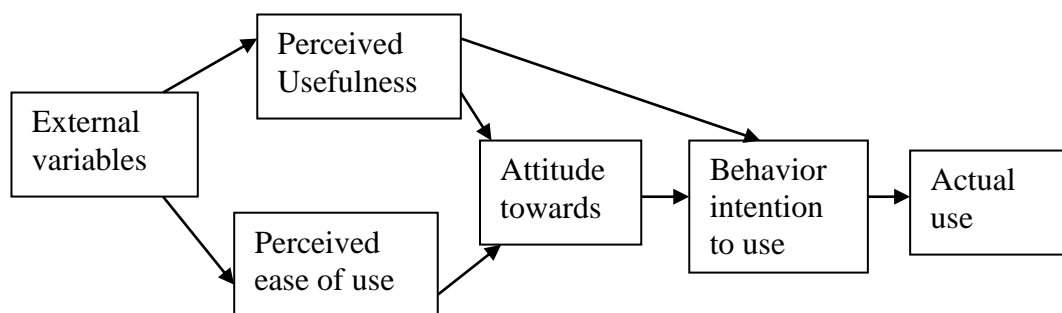
Figure 2.6 Technology Acceptance Model (TAM)
Source: Davis (1989).

2.2.4 Technology Acceptance Model 2 (TAM2)

TAM2 was developed by Venkatesh and Davis (2000) on the basis of TAM. Two processes, the Social Influence Processes (Subjective Norm, Voluntariness, and Image) and the Cognitive Instrumental Processes (Job Relevance, Output Quality, Result Demonstrability,

and Perceived Usefulness), were integrated into this model. The two processes were considered to be crucial to the study of user acceptance.

i. Social Influence Processes

TAM2 reflects the impacts of subjective norm, voluntariness, and image. The relationship among the three constructs is an important factor that affects user acceptance or rejection of an innovative system. Subjective norm is one of the components of TRA; it is a direct determinant of behavioral intention and also a key factor of the theoretical foundation of TAM (Venkatesh and Davis, 2000).

ii. Cognitive Instrumental Processes

The four cognitive instrumental processes in TAM2 are the determinants of perceived usefulness; they are job relevance, output quality, result demonstrability, and perceived ease of use. Job relevance is a key component of the matching process in which a potential user judges the effects of using a particular system on his/her job. In TAM2, it is defined as an individual's perception regarding the degree to which the target system is applicable to his/her job. Kieras and Polson and Polson argued that the knowledge on job situations, which can be used to determine what tasks can be performed within a given system, varies with users.Output quality. Figure 2.7 depicts the TAM2 model by Venkatesh and Davis (2000).
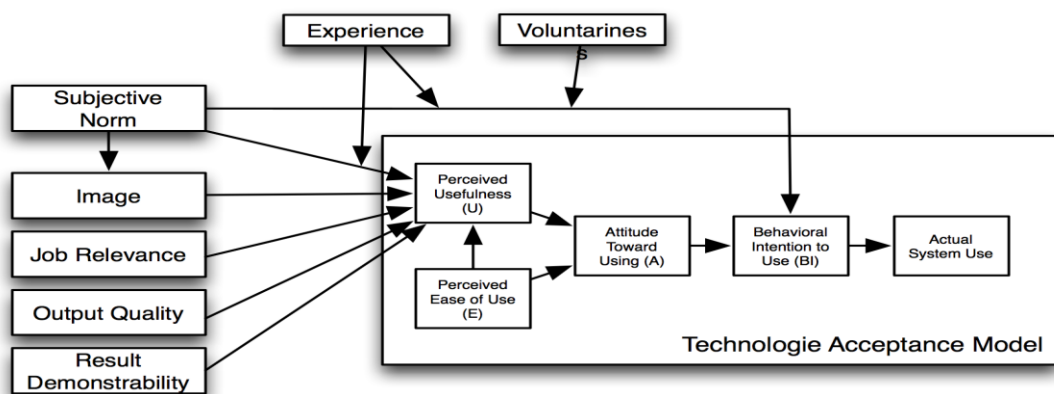
Figure 2.7 Technology Acceptance Model 2 (TAM2)

Source: Venkatesh and Davis (2000)

2.2.5 Technology Acceptance Model 3 (TAM3)

TAM3 presents a complete nomological network of the determinants of individuals' IT adoption and use. There is suggestion of three theoretical extensions beyond TAM2 *and* the model of the determinants of perceived ease of use. In this section, there is the discussion of these theoretical extensions and the rationale for the integration. Further, researcher suggests that the determinants of perceived usefulness will not influence perceived ease of use and the determinants of perceived ease of use will not influence perceived usefulness (Venkatesh, 2000).

Thus, TAM3 does not posit any cross-over effects. As noted earlier, two theoretical processes explain the relationships between perceived usefulness and its determinants: social influence and cognitive instrumental processes. The effects of the various factors that is, subjective norm, image, job relevance, output quality, and result demonstrability. Perceived ease of use has been theorized to be closely associated with individuals' self-efficacy beliefs and procedural knowledge, which requires handsome experience and execution of skills (Venkatesh, 2000; Davis & Venkatesh, 2000). Further, Venkatesh (2000) suggested that individuals form perceived ease of use about a specific system by anchoring their perceptions to the different general computer beliefs and later adjusting their perceptions of ease of use based on hands-on experience with the specific system. Social influence processes (i.e., compliance, identification, and internalization) in the context of IT adoption and use represent how important referents believe about the instrumental benefits of using a system. Even if individual gets information from important referents about how easy a system is to use, it is unlikely that the individual will form stable perceptions of ease of use based on the beliefs of referent others over and above his or her own general computer beliefs and hands-on experience with the system (Davis & Venkatesh, 2000). Further, the determinants of perceived ease of use represent several traits and emotions, such as computer self-efficacy, computer playfulness, and computer anxiety.Figure 2.8 depicts TAM3.
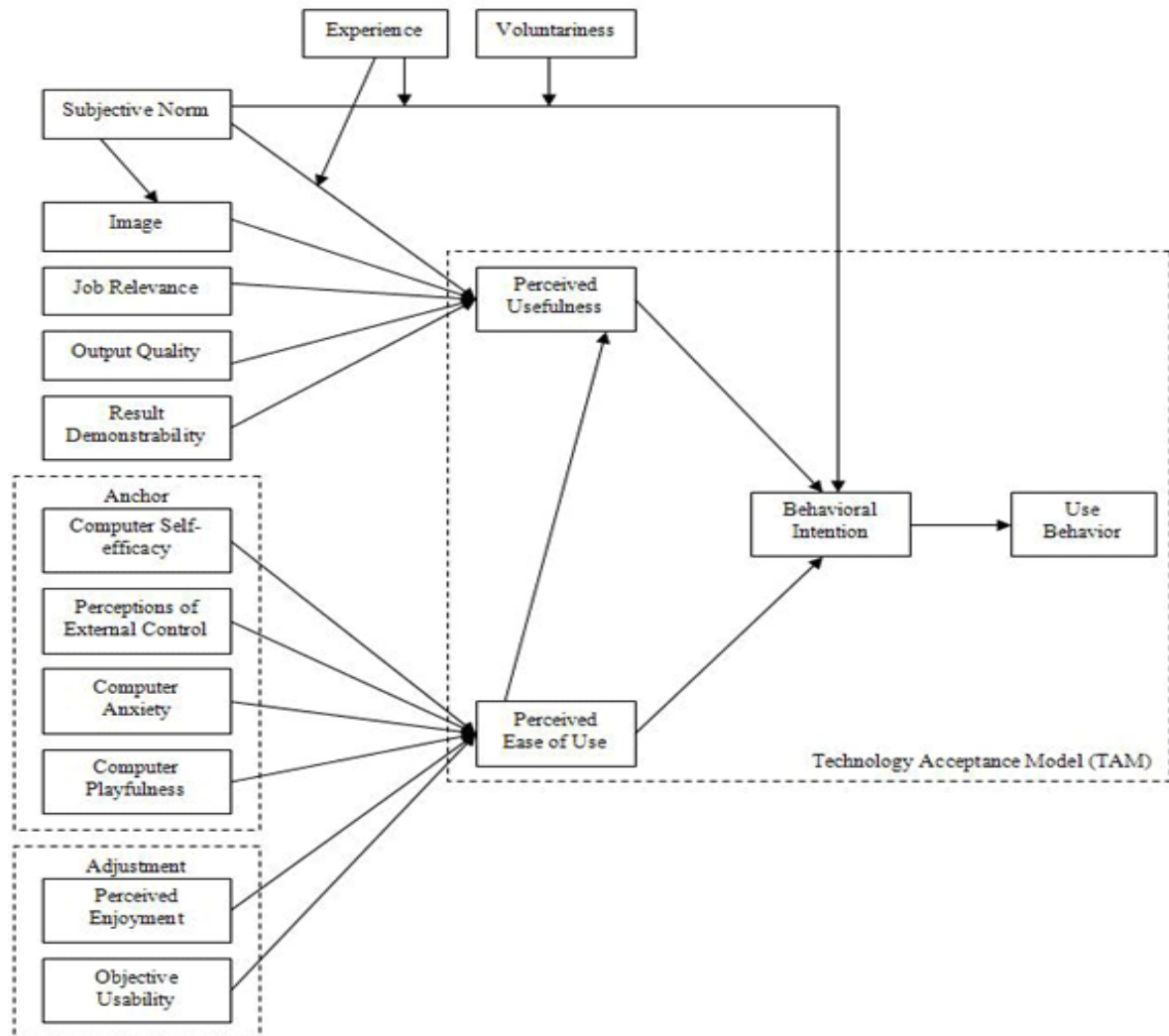
Figure 2.8 Technology Acceptance Model 3 (TAM3)

Source: Venkatesh and Davis (2000)

2.3 Empirical Literature

This study presents a review of the empirical literature analyzing the effects of Ncomputing technology on management of computing resources .The previous reviews of the literature indicated the general structure of Ncomputing technology.

Pham (2010) Opting to follow the computing-design philosophy that the best way to reduce power consumption and increase energy efficiency is to reduce waste, we propose an architecture with a very simple ready-implementation by using an NComputing device that can allow multi-users but only one computer is needed.

This intuitively can save energy, space as well as cost. In this study, researcher proposed a simple and realistic NComputing architecture to study the energy and power-efficient consumption of desktop computer systems by using the NComputing device. He also proposed new approaches to estimate the reliability of *k*-out-of-*n* systems based on the delta method. The *k*-out-of-*n* system consisting of *n* subsystems works if and only if at least *k*-of-the-*n* subsystems work. More specificly, He developed approaches to obtain the reliability estimation for the *k*-out-of-*n* systems which is composed of *n* independent and identically distributed subsystems where each subsystem (or energy-efficient usage application) can be assumed to follow a two-parameter exponential lifetime distribution function. The detailed derivations of reliability estimation of *k*-out-of-*n* systems based on the biased-corrected estimator, known as delta method, the uniformly minimum variance unbiased estimate (UMVUE) and maximum likelihood estimate (MLE) are discussed (Pham,2010).

To attain systems able to perform large-scale programming and computing, researchers must address architectural challenges in energy and power efficiency, both locally and globally. A simple architecture by using NComputing devices to improve energy and power efficiency of computer systems and energy consumption management systems in general. NComputing recently claims that up to 95% of computers resources are wasted and unnecessary for the average users, either at work or at home environments and therefore, developed a device called NComputing kit, which could allow users to save significantly on electricity consumption as compared to other 154 traditional ways (Pham, 2010).

An energy-management NComputing application is discussed to illustrate the reliability results in terms of the energy consumption usages of a computer system with quad-core, 8GB of RAM, and a GeForce 9800GX-2 graphics card to perform various complex applications. The estimated reliability values of systems based on the UMVUE and the delta method differ only slightly. Often the UMVUE of reliability for a complex system is a lot more difficult to obtain, if not impossible. The delta method seems to be a simple and better approach to obtain the reliability estimation of complex systems. The results of this study also show that, in practice, the NComputing architecture improves both energy cost saving and energy efficient living spaces (Pham, 2010).

Christian (2012) studied Ncomputing technology and showed that NComputing Desktop Virtualization is a modern take on the time-honored concept where multiple users share the processing power of a single computer. It has several advantages over the traditional PC

model, including lower overall costs, better energy efficiency, and simplified administration. It is where the researcher's study is anchored into. The researcher is using SDSSU-Tandag Students from four (4) colleges as respondents in order to gather relevant data.

The researcher uses the descriptive method in identifying the similarities and differences of the respondents' answers. In this study, two types of data were gathered the primary and secondary data derived from the participants' answers during the survey process and from published documents and literatures respectively that were relevant to the energy conservation, effectiveness and efficiency of Ncomputing Access Device. The use of NComputing Access Device for Surigao del Sur State University Main Campus, reduces upgrade and maintenance costs and lowers long-term expenses. Energy conservation in the use of NComputing Access Device is very evident in the internet cafe and computer laboratory considering that the institution saves a lot in terms of costs (Christian, 2012).

In their thesis Sugrañes (2012), with the objective of reducing the digital divide in disadvantaged countries and to improve the technological conditions of the region's central hospital located in Bluefield and the communication with several health posts spread all over the area. In the Chapter six (6), They wrote on Ncomputing technology as a technology enable multiple users to simultaneously share a single operating system instance.By comparing virtual desktop infrastructures (VDI) such as VMware (with VMware View), Citrix (with XenDesktop) and NComputing technology (with L-Series) were considered as great real options to implement as table below show.

The most important objective achieved during the 6 months has been the deployment of a remote desktop technology, Ncomputing technology. This allows to struggle with the problem of computer deterioration within the hospital, caused by the severe weather conditions of the region. In addition, the management of the hospital has seen it as a great initiative because it reduces the cost of the computers and its maintenance. However, they were only able to install 3 devices plus the server, due to a lack of funds, although the first approach was planned to expand the network with more equipment (up to 7) as there are some departments of the hospital with the same needs. The study was comparative study as showed by Table 2.1.

Table 2.1 Comparison of virtual desktop infrastructures

	Vmware	Citrix	Ncomputing technology
Protocol	RDP , PCOip	RDP,ICA	UXP
Operating System	Windows,mac,Linux	Windows,mac,Linux	Windows,Linux
Listening	✅	✅	✅
File Transfer	✅	✅	✅
Audio Support	✅	✅	✅
Multiple sessions	✅	✅	✅
Seamless Windows	✅	✅	✅

Source: Sugrañes (2012)

According to the general features displayed in Table 2.1, all three virtual desktop infrastructures have similar performance. Eventually, the choice was for NComputing technology due to a question of budget and its lower price as compared to the rest.

Table 2. 2 Advantages of Ncomputing Technology

Savings	Funcionality	Security
■ Savings of 50% in adquisition cost.	■ Easy to maitain a centralized architecture.	■ Avoids illegal extraction of information.
■ Savings in 85% in the cost of spares of PC's.	■ Easy to install the system and configure.	■ 128 bits encryption.
■ Savings in 95% in electrical power consumption.	■ Compact, small and thin.	■ Avoids the installation of virus.
■ Savings in maintenance and updates.	■ Does not generate noise nor heat; good for environment.	■ Solid and reliable.

Source: Sugranes (2012).

According to the general features displayed in Table 2.2, all three virtual desktop infrastructures have similar performance. Eventually, the choice was for NComputing technology due to a question of budget and its lower price as compared to the rest (Sugranes, 2012). Sugranes concluded that the implementation of Ncomputing technology has lead to improve the infrastructure of the hospital.

As explained before, it is easy to monitor and saves lots of energy, which translates to cutting down expenses and maintenance.

Ansari & Sharma(2014), computer is the basic need of every common man and they have to use it for time saving and to minimize human labour, rather than they also need to aware about its harmful impacts on the environment. In this study we take various factors related to the awareness of green computing. However, mostly users rarely need the capacity of operation more than five percent of available computing capacity. It would be possible to achieve significant environment and cost savings by sharing this excess or waste power by many users simultaneously. Ncomputing seized on this idea by which minimizes the power consumption.

The desktop(s) can also be confusing or seems glitch or otherwise messed up on occasion, most frequently in relation to the permanent window in the center of the desktop. Many companies and data centers faces such type of problems, which also reduces the life of these computers. The NComputing solution is based on a simple fact: today's PCs are so powerful that the vast majority of applications only use a small fraction of the computer's capacity. NComputing's virtualization software and hardware tap this unused capacity so that it can be simultaneously shared by multiple users.

The NComputing virtualization software works on a standard Windows or Linux one personal computer. Normal personal computers generally consume between one hundred and ten (110) to two hundred (200) watts of electricity. In contrast, NComputing access devices consume next to nothing. In fact, Ncomputing L-series devices consume five watts per added user and the X-series consume just one watt per added user (Ansari & Sharma,2014).

In their study Ansari & Sharma (2014), they concluded that Ncomputing virtualization solution deals with both hardware and software and uses a shared personal computer as the fountainhead of processing power for seven to thirty five (35) virtual desktops. The power consumed in processor is virtualized and shared through a small NComputing access device to which each user's peripheral components are connected.

Renatus (2014) Ncomputing technology has proved to be a key cost saving approach in educational sectors. This brings some interests of analyzing to which extent these devices bring cost relief to the users and stakeholders who deploy Ncomputing in secondary schools.

The analysis compares the deployment costs of desktop computers with the costs to deploy Ncomputing in the Computer Labs. This research also explores the cost implications for deploying each of the Ncomputing devices while comparing with the cost of deploying desktop computers. The findings show that, generally, Ncomputing has a significant cost relief by more than 53% when deployed on a single Computer Lab of 40 students when compared to deploying desktop computers. Furthermore, Ncomputing M300 seem to be the cheapest option with up to 74% cost saving while the least option found to be U170 (Renatus, 2014).

The research of Renatus (2014) exposes a lot of decision issues regarding cost-benefit analysis in deploying Ncomputing devices. Yes, it is with no doubt that it favours simplicity in terms of installation and usability and it has, in general, a significant cost implications. This research goes further by suggesting the best Ncomputing option for effective cost conscious decision by secondary schools although the decision makers who are in place have their criterions for selecting the best devices to use based on their personal interests which seem to rely on the usability issues. That means, there is a compromise on the trade-off between cost and usability issues which have to seriously be addressed.

According to Renatus (2015) Ncomputing technology has proved to be one of the key costs saving approach in educational sectors. This attracts some interests of analyzing to which extent these devices bring cost relief to the users and stakeholders who deploy Ncomputing in secondary schools. This research performs analysis by comparing the deployment costs of desktop computers with the costs to deploy Ncomputing in the Computer Labs.

This research also explores the cost implications for deploying each of the Ncomputing devices while comparing with the cost of deploying desktop computers.
The analysis goes further by observing the economic impact of each of the Ncomputing devices and explores their relationships in terms of costs when compared to the desktop computers 'implementation.

This research information discussed the cost implications in adopting Ncomputing technology. It targets Tanzania Education Sector by involving different stakeholders of secondary schools. The benchmark used was the cost of deploying desktop computers in a lab of forty (40) students. This cost was then compared by the costs of implementing different types of Ncomputing devices on the same room size.

The result shows that M300 device are much better in terms of cost by saving 74% of the cost while the worst option is the use of U170 which saves only 53% of the cost when compared to deploying desktop computers in the same room. This research also reveals that the traditional approach in adopting these Ncomputing devices do not rely on cost rather they depend on the interests of the decision maker which falls to the usability issues. The analysis also shows that the key factor which affects the adoption of Ncomputing in Tanzania perspective is awareness of such technology (Renatus, 2015).

It is necessary to work and develop an easy system. In this context module technology was used to for provide modularity in conducting educational development of eLearning course. Then, rapid e-learning was used for more quick and easy course development. In order to implement modular rapid e-learning, a desktop virtual environment was set up. Modular rapid e-learning was used by teachers and students in a one semester course and student success and reactions were evaluated. And also the overall hybrid system cost was calculated and reported.

In implementation we combined modular course design with rapid eLearning and desktop virtualization in education of 3rd year nursing students for a one semester course. The effectiveness of this hybrid method was evaluated with respect to students 'success, students' opinions and overall cost effectiveness. It was seen that the hybrid method was educationally more effective than traditional method comparing with previous year students' success and fit with students' requirements. The cost reduction was 41% comparing with traditional desktop and e-learning system (Parlakkilic, 2015).

2.4 Critical Reviews and Research Gap Identification

This part is composed by critical review and research gap identification.

2.4.1 Critical Review

The study of the models (UTAUT, TAM, TAM2, TAM3 and PVT) considered the use of U, X, M, L and N series technologies as to effect virtual desktop access. These models involved the study of facilitating conditions, sharing of devices (Social influence), energy conservation (effort expectance), and usability. But they did not consider centralized computing and security features.

Pham (2010) concluded that Ncomputing technology is the best way to reduce power consumption and increase energy efficiency and to reduce waste. This intuitively can save space as well as cost. Pham proposed a simple and realistic Ncomputing architecture to study the energy and power-efficient consumption of desktop computer systems by using the NComputing device. An energy-management NComputing application is discussed to illustrate the reliability results in terms of the energy consumption usages of a computer system with quad-core, 8GB of RAM, and a GeForce 9800GX-2 graphics card to perform various complex applications. The delta method seems to be a simple and better approach to obtain the reliability estimation of complex systems. The results of this study also show that, in practice, the NComputing architecture improves both energy cost saving and energy efficient living spaces. According to TAM2 said about external variables that included perceived usefulness and ease of use build up attitude toward using Ncomputing technology but space and reduced cost are not considered. Mainly TAM3 is applied in to U-series (include usability, space and reduced cost).

Christian (2012) studied on Ncomputing technology and showed that NComputing Desktop Virtualization is a modern take on the time-honored concept where multiple users share the processing power of a single computer. It has several advantages over the traditional PC model, including lower overall costs, better energy efficiency, and simplified administration. Energy conservation in the use of NComputing Access Device is very evident in the internet cafe and computer laboratory considering that Surigao del Sur State University Main Campus saves a lot in terms of costs while According Boughzala *et al*. (2010) stated that process virtualizability is synchronism requirements, which is defined as the degree to which the activities that make up a process need to occur quickly with minimal delay and also process virtualizability is identification and control requirements, which is defined as the degree to which the process requires a unique identification of process participants, and

the ability to exert control over influence their behavior. The study and theory confirm the use of U, X, M, L and N series technogies of Ncomputing Technology.

According to Sugrañes (2012) stated that Ncomputing technology is a technology that enable multiple users to simultaneously share a single operating system instance. By comparing virtual desktop infrastructures (VDI) such as VMware (with VMware View), Citrix (with XenDesktop) and NComputing technology (with L-Series) were considered as great real options and he concluded that the implementation of Ncomputing technology has lead to improve the infrastructure of the hospital. As explained before, it is easy to monitor and saves lots of energy, which translates to cutting down expenses and maintenance whereas Brown and Venkatesh (2005), performance expectancy, effort expectancy, and social influence are theorized to influence behavioral intention to use a technology, while behavioral intention and facilitating conditions determine technology use.

Ansari & Sharma(2014), computer is the basic need of every common man and they have to use it for time saving and to minimize human labour, rather than they also need to aware about its harmful impacts on the environment. In this study we take various factors related to the awareness of green computing. However, mostly users rarely need the capacity of operation more than five percent of available computing capacity. It would be possible to achieve significant environment and cost savings by sharing this excess or waste power by many users simultaneously.

Ncomputing seized on this idea by which minimizes the power consumption. According to TAM3 said about external variables that included perceived usefulness and ease of use build up attitude toward using Ncomputing technology but sharing untapped space and reduced energy consumption are not considered.

According to Renatus (2014), Ncomputing Technology has proved to be a key cost saving approach in educational sectors. This brings some interests of analyzing to which extent these devices bring cost relief to the users and stakeholders who deploy Ncomputing in secondary schools. The analysis compares the deployment costs of desktop computers with the costs to deploy Ncomputing in the Computer Labs.

This research also explores the cost implications for deploying each of the Ncomputing devices while comparing with the cost of deploying desktop computers. The study did not see about identification and control requirements which are defined as the degree to which the process requires identification of users (Username and password) and ability to control virtualization usage as specified by process virtualization theory Boughzala, *et al*. (2010).

In his study Renatus (2015) where the research performs analysis by comparing the deployment costs of desktop computers with the costs to deploy Ncomputing in the Computer Labs. This research also explores the cost implications for deploying each of the Ncomputing devices while comparing with the cost of deploying desktop computers. The analyisis goes further by observing the economic impact of each of the Ncomputing devices and explore their relationships in terms of costs when compared to the desktop computers'implementation. Using M-series the study showed that Ncomputing Technology has positive impact on economic issue. This study did not search on the part of output quality, social influence (Image), computer self efficacy and objective usability as required in TAM3.

Parlakkilic (2015) wrote on implementation of modular rapid e-learning where a desktop virtual environment was set up. Modular rapid e-learning was used by teachers and students in a one semester course and student success and reactions were evaluated. And also the overall hybrid system cost was calculated and reported. In implementation the combination of modular course designs with rapid eLearning and desktop virtualization in education of 3rd year nursing students for a one semester course.

The effectiveness of this hybrid method was evaluated with respect to students 'success, students' opinions and overall cost effectiveness. The study confirming the social influence and facilitation conditions stated by the Unified Theory of Acceptance and Use of technology (Venkatesh *et al*., 2003).The five models of Ncomputing technology are about this study.

2.4.2 Research Gap Identification

The previous studies such us Renatus (2014), Ansari & Sharma(2014) and Sugrañes (2012) covered about Ncomputing technology cost reduction, Energy reduction and sharing one personal computer hard disk but they did not cover about security features, device sharing, centralized computing ,data back-up as the users' access one personal computer, the back-up done automatically, are not covered about useful-life of

Ncomputing technology models and effects of Ncomputing technology in health services. These are knowledgeable gaps that the study intended to fill particularly in the case of Rwanda. Therefore the mentioned gaps are the area that will be covered through this study.

2.5 Conceptual Framework

The following framework shows the independent variables, dependent variables and intervening variables of the study as depicted by Figure 2.9.

Independent Variables   **Dependent Variables**
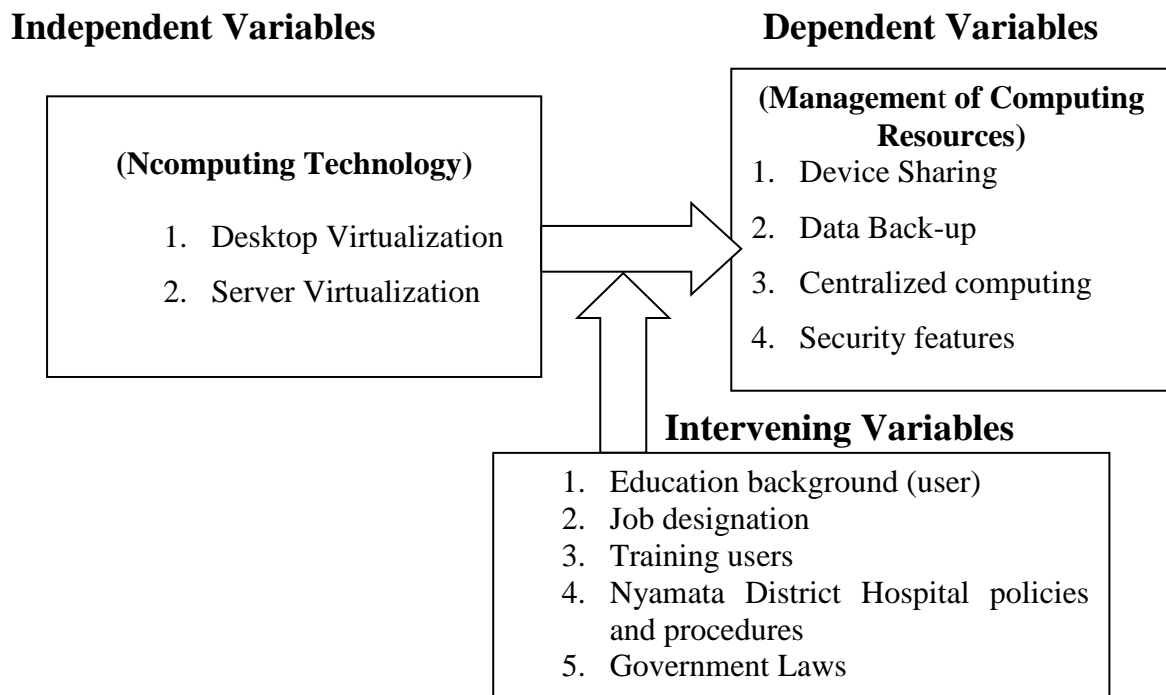
Figure 2. 9 Conceptual framework

Source: Personal interpretation

2.5.1 Independent Variables

In this study, the independent variable was desktop virtualization and server virtualization.

i. Desktop Virtualization

Desktop virtualization, sometimes referred to as client virtualization, is defined as a virtualization technology that is used to separate a computer desktop environment from the physical computer. Desktop virtualization is considered a type of client-server computing model because the virtualized desktop is stored on a centralized, or remote. This was measured using questionnaire

ii. Server Virtualization

Server virtualization is defined as the partitioning of a physical server into smaller virtual servers. In server virtualization the resources of the server itself are hidden (or masked) from users. Software is used to divide the physical server into multiple virtual environments, called virtual or private servers. This was measured using questionnaire.

2.5.2 Dependent Variable

Management of computing resources is the independent variable that consists of divice sharing, data back-up, centralized computing and security features. This variable was measured using questionnaire and interview guides.

i. Device Sharing

Device sharing is to spread one device (PC) to several users. This variable was measured using questionnaire and interview guides.

ii. Data Back-up

Data Back-up is defined as the result of copying or archiving files and folders for the purpose of being able to restore them in case of data loss. This variable was measured using questionnaire and interview guides.

iii. Centralized Computing

It is computing done at a central location, using terminals that are attached to a central computer. One computer itself may control all the peripherals directly. This variable was measured using questionnaire and interview guides.

iv. Security Features

Defending information from unauthorized access, use, disclosure, disruption, modification, perusal, inspection, recording or destruction. This variable was measured using questionnaire and interview guides.

2.6 Summary

In this chapter, the review of literature focused on the introduction of literature review, theoretical framework, the review of past studies where an emphasis was the use of Ncomputing technology as cost efficient, reduce power consummation and the role it play in management of computing resources. The chapter also covered critical reviews between critical reviews and empirical reviews. Technology Acceptance models were defined as information systems theories that model how users come to accept and use a technology. TAMs are widely applied to access users 'usage in various information technology areas. Also process virtualization theory introduces how virtualization technology avoid physical interaction during IT usage. Finally, theoretical framework and critical reviews have been considered. In summary most studies on Ncomputing technology usage were conducting in Tanzania, Macedonia and Central America. In Rwanda no such assessment or survey has been done on Ncomputing technology usage. The next chapter describes the methodology which was used to explore the effect of Ncomputing technology usage in management of computing resources at Nyamata District Hospital, Rwanda.

CHAPTER THREE: RESEARCH METHODOLOGY

3.0 Introduction

The purpose of this chapter is to present the methodological approach, the techniques and instruments used in conducting the research, analysis and its presentations to meet the objectives of the study. This chapter further describes the various methods that were used in the sample selection, the research design, target population, the sources of data, data collection methods and instruments, data processing and analysis.

3.1 Research Design

The study employed a case study research design. A case study design was chosen as empirical inquiry that investigates a contemporary phenomenon with its real-life context, when the boundaries between phenomenon and context are not clearly evident, and in which multiple sources of evidence are used (Yin, 1984).

3.2 Target Population

A research study population is also known as a well-defined collection of individuals or objects known to have similar characteristics. Adanza (1989) refer to the population as the number of persons or objects covered by the study or with which the study is concerned.

The total number of staff of Nyamata District Hospital was 117 in September 23, 2015 where the staff was composed of nursing service and support staff but only sixty five (65) staff of Nyamata District Hospital have access on Ncomputing Technology shared computers. This number was cover two IT staff, one Hospital Director and sixty two staff (A.Uwimana, Personal communication, September 23, 2015). Table 3.1 shows the target population.

Table 3.1 Target Population

Carrier	Number
ICT Service	2
Hospital Director	1
Other Services	62
Total	65

Source: Preliminary data

3.3 Sample design

Census was used, since the number that was targeted for the study was small. Especially, everyone who could retrieve access and analyze information was given with the questionnaire and researcher hope that their views and ideas were received and they were considered as suitable Data collection.

3.3.1 Sample size

Therefore, the sample size in this study was sixty five (65) staff of Nyamata District Hospital, the same as the total number of staff who accessed Ncomputing technology shared computers.

3.3.2 Sampling Technique

The sampling technique used was census, applied to the staff being the users of Ncomputing technology at Nyamata District Hospital.

3.4 Data Collection Methods

In this study, data was collected using both primary data collected directly on field and secondary data using the information available at Nyamata District Hospital.

i. Primary Data

Primary data are the first occurrence of a piece of work. They are sometimes referred to as grey literature as they are sometimes difficult to trace and least accessible (Ubonabenshi, 2015).

The primary source of instrument used to elicit responses from the selected population under study was self-administered questionnaires. These included close ended questionnaires which were designed in such a way that it was easy to understand. The study used structured questionnaires, as the main data collection method. The questionnaires were administered to respondents to solicit for desired information.

ii. Secondary Data

The study used secondary data for the analysis and in the estimation of the empirical model. Secondary data was obtained from the data files of the ICT office and archives. Other information and data were obtained through documented works and publications (academic journals, books, internet search engines etc) relevant to the topic for discussion.

3.4.1 Data Collection Instruments

The research instrument used for the collection of data was questionnaire. Questionnaires were administered to solicit for information from the target population. Close-ended questionnaires were designed for the research because the study intended to limit respondents to alternative questions provided by ticking the appropriate answer for each case.

3.4.2 Administration of Data Collection Instruments

i. Questionnaire

The study used a structured questionnaire. The research information was attained from targeted respondents. Then, a questionnaire was printed. In this study, a questionnaire was addressed to the staff of Nyamata District Hospital.

ii. Interview Guide

The study also used interview guides that helped to collect data. Under the primary sources, interview was conducted; this was used as the most mode of collecting data. Structured interviews addressed to the IT staff and Director of Nyamata District Hospital.

iii. Documentary Review

The study exploited the available written materials related to Ncomputing technology over computing resources.

3.4. 3 Reliability and Validity

The study ensured the validity and reliability in order to make sure the questionnaire is valid and reliable, to establish the reliability of the questionnaires the study used the pre-testing method where questionnaires were distributed to the staff from the other hospitals which were not included in the target population and was chosen to meet the purpose of the study.

In order to find out if the questionnaire actually captured the desired data, a pilot test was conducted to ensure the quality of both qualitative and quantitative data. A pilot study was carried out on five staff of Rwamagana District Hospital and sixteen staff of *Centre Hospital Universitaire de Kigali* (CHUK).

i. Pilot Study

First a pilot study was carried out on five staff of Rwamagana District Hospital and sixteen staff of *Centre Hospital Universitaire de Kigali* (CHUK). The questionnaire section that required the respondent to what level Ncomputing technology was used had the calculated Chronbach alpha equal to 0.672.The section that required the respondent to answer on how computing resources were managed had the calculate Chronbach's alpha equal to 0.667 . Finally for the section which required the respondent to determine how Ncomputing technology affects computing resources , the Chronbach's alpha was 0.715. Therefore, it was clear that the Chronbach's alpha for all the sections on the questionnaire was above 0.6 and therefore the questionnaire was found to be reliable and could be used to measure what is required to measure (Amir & Sonderpandian,2002).

Table 3.2: Pilot Study

Section of questionnaire	Chronbach's alpha	Number of questions
To what level Ncomputing technology is used	0.672	4
To what extent computing resources are managed	0.667	8
To determine how Ncomputing technology affects Computing resources	0.715	6

Source: Preliminary Data

3.5 Data Analysis Procedure

Quantitative data analysis was performed using the Statistics Package for Social Sciences (SPSS) version 20. Editing was carried out to direct any inconsistence in the data which was corrected; each data was given a code to be captured in the computer. This involved editing, summarizing into frequencies, percentages, weighted mean, standard deviation and Pearson correlation were used during analysis of the data. The two interview guides were analyzed qualitatively using content analysis.

3.6. Ethical considerations

An authorization letter was obtained from the Coordinator; School of Postgraduate Studies of Mount Kenya University. Using that letter, acceptance was sought from Nyamata District Hospital management to carry out the research. Each respondent participated voluntarily, following informed consent. Information obtained from the targeted respondents was treated with highest level of confidentiality. In addition, the information obtained during the course of study or emanating from it was strictly used for academic purposes only.

CHAPTER FOUR: RESEARCH FINDINGS AND DISCUSSION

4.0 Introduction

This chapter includes the presentation, analysis and interpretation of the results found. The analysis of the data was aimed at finding out the effects of Ncomputing technology in management of computing resources at Nyamata District Hospital, Rwanda. Data to be analyzed was gathered using questionnaires. The interview guides analyzed using content analysis.

4.1 Demographic Characteristics of Respondents

This section describes the background of respondents by age, level of education and position of the respondents at Nyamata District Hospital.

Table 4. 1 Distribution of Respondents by Age

Age	Frequency	Percentage
Below 30 years	28	43.08
30 - 50 years	34	52.31
Above 50 years	3	4.62
Total (n)	65	100.00

Source: Primary data.

Table 4.1 shows the age of respondents. As shown in Table 4.1, 28 respondents
 (43.08 %) of all respondents were aged below 30 years old while 52.31 % corresponding to 34 respondents were aged between 30 and 50 years old. This is the category having a lot of respondents in the study. The respondents aged above 50 years were 3 respondents corresponding to 4.62 % of all respondents. This indicated the maturity of the respondents as the information provides are reliable and correct.

Table 4. 2 Distribution of Respondents by Education Qualification

Level	Frequency	Percentage
Certificate	4	6.15
Diploma	20	30.77
Bachelor's Degree	32	49.23
First Degree	5	7.69
Masters' Degree	4	6.15
Total(n)	65	100.00

Source: Primary Data.

Table 4.2 shows the level of education of all respondents in the study. The greater portion of the respondents had Bachelors degree level of education that is 32 respondents corresponding to 49.23 % of all respondents. The smaller portions of the respondents in terms of level of education were those with masters degree and Certificate who are 4 respondents corresponding to 6.15% respectively of all respondents. The other part of respondents had A1 Diploma as level of education and they represent 33.77% of all respondents corresponding to 23 respondents while 4 respondents corresponding to 7.69 % of all respondents had first degree as highest educational level. This implies that the respondents picked for the purpose of this research were educated and they gave more informed information, which guided this research.

Table 4. 3 Distribution of respondents by job designation

Response mode	Frequency	Percentages
Accountant	12	18.46
Cashier	16	24.62
Nurse	20	30.77
Internal auditor	1	1.54
Doctor	14	21.54
IT staff	2	3.08
Total	65	100.00

Source: Primary data.

Table 4.3 shows staff job designation, those include accountants as shown by 12 respondents (18.46) of all respondents, cashiers as shown by16 respondents (24.62 %) of all

respondents, nurses as shown by 20 respondents (30.77 %) of all respondents, Internal auditor as shown by 1 respondent (1.54 %) of all respondents, Doctors shown by 14 respondents (21.54 %) of all respondents and IT staff shown by Two respondents

(3.08 %) of all respondents. This implies that majority of respondents picked for the purpose of this research had jobs that required to use and access computing resources and they gave more informed information, guided this research.

4.2 Presentation of Findings

Interpretation of findings was done by combining the scales. The questions involving Likert scale were analyzed by calculating weighted mean where weights are as follows: 5=Strongly agree 4=Agree 3=Not sure 2=Disagree 1=Strongly disagree and n is a total number of Respondents. The weighted mean and standard deviation determined the decision of respondents on dimensions which were mentioned.

4.2.1 Usage of Ncomputing Technology at Nyamata District Hospital

a. Desktop and server virtualization

The respondents were asked for how computers are used at Nyamata District Hospital. The question asked was to help identify whether the response would be categorized as sever virtualization or desktop virtualization.

Table 4. 4 Usage of Ncomputing technology at Nyamata District Hospital.

Usage of Ncomputing technology	n	SA 5	A 4	N 3	D 2	SD 1	WM	Std.
NComputing technology has provided virtual desktop access.	65	35 (53.84%)	25 (38.46%)	5 (7.69%)	0 (0.0%)	0 (0.0%)	4.46	0.639
Ncomputing technology has enabled server virtualization	65	61 (93.85%)	4 (6.15%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	4.94	0.242
Server and Desktop Virtualization	65	45 (69.23%)	15 (23.07%)	5 (7.69%)	0 (0.0%)	0 (0.0%)	4.51	0.831

	are beneficial

Source: Primary data.

Strongly agree (SA), Agree (A), Not Sure (N), Disagree (D) and Strongly disagree (SD).

Key: Std. < 0.5 indicated the respondents' views were more or less unanimous (*i.e* they were crowded around weighted mean). Std.≥ 0.5 indicated that the respondents' views were dispersed (it means there were some respondents with divergent views).

i. Ncomputing Technology has provided Virtual Desktop Access

Table 4.4 shows that 35 respondents strongly agreed that NComputing technology has provided virtual desktop access at Nyamata District hospital. The views of respondents regarding that NComputing technology provided virtual desktop access at Nyamata District Hospital lies between strongly agree and agree, with weighted mean of 4.46. The standard deviation of 0.639 indicated that the respondents' views were dispersed (it means there were some respondents with divergent views).

ii. Ncomputing Technology has enabled Server Virtualization

Table 4.4 shows that majority of respondents (61) strongly agreed that Ncomputing technology has enabled server virtualization at Nyamata District hospital. The views of respondents regarding that Ncomputing technology has enabled server virtualization at Nyamata District Hospital lies between strongly agree and agree, with weighted mean of 4.94. The standard deviation of 0.242 indicated that the respondents' views were more or less unanimous (*i.e* they were crowded around weighted mean).

iii. Desktop and Server Virtualization are beneficial

Table 4.4 shows that majority of respondents (45) strongly agreed that desktop and server virtualizations are beneficial at Nyamata District hospital. The views of respondents regarding that desktop and server virtualizations are beneficial at Nyamata District Hospital lies between strongly agree and agree, with weighted mean of 4.51. The standard deviation of 0.831 indicated that the respondents' views were dispersed (it means there were some respondents with divergent views).

b. The Services using Desktop or Sever virtualization

The respondents were asked to indicate the services which use either of the two virtualization types. Figure 4.1 shows the responses on which services using desktop or server virtualization.
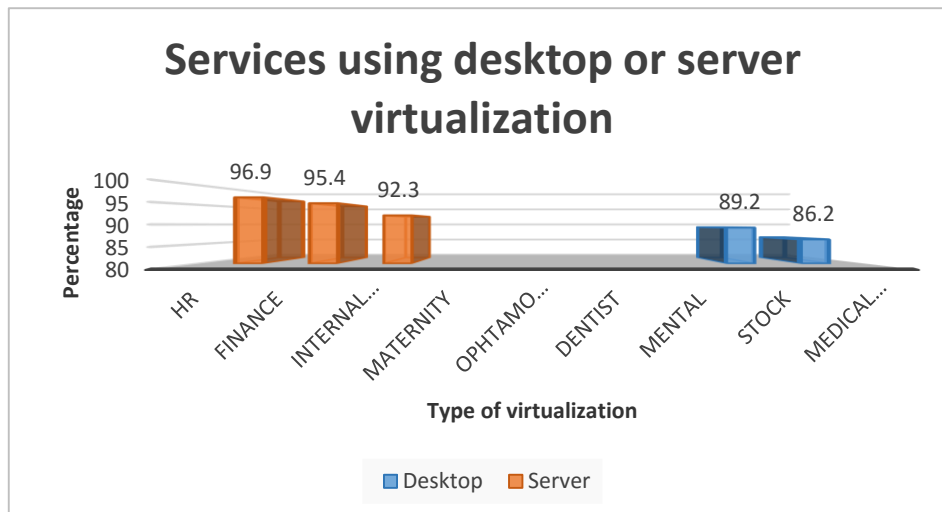
Figure 4.1: Services using desktop or server virtualization
Source: Primary data

According to Figure 4.1, 96.9% of the respondents indicated that Human Resources (HR) uses server virtualization, also 95.4% and 92.3% of finance and internal Medicine used server virtualization. A total of 89.2% in the stock and 86.2% in the Medical services used desktop virtualization. This implies that only stock and medical services used desktop virtualization.

4.2.2 Management of Computing Resources at Nyamata District Hospital.

The management of computer resources in Nyamata District Hospital was investigated under device sharing, centralized management, data back-up and security.

Table 4. 5 Device sharing as a computer resource management

Device sharing features	n	SA 5	A 4	N 3	D 2	SD 1	WM	Std.
At Nyamata District Hospital there is device sharing	65	50 (76.92%)	4 (6.15%)	11 (16.92%)	0 (0.0%)	0 (0.0%)	4.60	0.766
Sharing of device leads to few devices	65	35 (75.38%)	19 (15.38%)	6 (1.54%)	5 (1.54%)	0 (0.0%)	4.33	0.924
Device sharing has increased computing resources availability	65	40 (61.53%)	12 (18.46%)	5 (7.69%)	7 (10.76%)	0 (0.0%)	4.46	0.752
Device sharing leads to reduce computing resources damage	65	43 (66.15%)	15 (23.07%)	0 (0.0%)	7 (10.76%)	0 (0.0%)	4.29	0.931

Source: Primary data

Strongly agree (SA), Agree (A), Not Sure (N), Disagree (D) and Strongly disagree (SD).Key: Std. < 0.5 indicated the respondents' views were more or less unanimous (*i.e* they were crowded around weighted mean). Std.≥ 0.5 indicated that the respondents' views were dispersed (it means there were some respondents with divergent views).

i. At Nyamata District Hospital there is Device Sharing

Table 4.5 shows that majority of respondents (50) strongly agreed that at Nyamata District Hospital there is device sharing. The views of respondents regarding that at Nyamata District Hospital there is device sharing lies between strongly agree and agree, with weighted mean of 4.60. The standard deviation of 0.766 indicated that the respondents' views were dispersed (it means there were some respondents with divergent views).

ii. Device Sharing leads to few Devices

Table 4.5 shows that majority of respondents (35) strongly agreed that sharing of device leads to few devices at Nyamata District Hospital. The views of respondents regarding devices sharing leads to few devices lies between strongly agree and agree, with weighted mean of 4.33. The standard deviation of 0.924 indicated that the respondents' views were dispersed (it means there were some respondents with divergent views).

iii. Device sharing has increased Computing Resources Availability

Table 4.5 shows that majority of respondents (40) strongly agreed that device sharing has increased computing resources availability at Nyamata District Hospital. The views of respondents regarding computing resources availability lies between strongly agree and agree, with weighted mean of 4.46. The standard deviation of 0.752 indicated that the respondents' views were dispersed (it means there were some respondents with divergent views).

iv.Device Sharing leads to reduce Computing Resources damage

Table 4.5 shows that majority of respondents (43) strongly agreed that device sharing leads to reduce computing resources damage at Nyamata District Hospital. The views of respondents regarding device sharing leads to reduce computing resources damage lies between strongly agree and agree, with weighted mean of 4.29. The standard deviation of 0.931 indicated that the respondents' views were dispersed (it means there were some respondents with divergent views).

Table 4.6 Data back-up as a computer resource management

Data back-up features	n	SA	A	N	D	SD	WM	Std.
There is automatic back-up of data	65	50 (76.92%)	10 (15.38%)	5 (7.69%)	0 (0.0%)	0 (0.0%)	4.95	0.611
There is minimal data loss because of data back-up	65	62 (95.38%)	3 (4.61%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	4.97	0.211
Data back-up causes data integrity	65	50 (76.92%)	3 (4.61%)	10 (15.38%)	2 (3.07%)	0 (0.0%)	4.64	0.610

Source: Primary data

Strongly agree (SA), Agree (A), Not Sure (N), Disagree (D) and Strongly disagree(SD).Key: Std. < 0.5 indicated the respondents' views were more or less unanimous (*i.e* they were crowded around weighted mean). Std.≥ 0.5 indicated that the respondents' views were dispersed (it means there were some respondents with divergent views).

i. There is Automatic Back-up of Data

Table 4.6 shows that majority of respondents (50) strongly agreed that there is automatic back-up of data at Nyamata District Hospital. The views of respondents regarding users There is automatic back-up of data lies between strongly agree and agree, with weighted mean of 4.95. The standard deviation of 0.611 indicated that the respondents' views were dispersed (it means there were some respondents with divergent views).

ii. There is Minimal Data loss because of Data Back-up

Table 4.6 shows that majority of respondents (62) strongly agreed that there is minimal data loss because of back-up at Nyamata District Hospital. The views of respondents regarding the minimal data loss because of back-up lies between strongly agree and agree, with weighted mean of 4.97. The standard deviation of 0.212 indicated that the respondents' views were more or less unanimous (*i.e* they were crowded around weighted mean).

iii. Data back-up causes data integrity

Table 4.6 shows that majority of respondents (50) strongly agreed that data back-up causes data integrity at Nyamata District Hospital. The views of respondents regarding data back-up causes data integrity at Nyamata District Hospital lies between strongly agree and agree, with weighted mean of 4.64. The standard deviation of 0.610 indicated that the respondents' views were dispersed.

Table 4.7 Security as a computer resource management.

Security features	n	SA	A	N	D	SD	WM	Std.
Users are provided with username and password	65	58 (89.23%)	7 (10.76%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	4.85	0.364
There is high Information Confidentiality	65	45 (69.23%)	11 (16.92%)	9 (13.84%)	0 (0.0%)	0 (0.0%)	4.55	0.730
Users are assigned roles and responsibilities	65	65 (100.00%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	5.00	0.00
The users of computing resources respect the regulations	65	50 (76.92%)	7 (10.76%)	8 (12.30%)	0 (0.0%)	0 (0.0%)	4.61	0.652
The computer resources are used for what they intend to do	65	46 (70.76%)	17 (26.15%)	2 (3.07%)	0 (0.0%)	0 (0.0%)	4.61	0.651

Source: Primary data

Total number of Respondent (N), Strongly agree (SA), Agree (A), Not Sure (N), Disagree (D) and Strongly disagree (SD). Key: Std. < 0.5 indicated the respondents' views were more or less unanimous (*i.e* they were crowded around weighted mean). Std.≥ 0.5 indicated that the respondents' views were dispersed (it means there were some respondents with divergent views).

i. Users are provided with Username and Password

Table 4.7 shows that majority of respondents (58) strongly agreed that users are provided with username and password at Nyamata District Hospital. The views of respondents regarding use of username and password lies between strongly agree and agree, with weighted mean of 4.85. The standard deviation of 0.364 indicated that the respondents' views were more or less unanimous (*i.e* they were crowded around weighted mean).

ii. There is high Information Confidentiality

Table 4.7 shows that majority of respondents (45) strongly agreed that there is high information confidentiality at Nyamata District Hospital. The views of respondents regarding if there is high information confidentiality lies between strongly agree and agree, with weighted mean of 4.55. The standard deviation of 0.730 indicated that the respondents' views were dispersed (it means there were some respondents with divergent views).

iii. Users are assigned roles and responsibilities

Table 4.7 shows that totally of respondents were strongly agreed that the user are assigned the roles and responsibilities at Nyamata District Hospital. The views of respondents regarding how the user is assigned the roles and responsibilities at Nyamata District Hospital lies on strongly agree, with weighted mean of 5.00. The standard deviation of 0.00 indicated that the respondents' views were absolutely unanimous (*i.e* they were all crowded around weighted mean).

iv. Users of computing resources respect the regulations

Table 4.7 shows that majority of respondents (50) strongly agreed that the users of computing resources respect the regulations at Nyamata District Hospital. The views of respondents regarding the users of computing resources respect the regulations at Nyamata District Hospital lies between strongly agree and agree, with weighted mean of 4.61. The standard deviation of 0.652 indicated that the respondents' views were dispersed (it means there were some respondents with divergent views).

v. The computer resources are used for what they intend to do

Table 4.7 shows that majority of respondents (46) strongly agreed the computer resources are used for what they intend to do at Nyamata District Hospital. The views of respondents the computer resources are used for what they intend to do lies between strongly agree and agree, with weighted mean of 4.61. The standard deviation of 0.651 indicated that the respondents' views were dispersed (it means there were some respondents with divergent views).

Table 4.8 Centralized computing as a computing resource management

Centralized computing features	N	SA 5	A 4	N 3	D 2	SD 1	WM	Std.
There is centralized virus scanning at the hospital	65	56 (86.15%)	7 (10.76%)	1 (1.53%)	1 (1.53%)	0 (0.0%)	4.80	0.618
The coordination and resource are developed effectively	65	30 (46.15%)	20 (30.76%)	15 (23.07%)	0 (0.0%)	0 (0.0%)	4.15	0.972
The quality of ICT is tested	65	36 (55.38%)	14 (21.53%)	15 (23.07%)	0 (0.0%)	0 (0.0%)	4.37	0.840

Source: Primary data

Strongly agree (SA), Agree (A), Not Sure (N), Disagree (D) and Strongly disagree(SD). Key: Std. < 0.5 indicated the respondents' views were more or less unanimous (*i.e* they were

crowded around weighted mean). Std.≥ 0.5 indicated that the respondents' views were dispersed (it means there were some respondents with divergent views).

i. There is centralized virus scanning at the hospital

Table 4.8 shows that majority of respondents (56) strongly agreed that there is centralized virus scanning at the hospital at Nyamata District Hospital. The views of respondents regarding centralized virus scanning at the Nyamata District Hospital lies between strongly agree and agree, with weighted mean of 4.80. The standard deviation of 0.618 indicated that the respondents' views were dispersed (it means there were some respondents with divergent views).

ii. The coordination and resource are developed effectively

Table 4.8 shows that majority of respondents (30) strongly agreed that the coordination and resource are developed effectively at Nyamata District Hospital. The views of respondents regarding the coordination and resource are developed effectively lies between strongly agree and agree, with weighted mean of 4.15. The standard deviation of 0.972 indicated that the respondents' views were dispersed (it means there were some respondents with divergent views).

iii. The quality of ICT is tested.

Table 4.8 shows that majority of respondents (36) strongly agreed that the quality of ICT is tested at Nyamata District Hospital. The views of respondents regarding the quality of ICT is tested lies between strongly agree and agree with weighted mean of 4.37. The standard deviation of 0.840 indicated that the respondents' views were dispersed (it means there were some respondents with divergent views).

4.2.3 Effect of Ncomputing Technology Usage on the Management of Computing Resources at Nyamata District Hospital

The third objective of the study was to establish the effect of Ncomputing technology on the management of computing resources. Pearson's correlation coefficient was calculated to find the nature of relationship and using a significance level $P = 0.01$ to determine the significance of the findings as indicated in Table 4.9 and Table 4.10.

Table 4.9 Correlation between server virtualization and dependent variables

		Device sharing	Data Backup	Centralized Computing	Security features
Server Virtualization	Pearson Correlation	0.951**	0.914**	0.922**	0.926**
	Sig. (2-tailed)	0.000	0.000	0.000	0.000
	n	65	65	65	65

**. Correlation is significant at the 0.01 level (2-tailed).

Source: Primary data

According to Table 4.9, the correlation R between server virtualization and device sharing was R = 0.951; Back-up (R = 0.914, P<.01); Centralized computing (R = 0.922, P<.01) and Security (R = 0.926, P<.01). All the variables correlated positively and significantly implying that server virtualization directly increased device sharing, data back-up, centralized computing and security of the facilities, respectively. The converse was also true, for each of the mentioned variables.

Table 4.10 Correlation between Desktop virtualization and dependent variables (device sharing, data back-up, centralized computing and security features).

		Device sharing	Data Backup	Centralized Computing	Security features
Desktop Virtualization	Pearson Correlation	0.904**	0.817**	0.720**	0.933**
	Sig. (2-tailed)	0.000	0.000	0.000	0.000
	n	65	65	65	65
	**. Correlation is significant at the 0.01 level (2-tailed).				

Source: Primary data

According to Table 4.10, the correlation between desktop virtualization and device sharing was R = 0.904, P<0.01; Back-up (R = 0.817, P<0.01); Centralized computing (R = 0.720, P<0.01) and Security (R = 0.933, P<0.01). All the variables correlated positively and significantly implying desktop virtualization increased device sharing, data back-up, centralized computing and security of the facilities, respectively. The converse was also true, for each of the mentioned variables.

4.2.4 Findings from Interviews

As part of this study, the interviews to IT staff and hospital director were conducted. The interviews were conducted at Nyamata District Hospital in Bugesera district, Rwanda. From these interviews, the following opinions were collected.

i. Content Analysis of Interview Guide for IT Staff

a. The types of Ncomputing technology models are used by Nyamata District Hospital.

Nyamata District Hospital uses X-series model of Ncomputing technology. This model connects directly to the host server through a peripheral component interface card (included) which is installed into the host server.

b. The contribution of Ncomputing technology over computing resources to Nyamata District Hospital.

The hospital got the following advantages after adopting this new technology such as data management (automatic data back-up, data security), easy to manage staff and online printing.

The use of external disks before to implement this technology was a problem where the staff shared viruses and malwares which were a big problem to the hospital, this led the enough data security.

c. How regular maintenance is done in Ncomputing technology in Nyamata District Hospital.

The respondent observed that general maintenance was done once in six month whereas before implementing Ncomputing technology the general maintenance was done four times in a year and curative maintenance was needed most times. Nowadays, however, curative maintenance was done to printers and photocopier machines only.

d. Controlling and planning in Ncomputing technology is it simple or cumbersome.

The respondent observed that Ncomputing technology simplified planning since shared computers use a single license for antivirus, application software and operating system. It was further revealed that the three devices thus server or desktop, access device and monitor simplified controlling since staff accessed the interface using username and password.

e. The advantages from Ncomputing technology over ordinary Desktop usage.

The interview revealed that financially there are a lot of advantages to use Ncomputing technology, single operating system license, one server or one desktop shared by more than six users, single license of antivirus and application software requires few cost compare with use of ordinary computers. The study also revealed that, maintenance costs are very few as it is done two times in a year. The devices facilitate employee in both shifts of day and night.

Also data security increased as automatic data back-up is in place, the security of data is very high and there is no data loss. No other user who can access the data of the other staff. Centralized scanning is available and data integrity is very high.

f. The challenges are encountered during usage of Ncomputing technology.

Each system in all domains have advantages and challenges. This new technology at Nyamata District Hospital has the following challenges as highlighted by IT staff : Linux operating system is not user friendly, power system failure and internet connectivity is a problem due to low bandwidth.

ii. Content Analysis of Interview Guide for Hospital Director.

a. The motivation for using Ncomputing technology than other technologies in Nyamata District Hospital

Ncomputing technology is a technology that allows multiple users to share one computer simultaneously. Nyamata District Hospital got motivation where the staff can share devices as their accessing the shared computer using username and password and there is no data loss on using this technology. When a staff wishes to leave the hospital, there is no need to handover the data.

At Nyamata District Hospital, Ncomputing technology helps staff to share devices where the staff accesses their documents from another office and also the shared printer is used and accessed effectively in the hospital.

b. Ncomputing technology secure the data of Nyamata District Hospital.

The Hospital Director approved that Ncomputing technology provided data security. There is automatic data back-up where the security of data is very high and there is no data loss. No other user who can access the data of other staff. Centralized scanning is available and data integrity is very high.

c. How Ncomputing technology has used to reduce IT requirement cost.

Ncomputing technology devices have long useful life compared with ordinary computers; this helps the hospital to plan and publish few IT equipment tenders. In ordinary computer systems (combination central processing unit, monitor, Keyboard and mouse), each computer must have its own antivirus license every year, operating system and application programs like Microsoft office.

 Ncomputing technology helps Nyamata District Hospital to buy single license for any needed software to be installed on Ncomputing technology shared computer.

Based on functionalities of Ncomputing technology, there is no option to use the external drives (flash disks and external hard disks) where the supply of external devices was not applicable and this provides the IT equipment easy to maintain.

 d. How Ncomputing technology has influenced the employee performance and effort.

Ncomputing technology limits the number of devices on a single work space hence the technology provides a good working environment which is less congested and motivates employees to perform efficiently. The technology was further accredited for providing easy monitoring of employee through the performance form signed by employee.

e. The challenges from using Ncomputing technology at Nyamata District Hospital

The challenges are users attitude to use ICT, power failure and internet connection is a problem due to low bandwidth.

4.3 Summary

This chapter was based on the presentation, analysis and interpretation of the results found. The analysis of the data was aimed to assess Ncomputing technology in the management of computing resources at Nyamata District Hospital. The majority of the staff who participated were aged between 18-50 years.

The data collected in this study revealed that Ncomputing technology provides device sharing, stops data loss, provides centralized computing, provides the use of username and password for security purpose. The majority of the tested staff approved that Ncomputing technology has a positive impact on information management where the data confidentiality is in place, automatic back-up, centralized scan, providing easy monitoring of employee and reduces damaged of hardware and software. The study revealed that there is a negative impacts on usage of Ncomputing technology such us power failure, internet problem due to low bandwidth and statf attitude toward ICT usage. The research found that Ncomputing technology is a technology that provided good computing resources management.

CHAPTER FIVE: SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter focuses on the research conclusions pertaining to the objectives formulated for this study. The first part of this chapter gives a brief summary of the study, which is followed by concluding statements on all the objectives formulated. The conclusions are also compared with previous research to ascertain the consistency or inconsistency of the results. Theoretical implication, recommendations and limitations of this study are also addressed in this chapter. The chapter concludes by highlighting areas for future research.

5.2 Summary

As mentioned in chapter one, this study focused on assessing Ncomputing technology in management of computing resources at Nyamata District Hospital, Rwanda. The findings were described using Frequencies, Percentages, Weighted Means, and Standard Deviation and Pearson Correlation. The correlation coefficients were calculated through the use of SPSS version 20.While two interview guides were analyzed qualitatively using content analysis.

5.2.1 Achievement of the research objectives

The first objective of this study was:

i) *To investigate the usage of Ncomputing technology at Nyamata District Hospital,Rwanda.*

The views of respondents regarding that Ncomputing technology provided virtual desktop access at Nyamata District Hospital lies between strongly agree and agree, with weighted mean of 4.46. The standard deviation of 0.639 indicated that the respondents' views were dispersed (it means there were some respondents with divergent views).

The views of respondents regarding that Ncomputing technology has enabled server virtualization at Nyamata District Hospital lies between strongly agree and agree, with weighted mean of 4.94. The standard deviation of 0.242 indicated that the respondents' views were more or less unanimous (*i.e* they were crowded around weighted mean).

The views of respondents regarding that desktop and server virtualization are beneficial at Nyamata District Hospital lies between strongly agree and agree, with weighted mean of 4.51. The standard deviation of 0.831 indicated that the respondents' views were dispersed (it means there were some respondents with divergent views).

The second objective of this study was to:

ii) *To assess how computing resources are managed at Nyamata District Hospital.*

The second objective of this study was to assess how computing resources are managed at Nyamata District Hospital where four variables are assessed such as device sharing, data back-up, security features and centralized computing. The respondents asked on how Ncomputing technology provided device sharing where views of respondents regarding that at Nyamata District Hospital there is device sharing lies between strongly agree and agree, with weighted mean of 4.60 and the standard deviation of 0.766 indicated that the respondents' views were dispersed (it means there were some respondents with divergent views). The views of respondents regarding that sharing of device leads to few devices at Nyamata District Hospital lies between strongly agree and agree, with weighted mean of 4.33 and the standard deviation of 0.924 indicated that the respondents' views were dispersed (it means there were some respondents with divergent views). The views of respondents regarding computing resources availability lies between strongly agree and agree, with weighted mean of 4.46 and the standard deviation of 0.752 indicated that the respondents' views were dispersed (it means there were some respondents with divergent views). Finally, the views of respondents regarding device sharing leads to reduce computing resources damage lies between strongly agree and agree, with weighted mean of 4.29 and standard deviation of 0.931 indicated that the respondents' views were dispersed (it means there were some respondents with divergent views).

Secondary, variable regarding data back-up the following views are encountered: the views of respondents regarding if there is automatic back-up of data lies between strongly agree and agree, with weighted mean of 4.95 and the standard deviation of 0.611 indicated that the respondents' views were dispersed (it means there were some respondents with divergent views).

The views of respondents regarding the minimal data loss because of back-up lies between strongly agree and agree, with weighted mean of 4.97 and the standard deviation of 0.212 indicated that the respondents' views were more or less unanimous (*i.e* they were crowded around weighted mean). The views of respondents regarding data back-up causes data integrity at Nyamata District Hospital lies between strongly agree and agree, with weighted mean of 4.64 and the standard deviation of 0.610 indicated that the respondents' views were dispersed.

While variable regarding security features have the following views: the views of respondents regarding use of username and password lies between strongly agree and agree, with weighted mean of 4.85 and the standard deviation of 0.364 indicated that the respondents' views were more or less unanimous (*i.e* they were crowded around weighted mean). The views of respondents regarding if there is high information confidentiality lies between strongly agree and agree, with weighted mean of 4.55 and the standard deviation of 0.730 indicated that the respondents' views were dispersed (it means there were some respondents with divergent views). The views of respondents regarding how the user is assigned the roles and responsibilities at Nyamata District Hospital lies on strongly agree, with weighted mean of 5.00 and the standard deviation of 0.00 indicated that the respondents' views were absolutely unanimous (*i.e* they were all crowded around weighted mean). The views of respondents regarding the users of computing resources respect the regulations at Nyamata District Hospital lies between strongly agree and agree, with weighted mean of 4.61 and the standard deviation of 0.652 indicated that the respondents' views were dispersed (it means there were some respondents with divergent views). Lastly, the views of respondents the computer resources are used for what they intend to do lies between strongly agree and agree, with weighted mean of 4.61 and the standard deviation of 0.651 indicated that the respondents' views were dispersed (it means there were some respondents with divergent views).

Lastly, centralized computing variable was assessed where the study found that (86.15%) staff are strongly agreed that there is centralized virus scanning at Nyamata District Hospital, (46.15%) staff are strongly agreed that the coordination and resource are developed effectively at Nyamata District Hospital and (55.38%) staff are strongly agreed that the quality of ICT is tested at Nyamata District Hospital.

The third objective of the study was to:

iii) *To determine how Ncomputing technology affects the management of computing resources at Nyamata District Hospital, Rwanda.*

The third objective of this study was to determine how Ncomputing technology affects the management of computing resources at Nyamata District Hospital, Rwanda. The Pearson correlation revealed that the correlation coefficients, R between independent variable (server virtualization) and dependent variables (device sharing, data back-up, centralized computing and security features) were 0.951, 0.914, 0.922 and 0.926 respectively. In addition, correlation coefficients, R between independent variable (desktop virtualization) and dependent variables (device sharing, data back-up, centralized computing and security features) were 0.904, 0.817, 0.720 and 0.933 respectively. This means that there is a strong positive correlation between server virtualization and device sharing, data back-up, centralized computing and security features, respectively. Similarly, there is a strong positive correlation between desktop virtualization and device sharing, data back-up, centralized computing and security features, respectively.

5.3 Conclusion

The study sought to determine the relationship between Ncomputing technology and management of computing resources at Nyamata District Hospital. It established that Ncomputing technology was well utilized at Nyamata District Hospital by applying desktop virtualization and server virtualization models, respectively. The study also established that there was indeed a very strong correlations between the independent variable (Ncomputing technology) and the construct of the dependent variable (management of computing resources).In particular, server virtualization had very strong positive correlations with device sharing, data back-up, centralized computing and security features, respectively. Similarly, desktop virtualization had very strong positive correlations with device sharing, data back-up, centralized computing and security features, respectively.

5.4 Recommendations

The study recommended that:

5.4.1 Short-term Recommendation

In the short term, the study recommended Nyamata District Hospital administration should provide training to all staff about Ncomputing technology features in order to use the technology frequently and effectively.

5.4.2 Medium-term Recommendations

In the medium term, the study recommended Nyamata District Hospital should provide a secondary server for data back-up which should be hosted outside of the hospital. The hospital should also invest in an automatic standby generator to overcome frequent electrical power outages.

5.4.3 Long-term Recommendations

In the long run, the study recommended Nyamata District Hospital should increase Internet bandwidth to avoid internet failure and to provide modern facilities such as 4G internet. To help all staff to have access on Ncomputing technology. In addition, the Hospital is recommended to update the policies relating to ICT and in particular embrace those in support of further usage of Ncomputing technology.

5.5 Suggestion for Further Studies

1. Since the study was conducted at a particular time, a longitudinal study on effect of Ncomputing technology on institutional computing resources management should be conducted in Rwanda.

2. A study should be carried out by comparing Ncomputing technology and cloud computing in relation to the performance of employees and saving of computing costs and computing resources,respectively.

REFERENCES

Amir,D., & Sonderpandian,J. (2002) *Complete Business Statistics*, 5th edition, New York: McGraw Hill.

Ansari, S., H. & Sharma,K.M. (2014). An Empirical Study on Ncomputing as an architecture that changes the Green Equation. *Int. Journal of Engineering Research and Applications,*4(5), 15-18.

Ayankunle *et al* (2013). The Theory Of User Acceptance and Use of Technology (Utaut): A Meta-Analytic Review of Empirical Findings. *Journal of Theoretical and Applied Information Technology,*49 (1),48-54.

Berg, M. & Van, D.(2003). ICT in health care: Socio technical approaches. *Methods of Information in Medicine*, 42,297-301.

Boughzala *et al*. (2010). *An E-government field study of process virtualization modeling*. In 11th Annual meeting of Group Decision & Negotiation, Delft, The Netherlands, 1-19.

Christian,A. (2012). The 3Es (Energy conservation, Efficiency and Effectiveness): Ncomputing Access Device.*International Journal of mathematics,Engineering and Technology*,3(1),95.

Couzens, D., & Kurteva, D. (2014). NComputing Sponsors eLearning Africa 2014 to Showcase African Success in Educational ICT , *Updates on how African educators are accelerating e-learning in schools, colleges and universities with cutting edge, affordable and simple to manage client virtualisation solutions*. Proceedings of the 9th international conference on ICT in education and training eLearning Africa held in Kampala, Uganda. (pp. 34-40). Kampala, Uganda.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly, 13*(3), 319–339.

Davis, F. D., & Venkatesh, V. (2004). Toward preprototype user acceptance testing of new information systems: Implications for software project management. *IEEE Transactions on Engineering Management, 51*(1), 31–46.

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention and behavior: An introduction to theory and research*. Reading, MA: Addison-Wesley.

Fraenkel,J.R. & Wallen,N.E. (2003).*How to design and evaluate research in education*.Retrived May,21,2015,from www.mhhe.com.

Google. (2015). *Bugesera District Map. Retrieved* August 25, 2015 from: http://www.rwandaenvironment.org/map.html.

Hoang,P. (2010). Automation and computing:Improving energy and power efficincy using Ncomputing and approaches for predicting reliability of complex computing systems.*International Journal of Automation and Computing*,7(2),153-159.

Hosman,L. (2010) IT in education initiative: Macedonia. *Journal of Information Technology & Politics*,7 (4),269-383.

James, A. (1997) *Research Design in Occupational Education*. Oklahoma, Oklahoma State University.

Jayson,W.,Scott,M.Kevin,F. & Nick,J. (2013). Computing initiatives: An open access database.*International Journal of Education and Development using Information and Communication Technology*,9(1),13-14.

Jeffrey,J. (2010). Mechanisms of access to the Internet in rural areas of developing countries,*Telematics and Informatics Journal*,27 (20),370-376.

Kannan,S. (2013). Computing initiatives: An open access database. *International Journal of Education and Development using Information and Communication Technology*,9 (1),11-13.

Kenneth,L. (2006).*The performance and compatibility of thin client computing with fleet operations*. Calfornia: Lieutenant Publishers.

Kumar, P. (2010).*Basic Concept behind Ncomputing Desktop Virtualisation*. Retrieved June 30,2015, from http://ncomputinginaction.blogspot.com/p/about-ncomputing_02.html.

Kusnetzky,D. (2008).*Ncomputing the benefits of operating system virtualisation*. Retrieved June 5,2015, from http://www.zdnet.com/article/ncomputing-the-benefits-of-operating-system-virtualization.htm.

Laundry, K.J. (2006). *The Performance and Compatibility of Thin Client Computing with Fleet Operations*. United States Navy .Unpublished Master's thesis. Naval Postgraduate School, Monterey, California.

Legris.P, Ingham.J, Collerette.P.(2003) Why do people use information technology? A critical review of the technology acceptance model. *Information & Management* 40 (3),191–204.

Marshall,B. (2012). Taking green computing to the computer: Desktop virtualisation. *Issues in Information Systems*,13(1),294-299.

Murray, D. (2007). *Ncomputing changes Economics of PC Access Worldwide*. Retrieved June 5, 2015, from http://www.marketwired.com/press-release/ncomputing-changes-economics-of   -pc-access-worldwide-770193.htm.

Ngganda.S.H. (2011). Reducing Component Time to Dispose through Gained Life.*International Journal of Advanced Science and Technology*,35,107-108.

Nyamata District Hospital (2009).*Nyamata District Hospital annual report*. Nyamata: (Unpublished [Author]).

Nyamata District Hospital (2014).*Nyamata District Hospital strategic plan:2012-2018*. Nyamata: (Unpublished [Author]).

Olof,H. (2011).*ICT in five African countries*.Abidjan:Olokol Publishers.

Omuterema,S.(2013). Factors Affecting sustainability of Low Priced Computers for Learning in Kenya. *International Journal of Emerging Sciences,*3 (2),182-199.

Overby, E. (2008). Process virtualization theory and the impact of information technology. *Organization science,* 19 (2), 277-291.

Overby, E. (EDs). (2012). *Migrating Processes from Physical to Virtual Environments: Process Virtualization Theory* (4th ed.).Springer, New York, USA.

Pal,J., *et al* (2009) . The case of the occasionally Cheap Computer: Low-cost Devices and Classrooms in the developing World. *Information Technology & International Development*,5 (1),49-64.

Parlakkilic,A. (2015). Modular rapid e-learning framework (morejf) in desktop virtualisation environment: An effective Hybrid Implementation in Nurse Education. *Turkish Online Journal of Distance Education*,16 (1),9-10.

Pham, H. (2010). Improving energy and power efficiency using NComputing and approaches for predicting reliability of complex computing systems. *International Journal of Automation and Computing.7(2),153-159.*

Public Service Commission (2012).*Public Service Commission audit report*. Kigali: (Unpublished [Author])

Renatus, M. (2014). Cost Implication Analysis of Ncomputing Adoption: A Case study of Tanzania Education Sector . *Proceedings of the International*

Conference on Computer Science, Computer Engineering, and Education Technologies, 1(1), 113-121.

Renatus, M. (2015).   Acceptance of Desktop Visualization Technology in Education Sectors:A case study of Ncomputing in Tanzania . *The International Journal of E-Learning and Educational Technologies in the Digital Media,* 1(2), 81-91.

Shortliffe, E.H., & Blois,M.S. (2006). *The computer meets Medicine and Biology*: Emergence of a displine.New York: Springer Publication.

Smith, T. (2010, June 20). *NComputing in Education*, White paper education, P.1-12.

Springer. (2011).*Improving energy and power efficiency using Ncomputing and approaches for predicting reliability of complex computing systems*.Retrieved June 23,2015, from http://link.springer.com/article/10.1007/s11633-008-0001-7.

Sugranes, A.B. (2012). *Telemedicine System in the South Atlantic. Phase VII*: *The Case Of South Atlantic Autonomous Region* .Unpublished Masters thesis. Universitat Politecnica De Catalunya, Nicaragua, Central America.

Sarwar,S., Gupta,A. & Vashishtha,V (2014). Green Computing : An Approach Of Saving Energy By Computer Virtualization. . *International Journal of Application or Innovation in Engineering & Management (IJAIEM), 3* (2), 103–105.

Torvinem, T. (2013).Kill your Desktop: Virtual Desktop Hardware and Software.*Official publication of the washoe county bar association journal*, 35 (7),14-17.

Ubonabenshi,J.C. (2015). *Internal Auditing And Financial Management: The Case Of Musanze District* (Masters thesis).Mount Kenya University, Kigali, Rwanda.

Vashishtha,V., Gupta, A. & Sawar, S. (2014). Green Computing: An Approach of Saving Energy by Computer Virtualisation. *International Journal of Application or Innovation in Engineering & Management*, 3(2),103-104.

Venkatesh, V. (2000). Determinants of perceived ease of use: Integrating perceived behavioral control, computer anxiety and enjoyment into the technology acceptance model. *Information Systems Research, 11*, 342–365.

Venkatesh, V. & Davis, F. D.(2000). A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies. *Management Science*, 46(2), 186-204.

Williams, D.(2007).*Virtualization of Xen.* Atlanta:Google Publisher.

Williams, G. (2005).Thin client technology: Evaluation thin-client in sustaining library technology. *Library Hitech News*,7,9-14.

Wingstrand,G. (2010). *Success factor for thin clients* Retrieved July2, 2015, from http://www.divaportal.org/smash/record.jsf?pid=diva2%3A4460788&dswid=2952.

Winkelman,R.J., & Leonardm K. (2004) . Overcoming Structural Constraints to Patient Utilisation of Electronic Medical Records: A critical review and proposal for an evaluation framework. *Journal of the American Medical Informatics Associations*, 11 (2), 151-161.

Yin, R. K. (2009). *A case study research : design and methods.* (4th ed.).Sage Publications, New Delhi, London.

Zedwiz, T. (2011). *What is Ncomputing?* Retrieved May 21,2015, from http://ncomputinginzambia.blogspot.com/2011/01/what-is-ncomputing.html.

ZeroDesktop. (2015). *Emergency medical provider Grupo EMI drastically reduces total cost of ownership*. Retrieved May 21, 2015, from http://www.ncomputing.com/resources/customer success/emergency-medical-provider-grupo-emi-dratically-reduces-total-cost.

APPENDIX I: AUTHORIZATION LETTER FROM MOUNT KENYA UNIVERSITY

Mount Kenya University

SCHOOL OF POST GRADUATE STUDIES

LETTER OF INTRODUCTION

4 th Jan, 2016

TO WHOM IT MAY CONCERN

Dear Sir/Madam,

> NYAMATA HOSPITAL
> A Traiter par. Direction
> Date. 11 . 02 . 2016
> No 85 / 2016

MS. UWINGENEYE CONSOLEE- MIS/0002/11

This is to confirm that the above named person is a bona fide student of Mount Kenya University (Kigali Campus). She is currently carrying out research work to enable her complete her **Master of Science in Information Science (Information and Communication Technology Option)** degree program. The title of her research is:

NCOMPUTING TECHNOLOGY AND MANAGEMENT OF COMPUTING RESOURCES: A CASE STUDY OF NYAMATA DISTRICT HOSPITAL, RWANDA

The information received will be confidential and for academic purpose only.

Any assistance accorded her to complete this study will be highly appreciated.

Thank you.

Tom Mulegi, PhD
COORDINATOR SCHOOL OF POST GRADUATE STUDIES

APPENDIX II: ACCEPTANCE LETTER FROM NYAMATA
DISTRICT HOSPITAL

REPUBLIC OF RWANDA   29th March, 2016

BUGESERA DISTRICT

ADEPR

NYAMATA HOSPITAL
B.O.Box : 7112 Kigali
Tel : 0788130100
E-mail: nyamata.hospital@moh.gov.rw

Dear **Uwingeneye**,

RE: Approval of conducting research project

After review of research protocol of your research project entitled "**Ncomputing Technology and Management of Computing Resources: A Case Study Nyamata District Hospital, Rwanda**" required for completion of your Masters Programme, the Nyamata Hospital Ethics Committee has decided to give you permission to continue your research procedures.
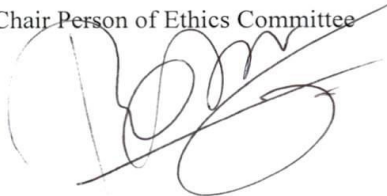
However, the Ethics Committee finally recommends you to:

a. Revise your methodology and clarity the study design
b. Ensure confidentiality of health information from the hospital staff
c. Submit a final copy of your research findings to the hospital administration after completion of the study
d. Consult Nyamata Hospital administration in case you need to publish the findings.

Wish you all the best,

Dr Samuel NDAYISHIMIYE   Approved by **Dr Alfred RUTAGENGWA**

Chair Person of Ethics Committee   Hospital Director

APPENDIX III: INFORMED CONSENT FORM

Informed Consent Form

I, ... confirm that (please tick box as appropriate):

1.	I have read and understood the information about the project, as provided in the Information Sheet dated _____.	☐
2.	I have been given the opportunity to ask questions about the project and my participation.	☐
3.	I voluntarily agree to participate in the project.	☐
4.	The procedures regarding confidentiality have been clearly to me.	☐
5.	The use of the data in research, publications, sharing and archiving has been explained to me.	☐
6.	I understand that no other researchers will have access to this data.	☐
7.	Select only **one** of the following: • I would like my name used and understand what I have said or written as part of this study will be used in reports, publications and other research outputs so that anything I have contributed to this project can be recognised.	☐
	• I do not want my name used in this project.	☐
8.	I, along with the Researcher, agree to sign and date this informed consent form.	☐

Participant:

_____   _____   _____

Name of Participant   Signature   Date

Researcher:

_____   _____   _____

Name of Researcher   Signature   Date

APPENDIX IV : QUESTIONNAIRE FOR NYAMATA DISTRICT HOSPITAL STAFF

I am a student at Mount Kenya University, Kigali Campus pursuing Masters in Information Science (MIS), Information and Communication Technology option. As partial fulfillment of the award of a MIS, I am carrying out a research on "Effects of Ncomputing Technology on The Management of Computing Resources: A Case Study of Nyamata District Hospital, Rwanda" as case study to my research.

Please, you are requested to extend your assistance in this study by answering the following questions according to your observation, knowledge, and feelings. The information you give will be used for academic research purposes and will be treated confidentially.

Hoping to be accorded your best cooperation, I thank you in advance.

SECTION A: DEMOGRAPHIC CHARACTERISTICS OF RESPONDENTS

(N.B Answer by Ticking where applicable)

A: Demographic characteristics of respondents (Staff of Nyamata District Hospital) (Tick where appropriate)

1.   Age (Tick one option only)

 Below 30 years ☐   30-50 ☐   above 50 ☐

2.   Highest Level of Education (Tick one option only)

Certificate ☐ Diploma ☐   Bachelor's Degree ☐   First degree ☐

Masters degree ☐

5.   What is your job designation at Nyamata District Hospital? ☐

Section B**: To what level is Ncomputing technology used in Nyamata District Hospital, Rwanda?**

B1: Tick (√) only one option in each row.

Item	Indicate the level Ncomputing technology is used at Nyamata District Hospital	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
		5	4	3	2	1
1	NComputing technology has provided virtual desktop access.					
2	Ncomputing technology has enabled server virtualization					
3	Desktop and server virtualization are beneficial to you?					

B2: Which of the following services use desktop or sever virtualization?

Which of the following services use desktop or sever virtualization *(please tick the box √)*	Desktop Virtualization	Sever Virtualization
(a) Human Resources (HR) (b) Finance (c) Internal Medicine (d) Maternity service (e) Ophthalmology service (f) Dentists (g) Mental (h) Stock (i) Medical services		

Section C: To what extent are computing resources managed at Nyamata District Hospital?

Tick (√) only one option in each row.

Item	Indicate the level computing resources are managed at Nyamata District Hospital	very well	well	not sure	bad	very bad
		5	4	3	2	1
	Device sharing on management of computing resources					
1	At Nyamata Hospital there is device sharing					
2	Device sharing has increased computer resource availability					
3	Sharing of device leads to few devices					
4	Device sharing leads to reduce computing resources damage					
	Data back-up as a computer resource management					
5	There is automatic back-up of data					
6	There is minimal data loss because of back-up					
7	Data back-up causes data integrity					
8	Users are provided with username and password					
9	There is high Information Confidentiality					
10	The users of computing resources respect the regulations					
11	Users are assigned roles and responsibilities.					
12	Users of computing resources respect the regulations.					

Item	Indicate the level computing resources are managed at Nyamata District Hospital	very well	well	not sure	bad	very bad
		5	4	3	2	1
13	The computer resources are used for what they intend to do					
	Centralized computing as a computing resource management					
14	There is centralized virus scanning at the hospital					
15	The coordination and resource are developed effectively					
16	The quality of ICT is tested.					
17	The quality of ICT is tested					
18	Use of Ncomputing Technology has made provision of availability of computing resources					
19	Use of Ncomputing Technology has provided data back-up that causes data integrity					
20	Use of Ncomputing Technology has reduced damaged of hardware and software					

THANK YOU.

APPENDIX V: INTERVIEW GUIDE FOR IT STAFF

a. What types of Ncomputing technology models are used by Nyamata District Hospital?

b. What is the contribution of Ncomputing technology over computing resources to Nyamata District Hospital?

c. How regular is maintenance done in Ncomputing technology in Nyamata District Hospital?

d. Controlling and planning in Ncomputing technology is it simple or cumbersome?

e. Provide the advantages from Ncomputing technology over ordinary Desktop usage?

f. What are the challenges are encountered during usage of Ncomputing technology?

THANK YOU.

APPENDIX VI: INTERVIEW GUIDE FOR HOSPITAL DIRECTOR

a. What is the motivation for using Ncomputing technology than other technologies in Nyamata District Hospital?

b. Ncomputing technology secure the data of Nyamata District Hospital?

c. How has Ncomputing technology used to reduce IT requirement cost?

d. How has Ncomputing technology influenced the employee performance and effort?

e. What are the challenges from using Ncomputing technology at Nyamata District Hospital?

THANK YOU.

APPENDIX VII: NYAMATA DISTRICT HOSPITAL ORGANIZATIONAL STRUCTURE

```
                    ┌─────────────────────────┐
                    │  Administrative Council │
                    └────────────┬────────────┘
                                 ▼
                    ┌─────────────────────────┐
                    │  Management Committee   │
                    └────────────┬────────────┘
                                 ▼
  ┌──────────┐       ┌───────────────┐       ┌────────────────────┐
  │ Internal │◄──────│    Director   │──────►│ Director Secretary │
  │ Auditor  │       └───────┬───────┘       └────────────────────┘
  └──────────┘               ▼
              ┌─────────────────────────────────────┐
              │  Administration and Finance Manager │
              └─────────────────────────────────────┘
```
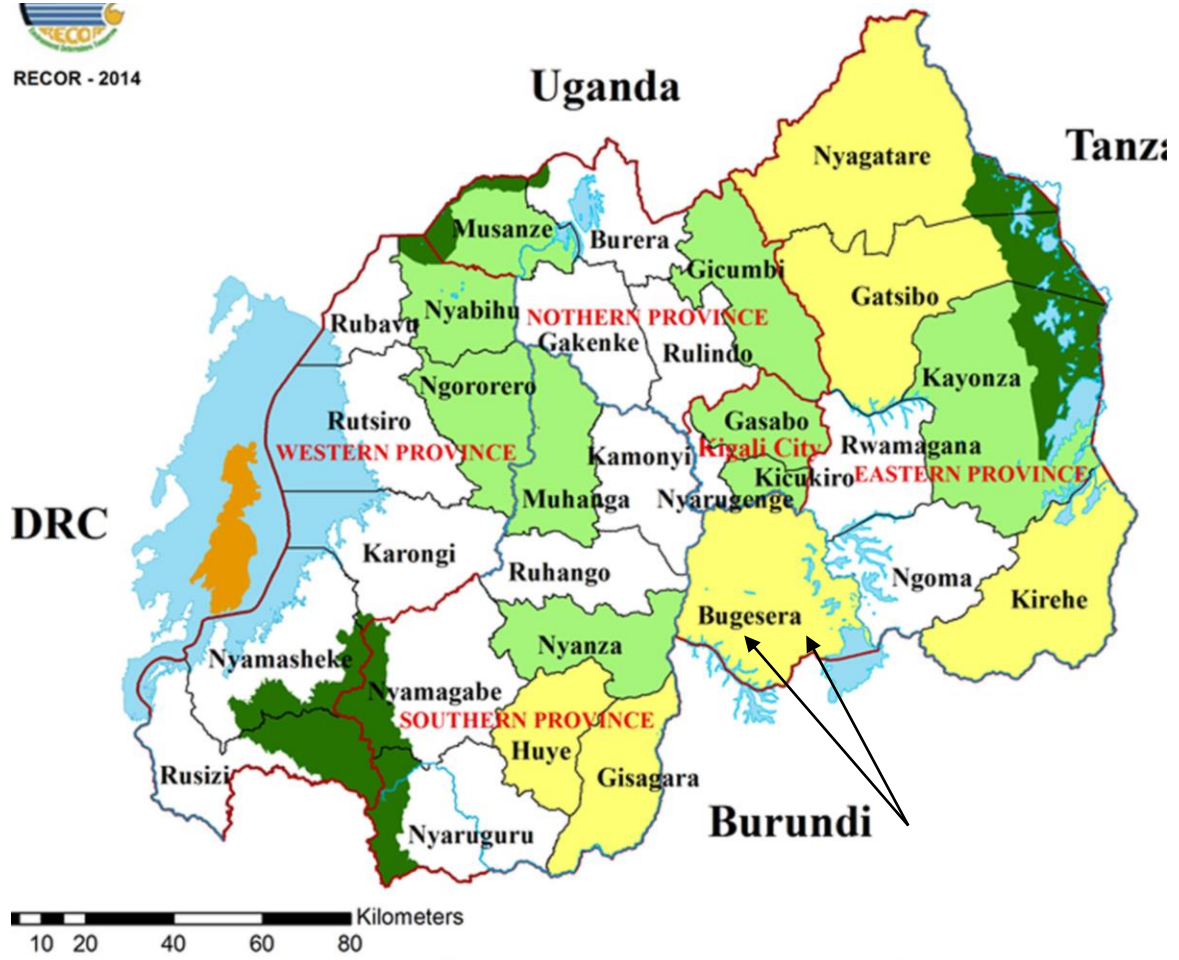
- Chief Human Resources
- IT Staff
- Chief Accountant → Assistant Accountant
- Medical Chief Staff
- Chief Nursing
- Principal cashier → Cashiers
- Stock Officer

Nurse Head of Mental Health → Nurses

Nurse Head of maternity → Nurses

Nurse Head of Internal Medicine → Nurses

Nurse Head of Surgery

Nurse Head of Gynecology → Nurses

Nurses

Nurse Head of Podiatry → Nurses

Med Serv Head of EC

Chief Medical Service CHI-

Laboratory Staff

Radiology Staff
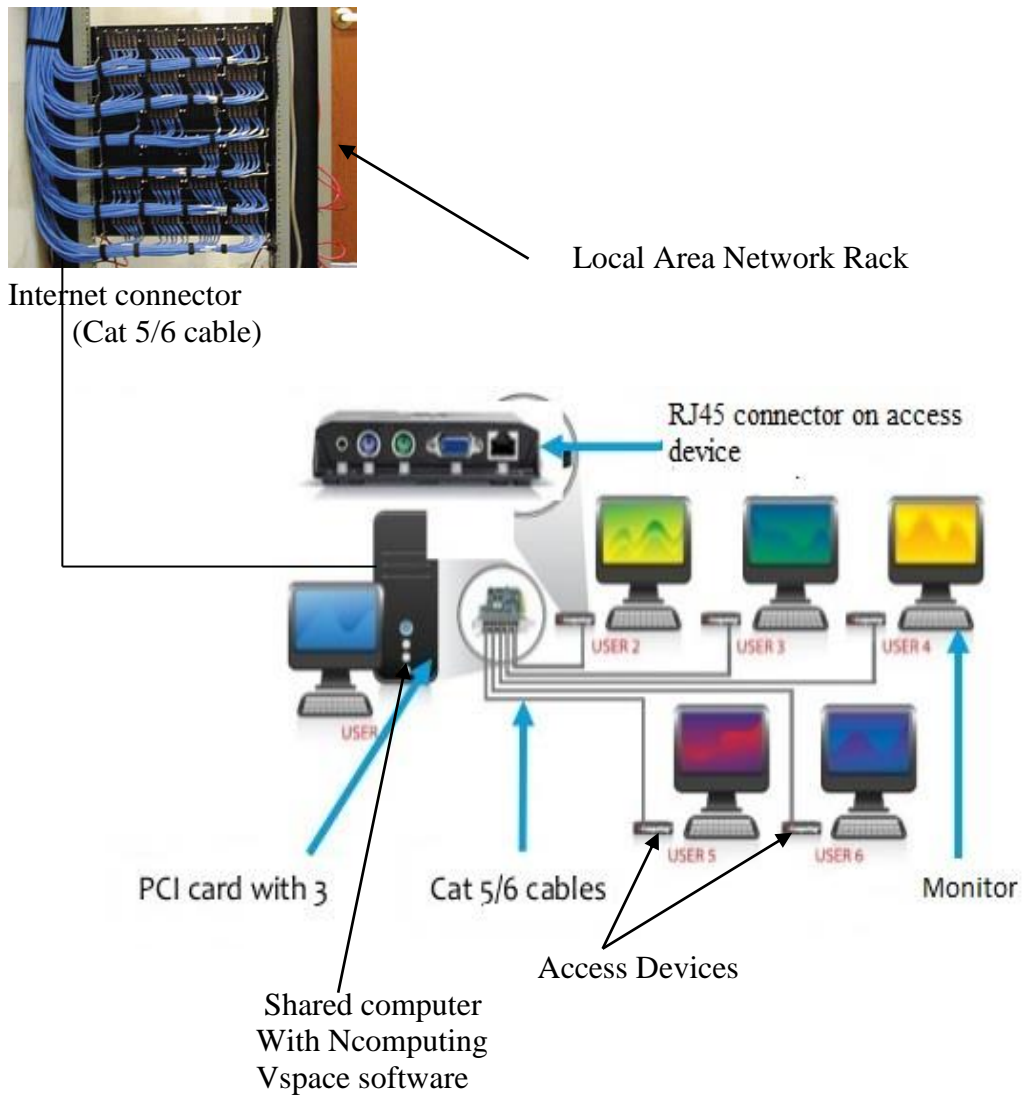
Dentists

Ophthalmology

Source: Public Service Commission (2012)

APPENDIX VIII: MAP OF RWANDA SHOWING BUGESERA DISTRICT

Source: Google (2015)

APPENDIX IX: A DIAGRAM OF NCOMPUTING NETWORK TOPOLOGY USED AT NYAMATA DISTRICT HOSPITAL

Local Area Network Rack

Internet connector
(Cat 5/6 cable)

RJ45 connector on access device

USER 2   USER 3   USER 4

USER 5   USER 6

PCI card with 3   Cat 5/6 cables   Monitor

Access Devices

Shared computer
With Ncomputing
Vspace software

Source: Nyamata District Hospital (2016)