A MODEL FOR EVALUATING TOTAL COST OF OWNERSHIP OF UNIVERSITY ENTERPRISE RESOURCE PLANNING: CASE OF MASENO UNIVERSITY

Patrick Oduor Owoche

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Information Technology of Masinde Muliro University of Science and Technology

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DECLARATION AND CERTIFICATION

Student's Declaration

This thesis is my original work prepared with no other than the indicated sources and support and has not been presented elsewhere for a degree or any other award.

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Patrick Oduor Owoche
Reg. No. SIT/G/6/10

The undersigned certify that they have read the thesis and hereby recommend for acceptance by Masinde Muliro University of Science and Technology a thesis entitled "Model for Evaluating Total Cost of Ownership for University Enterprise Resource Planning: Case of Maseno University"

Signed _____ Date _____

Mr. Kilwake Humphrey Juma
Department of Computer Science
Masinde Muliro University of Science and Technology

Signed _____ Date _____

Prof. Wanyembi Gregory
School of Information Science and Knowledge Management
University of Kabianga

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DEDICATION

I dedicate this thesis to my family and friends for their continued support and inspiration.

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Owoche P. O

ABSTRACT

Enterprise Resource Planning, (ERP) makes it possible to improve institutional efficiency and effectiveness. There is, however, a great deal of difficulty reported in the normative literature when it comes to the evaluation of investments in ERP, with organizations often finding themselves unable to assess the full implications of their ERP implementation. Organizations looking to reduce technology costs typically look for ways to reduce the Total Cost of Ownership (TCO). When properly analyzed, TCO captures all direct and indirect costs related to acquiring, configuring, deploying, managing and retiring a particular asset or system. Each one of these categories is a valuable opportunity to save scarce resources, improve IT and increase productivity. This research is based on cost analysis of an ERP system solution in universities. It explores on how to develop a model for evaluating the total cost of ERP ownership in a university and to provide basis upon which to monitor costs over time. The study sought to identify the major cost drivers that can influence the TCO of ERP in universities, to analyze the TCO of university ERP and to develop a model for evaluating TCO of university ERP. The study identified the major cost factors that can influence TCO in university ERP system as; the number of implementation locations, scope of business impact, technology familiarity among users, life cycle of technology, and the system support. The proposed TCO model was built based on Gartner's TCO model, the Distributed Computing Chart of Account as the theoretical framework. The proposed TCO model has five cost elements which are; procurement costs, hardware and software acquisition costs, implementation costs, operations and maintenance costs and end-user usage costs. The model has seventeen nodes and sixty five background factors. The developed TCO model was used to determine the total cost of owning Maseno University ERP system. The results obtained indicate that operations and maintenance account for 51% of the TCO of ERP system followed by end-user usage with 23%. Hardware and Software Acquisition costs accounted for 16 %, Implementation costs with 7% and the least cost was taken by Procurements costs with 3%. Case study was used in gathering both qualitative and quantitative data from Maseno University. Maseno University currently comprises four campuses; Main Campus, College Campus, Kisumu City Campus and Homa Bay Campus. Interviews, document analysis, questionnaires as well as observation techniques were used to gather the research data. It is hoped that the results of this study will help higher educational institutions improve management of their ERP systems.

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ACRONYMS AND ABBREVIATIONS

CBS – Cost Breakdown Structure

CIO - Chief Information Officer

COCOMO - Constructive Cost Model

CoSN- Consortium of School Network

CVI -Content Validity Index

DECS - Department of Education and Children's Services

ERP- Enterprise Resource Planning

FEC - Federal Electronics Challenge

GAAP - Generally Accepted Accounting Principles

GeSCI – Global e-School and Community Initiative

ICT – Information and Communication Technology

IDG - International Data Group

IFRS - International Financial Reporting Standards

IFRS - International Financial Reporting Standards

IS - Information Systems

ITAM -Information Technology Asset Management

LDC- Least Developed Country

MoE- Ministry of Education

MOEST - Ministry of Education Science and Technology

NCST - National Council of Science and Technology

NETC - Northwest Educational Technology Consortium

OECD - Organization for Economic Co-operation and Development

OSS- Open Source Software

RICE – Reports, Interfaces, Conversions, and Extensions.

FRP – Request for Proposal

ROI - Return on Investment

SA- Southern Australia

SCE -Software Cost Estimate

SLA- Service Level Agreement

SPSS -Statistical Package for Social Sciences

TCO –Total Cost of Ownership

TVO -Total Value of Ownership

VOI - Value of Investment

VPN - Virtual Private Network

WBS - Work Breakdown Structure

CHAPTER ONE

INTRODUCTION

The thesis seeks to evaluate an Enterprise Resource Planning system in a university setup. Specifically, it was to identify the major cost drivers of a university Enterprise Resource Planning (ERP) system, analyze the Total Cost of Ownership (TCO) of ERP system and develop a model of evaluating the cost of ownership of a university ERP.

This chapter introduces the study by discussing the background of the study where existing software cost estimations approaches and methods are reviewed and the available cost and value analyst tools in IT investment are also highlighted. Statement of the problem is stated followed by statement of general and specific objectives and the research questions. The chapter then continues with the scope and limitations and significance of the study. Towards the end of the chapter justification of the study is discussed briefly and it ends with research contributions and assumptions.

1.1. Background to the Study

As Kenyan universities struggle to fulfill the role of drawing on the advantages and potential of new information communication technologies (ICT) in ensuring quality and maintaining high standards for educational practices and outcome in a spirit of openness, equity and international cooperation, the sector faces challenges. The most notable constraint to full exploitation of the ICT facilities is inadequate funding (Mwiria, 2006). As budgets tighten, however, institutions of higher learning are coming

under pressure to articulate the costs and benefits of existing and planned technology expenditures. Increasingly, educational decision makers are seeking evidence that their highly visible investments in technology are meeting educational needs and that these information technology (IT) investments are closely monitored and well-managed. According to a World Bank Institute survey (Gakio, 2006), the state of ICT infrastructure in African universities can be summed up as "too little, too expensive, and poorly managed".

The adoption of tools to measure the cost and value of ICT investment in education are becoming more common. Gartner, a leading IT research firm, came up with the concept of TCO in 1987. TCO is an analysis meant to uncover all the lifetime costs that follow from owning certain kinds of assets. Public sectors have adopted the use of the TCO concept to assist in making decisions about the value for money of ICT deployments. TCO is a comprehensive set of methodologies, models and tools to help organizations better measure and manage their IT investments (Gartner, 2011). According to Forrester research, TCO requires significant investments in time and rigor, and TCO is without a doubt the most thorough and potentially accurate cost-analysis method available to an IT organization (Reichman & Staten, 2008).

Several software cost estimate approaches exist, such as the COCOMO (COnstructive COst MOdel) method and its successor, COCOMO II, developed by Boehm (1983). The approach states that under normal circumstances development costs are a function of

project size. The cost driver ‘size’ is viewed as the most dominant cost driver, not only in COCOMO but also in many other models (Kusters, 1990). Stensrud (2001) concluded that since most software cost estimates (SCE) approaches are based upon the use of the number of lines of source codes (Boehm, 1983) or some synthetic variables such as function points (Albrecht & Gaffney, 1983) to assess the size of the project, these approaches are not immediately applicable to ERP cost analysis. An ERP implementation project may contain some software development, but will also contain substantial modeling, installation and reorganization effort. It seems unlikely that a one-dimensional measure of software size will capture this complexity.

Many analysis tools for measuring IT cost and value have been developed using a variety of methodologies. Some of these tools include Total Value of Ownership (TVO), Return on Investment (ROI) and Value on Investment (VOI). TVO measures the business value of IT investment decisions based on a set of defined measures that model the controllable business activities of an organization (Dell, 2003) while ROI is a project-based financial measure of the economic return from an investment (Hurwitz, 2009) whereas VOI goes beyond ROI by including the costs and related benefits of specific proposed technology projects investment (CoSN, 2011). VOI is a measurement of the expected benefit of an investment. Unlike TCO that only considers the life cycle costs, VOI considers both financial and intangible benefits.

Whereas there is no literature on TCO use in educational institutions in Kenya, studies have been carried out in developed countries. Consortium for School Networking (CoSN) launched its “Taking TCO to the Classroom” project in 1999 in the US to help school leaders understand the long-term costs involved in building and operating a network of computers. Through these, they will be able to budget adequately to cover all the associated costs and build and operate their networks in the most cost-efficient way to achieve their technology goals (CoSN, 2001).

Peterson (2007) asserts that in developing countries that have to deal with constrained resources, financial allocations to ICT must properly take into account the full costs of sustainable ICT systems. However, he further observes that there is a lack of information about ICT costs that can assist Ministry of Education (MoE) decision makers to apportion their budgets between competing demands between the four 'T's' - teachers, textbooks, time and technology. The World Bank notes that there is very little data on the costs of deploying computers in developing country educational contexts (Vital Wave Consulting, 2008).

In Kenya, through session paper No. 2 of 2005, the Ministry of Education Science and Technology (MOEST, 2005) highlights the importance of considering the TCO of ICT in education by emphasizing its importance to budgeting for ongoing maintenance and support, upgrades, and training of support personnel and teachers.

ERP is a software solution that integrates information and business processes to enable information entered once into the system to be shared throughout an organization (West & Daigle, 2004). Universities are implementing ERP system majorly to integrate different administrative functions into a more systematic and cost effective approach to gain a strategic advantage (Rabaa'i, 2009).

Maseno University founded in 1991 lies along the Equator (0^0). It is one of the public universities in Kenya. The University is located in Maseno Township along Kisumu-Busia road, 25 km from Kisumu City and approximately 370 km west of Nairobi the capital city of Kenya. The University offers undergraduate and post-graduate programs in different disciplines. At the time of this study, Maseno University had a total student enrolment of 8,000 registered at the Main Campus, Kisumu City Campus, College Campus and Homa Bay Campus (MUC, 2013). The core activities and central administration of the University takes place in the Main Campus. Apart from academic activities it also runs a hospital, and a hotel. The University implemented the Microsoft Dynamics Nav ERP system in 2008.

1.2. Statement of the Problem

There is little data related to the costs of using ICTs to support education in Kenya. Few good, reliable cost studies of ICT in education implementations exist (Trucano, 2011). Those that do exist measure different things, such as teaching practices, and issues associated with enhancing a student's learning experiences. The MOEST (2005) in

session paper No. 2 of 2005 emphasized the importance of TCO in education but no empirical research has been conducted to this effect.

There has been plenty of research in ERP in Kenya (Otieno, 2010, Abdullabhai & Acosta, 2012, Koech, 2012) however, a clear gap in ERP cost identification, management, and estimation exists. Such cost analyses are needed if real costs of operation and maintenance of ICTs to benefit education are to be undertaken. Such work is especially relevant in education systems that exhibit great resource scarcity (Trucano, 2011). Complete TCO model for evaluation of ERP in the context of Maseno University and Kenyan setup would be a big contribution to the literature and could help to move towards establishing best practices in area of ICT investment management.

1.3. Objectives

This research was guided by a general objective and three specific objectives outlined next.

1.3.1. General Objective

To develop a model for evaluating the TCO of ERP system in a university and to provide basis upon which to monitor costs over time.

1.3.2. Specific Objectives

The specific objectives of the research study are to:

i. Identify the major cost drivers that can influence TCO in university ERP
ii. Analyze the total cost ownership of ERP in a university
iii. Develop a model for evaluating the total cost of ownership of ERP in a university

1.4. Research Questions

i. What are the major cost drivers that influence TCO in a university ERP?
ii. What is the total cost ownership of ERP in a university?
iii. How should a model for evaluating the total cost of ownership of ERP in a university be developed?

1.5. Scope and Limitations

Some of the challenges encountered in ERP implementations in universities include ERP adoption decisions, ERP selection, customization procedures, integration aspects, role of consultants, and ERP system evaluation. However this study concentrated on the cost analysis of Maseno University ERP system. The major limitations in the study were:

i. Given that TCO modeling tracks life-cycle costs, getting the benefits of cost analysis in a single year's budget is not easy.
ii. TCO modeling does not assess how well an ERP system fits with an institution's strategic goals.

iii. Environmental or social costs and benefits are not tracked by TCO modeling.

1.6. Significance of the Study

To develop a TCO model using ERP system dynamics that will enable organizations to better predict the long-term cost of ERP implementations, identify key cost drivers of an ERP deployment and improve decision making process.

1.7. Research Contribution

The study produced a Total Cost of Ownership model that is detailed and specifically focused on ERP system in universities.

1.8. Research Assumptions

i) First data is likely to be incomplete or based around rough estimates

ii) First data helps to focus on what is not know

iii) TCO work should be repeated at regular intervals

iv) TCO analysis should lead to more formal record-keeping

v) Regular TCO analyses are valuable for monitoring and tracking changes over time

1.9. Definition of Terms

Total Cost of Ownership (TCO) is a comprehensive assessment of information technology (IT) or other costs across enterprise boundaries over time. For IT, TCO includes hardware and software acquisition, management and support, communications,

end-user expenses and the opportunity cost of downtime, training and other productivity losses.

Enterprise Resource Planning (ERP) is a comprehensive, packaged software solutions that seeks to integrate the complete range of business's processes and functions in order to present a holistic view of the business from a single information and IT architecture.

Cost Element is a component of total cost of ownership (TCO), "buckets" of cost that can be quantified.

Cost Drivers are factors or activities that can be changed and have an impact on the magnitude of the cost element.

Cost Node is a breakdown of TCO cost element into smaller cost category in line with the project work breakdown structure (WBS), indicating where costs are allocated. The breakdown can sometimes be in line with the company's Chart of Accounts, indicating "what" the costs are for.

1.10. Thesis Structure

In this introductory chapter, the impetus to understand the background and motivations towards the undertaking the study were highlighted, presenting the reader with the research objectives and questions, and potential contributions from the study as well as the scope and limitations and research assumptions. By providing a background to the overall context of the study, the motivations and rationale for the study are put forth.

Chapter 2 presents a review of the relevant background literature. The study highlights the total cost of ownership drivers in ERP deployment, TCO studies, ERP life cycle as well as review of the TCO model development framework. Maseno university ERP system and the theoretical framework are also presented.

In Chapter 3, the research methodology is presented. The methodology used in the study is case study, using a combination of techniques including interview, survey, document analysis and observation. The framework used integrates qualitative and quantitative research approaches. The research procedure, quality control and ethical consideration are also presented in this chapter.

Chapter 4 presents the results of qualitative and quantitative data analysis. The developed TCO model of ERP system in universities is presented and used to discuss the background factor.

In chapter 5, findings of the study are summarized and the conclusion and recommendations of the study outlined. Finally, the chapter concludes the thesis by presenting the directions for future research. Other relevant details not included in the body of the thesis are kept in the appendices.

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview

This chapter starts by looking at the originality, development and implementation of the concept of TCO in the IT industry. Discussion on ERP system and its implementation in universities is presented. TCO cost drivers and the measurement of cost elements of TCO are then highlighted. Studies carried out in the field of ERP TCO are reviewed. The chapter ends with overview of the theoretical framework for the study.

2.2 Total Cost of Ownership and Enterprise Resource Planning

The phrase 'TCO' was originally developed by Gartner Group Inc. a global IT research firm, to refer to all the costs associated with the use of computer hardware and software including the administrative costs, license costs, implementation, hardware and software updates, training, operations and maintenance, and any other costs associated with acquiring, deploying, operating, maintaining and upgrading computer systems in organizations (Moyle, 2004). Bill Kirwin, the Father of TCO defined TCO as the total cost of procuring, using, managing and disposing of an asset over its useful life (Pisello, 2001). The TCO approach considers software, and the IS it supports, placed within its organizational context and related to the business ecosystem from which software, support and services are drawn (Shaikh & Cornford, 2011). The "total" in TCO is expressed by use of an extended life cycle model which recognizes the various stages through which software goes, from selection through acquisition, implementation, use

and finally decommissioning. In other words TCO reflects a measure of all the costs of procuring software, installing it and operating it, and finally the retirement costs found in migrating away from the software. TCO reveals the balance of the direct qualities of competing software products such as price, functionality, reliability and the relationship of the software to the institution's wider set of technology platforms, deployed systems, culture and skills base, and strategic goals, as well as the ability to access market and community based services and support (Shaikh & Cornford, 2011).

Total Cost of Ownership (TCO) refers to a useful accounting system to tally all of the costs associated with a given asset, particularly accounting for costs beyond just the initial purchase price. In order to appreciate the total cost of an asset, costs such as procurement labor, management and support need to be considered. As well, computer assets have hidden costs such as shadow support (peers supporting each other in lieu of formal support) and downtime impacts (Pisello, 2001). Before TCO, many IT executives and even solution providers were unaware of the true cost of computing. TCO made everyone poignantly aware of the issues. In the IT industry, TCO is used to calculate the total cost of purchasing and of operating a technology solution over its useful life. TCO provides a realistic and holistic measure of the long-term costs required to acquire and operate technology solutions (Hurwitz, 2009). The purpose of TCO model is to provide an organization's executive leadership with financial projections with which it can make informed IS business decisions related to a specific project (Konschak, 2010), such as purchase or upgrade of a system for example. Ellram et al.,

(2006) in Supply chain management book lists the following as the reasons for undertaking TCO analysis:

i. Performance measurement
ii. Framework for cost analysis
iii. Benchmarking performance
iv. More informed decision making
v. Communication of cost issues internally and with suppliers
vi. Encourages cross-functional interaction
vii. Support external teams with suppliers
viii. Better insight/understanding of cost drivers
ix. Build a business case
x. Support an outsourcing analysis
xi. Support continuous improvement
xii. Helps identify cost savings opportunities
xiii. Prioritize/focus your time on high potential opportunities

The concept of TCO has been in existence since 1987; however its use in education can be traced back to 1998 when CoSN introduced the “Taking TCO to the Classroom” with the K-12 TCO initiative (CoSN, 2011). CoSN has worked to develop tools and resources to help ensure that school leaders budget adequately to support their technology (Gartner, 2011). CoSN launched its "Taking TCO to the Classroom" project to provide school leaders with tools to help them estimate the TCO for their networked

computing infrastructure. Their TCO also includes calculations of costs that may not turn up in a budget, but that can still have an impact on school district. In 2003, CoSN produced a set of online analyst tools including the development of a TCO framework for use by schools. The TCO tool requires 100 pieces of data to be collected and entered into the database. The online TCO Tool is a vendor-neutral, free resource that until 2013 was only available to schools within the USA (Moyle, 2004).

This online TCO is updated within the USA context using the US Generally Accepted Accounting Principles (GAAP) provisions which differ somewhat from International Financial Reporting Standards. Each country has its own accounting or costing approaches and, therefore, the CoSN- Gartner TCO tool is not a generic tool for use outside the US. Furthermore the tool is customized for educational system of US, which is different from other parts of the world. Moreover, generic TCO model needs to be detailed and focused for specific projects or areas of study and the cost estimation method should be customized to local conditions (Fischer & Lugg, 2006).

Global e-School and Community Initiative (GeSCI) in 2009 developed TCO tools for any educational institution, school or government planning agency that may be interested in deploying ICTs for education (Twinomugisha, 2009). GeSCI appreciates the fact that every region or country has unique accounting or costing approaches. The tool is, therefore, not meant as a "one size fits all", but rather as a starting point to consider alternatives among technology platforms and to develop a reasonable cost

estimate. However, the GeSCI TCO tools can only calculate direct costs of deploying and using ICTs in a classroom. It does not calculate indirect or opportunity costs. It also does not calculate cost increases or reductions as a result of improved or reduced efficiency. It is not designed for ERP in universities and as such it is an electronic tool that is an econometric model for ICTs in Education.

In response to the World Bank finding that there was very little data on the costs of deploying computers in developing country school contexts (Trucano, 2011), Vital Wave Consulting (2008) created a five-year TCO model to enable government leaders to make accurate and reliable investment decisions, that illustrates the true relative costs of hardware, software, teacher training, connectivity, infrastructure, support and maintenance for computers installed in developing-country schools. This TCO model was created based on data inputs from developing-country technology and education experts specializing in (or from) countries from a mixture of income levels and geographic regions including: Chile, China, Dominican Republic, Georgia, Ghana, India, Pakistan and South Africa (Vital Wave Consulting, 2008). However the limitation with this model is its inability to cover performance or usability issues and only looks at the costs of technology. Their TCO model broke down the costs into three categories as initial costs, recurrent costs and hidden costs. Initial costs consisted of retrofitting, cabling and wiring, software, hardware and deployment costs while recurrent costs were composed of support, training, connectivity, electricity, consumables and subscription

costs while hidden costs were replacement hardware, damage or theft, planning, and end-of-life costs.

Even though TCO models developed by Vital Wave (2008) used data samples from selected developing countries, it was not detailed enough to pass as a generic TCO model which can accommodate the varied setting of the countries represented. Different countries within the developing world use different accounting standards and different inflation magnitudes and these waters down the idea of creating a TCO model that can be applied uniformly in different countries.

Though ERP has gained some prominence in the IS literature over the past few years and is a significant phenomenon in practice, ERP systems are not easy to define (Boersma & Kingma, 2005) and there are various definitions of ERP systems just as they are complex and dispersed within and between organizations. Deloitte Consulting (1998) gives a good starting point by defining ERP as a system of packaged business software system that allows a company to:

i Automate and integrate the majority of its business processes

ii Share common data and practices across the entire enterprise

iii Produce and access information in a real-time environment

Esteves (1999) defined ERP system as software packages composed of several modules, such as human resources, sales, finance and production, providing cross-organization

integration of data through imbedded business processes. These software packages can be customized to answer the specific needs of each organization.

ERP is also defined as a software solution that integrates information and business processes to enable information entered once in the system to be shared throughout an organization (West & Daigle, 2004). ERP is also defined as a comprehensive, packaged software solution that seeks to integrate the complete range of a business processes and functions in order to present a holistic view of the business from a single information and IT architecture (Klaus et al., 2000).

From the above definitions it can be seen that the ERP concept can be viewed from a variety of perspectives. First, ERP is a product in the form of computer software. Secondly, ERP can be considered as a development objective of mapping all processes and data of an enterprise into a comprehensive integrative structure. And finally ERP can be seen as the key element of an infrastructure that delivers a solution to business (Klaus et al., 2000).

This study adopted Klaus et al.'s (2000) definition of ERP as a comprehensive, packaged software solution that seeks to integrate the complete range of a business's processes and functions in order to present a holistic view of the business from a single information and IT architecture.

2.3 Total Cost of Ownership Cost Drivers

Cost factor or cost driver is an activity that can be changed and have an impact on the magnitude of the cost element, where cost element is a component of TCO. Cost element is like a "buckets" of cost that can be quantified. The ERP TCO cost drivers are spread throughout the life-cycle phases of the ERP system. According to him, the events that take place during the concept phase are strategic planning and ERP software selection and in the implementation phase the are activities are deployment, integration and stabilization while in the post implementation phase, progress and project evaluation are done.

Various studies have been carried out on the cost drivers of ERP TCO. Aberdeen Group (2007) found that the TCO of ERP of midsize company is among others influenced by:

i) Company size

ii) Number of ERP users

iii) The deployed functionality

iv) Business benefit that are gained from ERP

These findings are in agreement with those of West & Daigle (2004) who identified the major cost drivers within an educational ERP life-cycle as:

i) The nature of organization (for example, a large public, multi-campus system versus a small private institution).

ii) The quality and type of technologies, (for example mainframe versus client-server system).

iii) Management practices (centralized versus decentralized IT operations).

iv) The life cycle of technologies themselves.

In support of West & Daigle's (2004) assertion that the life cycle of technologies themselves is a major cost driver within an educational ERP life-cycle, various studies have shown that the life cycle of technologies is a major cost driver of TCO of ERP system. Keeping old terminal clients and networking devices eventually incur increased support and maintenance costs. Research has shown that older PC's can cost up to 59% more to support than a newer one (Cibecs, 2012). As network and terminal devices age, their support costs increases. Warranties end and new software can face compatibility problems with older machines. Older hardware can negatively affect productivity causing user downtime and wasted IT resources because of increased failures and thus more support requests. Older hardware are also generally not as environmentally friendly as newer machines, requiring more energy and offering less power saving functionality. According to an Intel study, older PC's can use an average of 50% more energy than a new PC (Cibecs, 2012). In tests conducted for energy savings from energy star-qualified servers study, a newer energy star-qualified server running a modern operating system consistently used less power to deliver substantially better performance, compared to an older non-qualified model running an older operating system (Cadmus Group, 2010). Reduced risk of incidents/outages and duration of

outage incidents is another benefit that comes with short hardware refresh cycle. Hardware standardization is another benefit of an efficient technology refresh policy as it reduces IT infrastructure complexity. Life cycle of technology therefore is a major TCO cost driver.

A case study of four ERP implementations done by a vendor of ERP systems and provider of consultancy services relating to the implementation of ERP systems suggested the following as the major TCO cost drivers of the ERP implementation (Palmberg, 2010):

i) Amount of resources allocated to the project by top management
ii) Priority of the project in the organization
iii) Skill and experience of the customer project manager
iv) Control and follow-up procedures
v) Communication between stakeholders regarding expectations and project scope
vi) The amount and complexity of integrations, customizations, data migration and testing
vii) Type of contract regarding pricing and risk sharing
viii) Change management effort

Another study exploring ERP adoption cost factors (Haddara, 2012) suggested that the ERP cost drivers are as shown in figure 1. In the figure, Haddara show the cost drivers

with the percentages they account for in a typical ERP deployment, however the end user usage costs such as training and downtime are not shown, and this makes it incomplete.

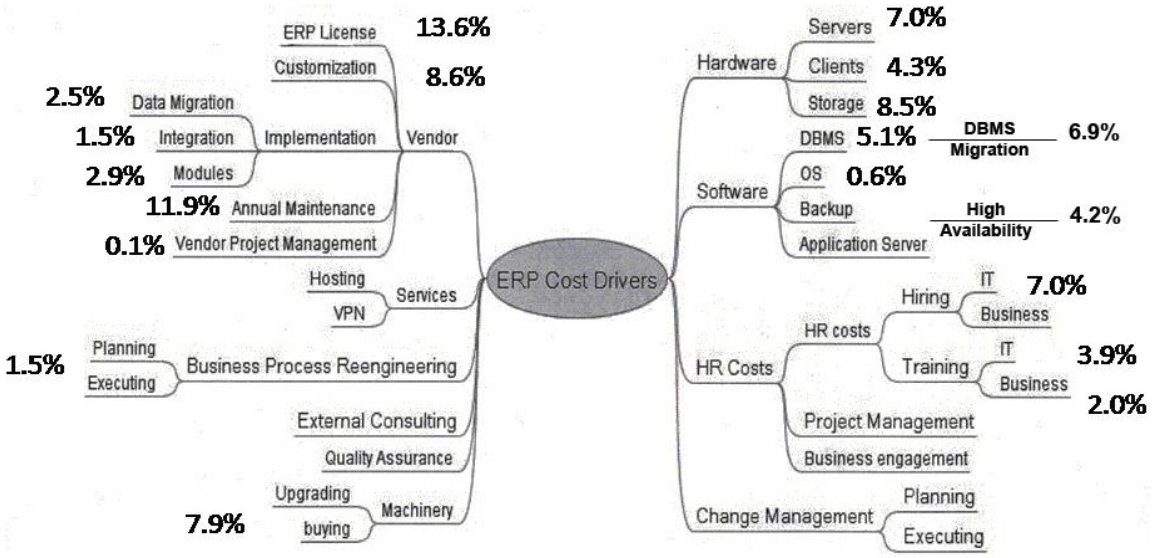

Figure 1: List of ERP cost drivers with percentages (Source: Haddara, 2012)

Hest (2013) identified and categorized ERP TCO costs as acquisition & implementation costs and usage costs. Table 1 show the acquisition & implementation costs and Table 4 has the usage costs.

Table 1: Costs drivers during the acquisition and implementation phases of ERP (Source: Hest, 2013)

Phase	Cost category	No.	Cost driver
Acquisition costs	Consultancy	1	Availability of consultants
		2	Experience and quality of consultants
		3	Process standardization and harmonization
		4	Pressure due to cutting project duration
		5	Sound ERP project plan
	Other costs	6	Project organization with key decision makers/ champion
		7	Project organization with key subject matter expert
		8	Management commitment
Implementation costs	Consultancy	9	Availability of consultants
		10	Experience and quality of consultants
		11	Process standardization and harmonization
		12	Configuration and customization magnitude, number of RICE objects
		13	Pressure due to cutting project duration
		14	Implementation approach
		15	Complexity of data conversion
		16	Coherence between implemented modules
		17	Management commitment
		18	Monitoring and performance management
	Software & licenses	19	Number of users
		20	Breadth and depth of ERP solution
		21	Number of user groups
		22	Number of modules
	Hardware	23	Required hardware
		24	Required data storage
	Business process redesign	25	Required degree of business process re-engineering
		26	Number and complexity of involved processes
		27	Process standardization and harmonization
		28	Number and complexity of interfaces
		29	Number and complexity of transactions
		30	Fit between organization and ERP system
	Training	31	Required effort of employee/user training
		32	Training effort realized in practice
		33	Current quality of employees
		34	Availability of training
		35	Availability of users
	Other implementation Costs	36	Maturity of project organization (e.g. contracts)
		37	Sound testing plan

Table 2: Cost drivers during usage phase of ERP (Source: Hest, 2013)

Phase	Cost Category		Cost driver
Usage Phase	Software & license	38	SaaS contracts
		39	Future licensing policies
		40	Introduction of new information flows and processes
	Hardware	41	Frequency of change of hardware
		42	Fixed trough service agreement
		43	Hosting
	Training	44	Continuity of employees
		45	Technology change in ERP software
	Usage	46	Cost of facilitating ERP
	Maintenance	47	Technology change in ERP software
		48	Frequency of change in demands
		49	Availability of updates/new applications
	Support	50	Support contracts
		51	Availability of updates/new applications
	Personnel	52	IT personnel

Hest, (2013) categorized cost in three classes as acquisition phase costs, implementation phase costs and usage phase costs together with their cost drivers. However, just as the other findings highlighted in this section, Hest (2013) also did not include the downtime as a cost driver.

2.4 Total Cost of Ownership Analysis

There is no formal work currently available from Kenya on either TCO per se, or on total cost of ERP ownership. There is, however, some recent work on TCO in schools emerging from overseas and particularly the USA, upon which the study can draw. A study done by Unisys, a technology company, illustrates their findings of direct and indirect costs of ICT deployment in an Australian education system conducted in late 1999-2000 (Moyle, 2004). The findings shows that direct costs which are the costs of

hardware, software, operations and administration account for 56% of the TCO while indirect costs, that is the costs of downtime and end user operations account for 44% of the TCO. A case study on university ERP conducted at the Albany, State University of New York revealed TCO cost breakdown with employee salary taking the lion's share of TCO with 46%, equipment and software purchase accounted for 11% and 10% respectively. Software maintenance consumed 15%, consulting 9%, equipment maintenance took 3%, training and travel accounted for 4%, while miscellaneous and personal services each accounted for 1% of the TCO (Fryling, 2010).

A Gartner Group study found that only 20% of TCO lies in initial acquisition costs; the rest lies in administration costs (David, 2002). This makes it difficult for organization to gain a competitive advantage by reducing the purchase cost of its hardware and software, but they have significantly greater control of over 80% of IT expenditure they direct toward administering their IT system. In another study it was found that licensed software, licensed software support and professional services are the three top drivers of costs in IS TCO expense analysis (Konschak, 2010). In reviewing the cross-organizational scope of this analysis, it becomes clear that the TCO is driven by processes, people, technology and tools and comprises all costs expected in a defined timeframe. The timeframe might cover three, five, or ten years for some projects.

Case studies of large, medium, and small school districts, conducted by the CoSN (Kaestner, 2009) indicate that technology, direct labor and indirect labor share of the

TCO for each is 23 percent for technology (amortized over useful life), 21 percent for direct labor, and 56 percent for indirect labor. A TCO case study conducted in California school district which serves 148,000 students in kindergarten through grade 12 in an urban setting with 187 schools, including 16 high schools, 23 middle schools and 114 elementary schools revealed that Two-thirds (67.7 percent) of the TCO consisted of indirect costs (Stegman, 2003).

Based on the TCO model, a study inquired into the captured expenditure of selected Rwandan higher education institutions on the major TCO cost drivers. The study revealed that institutions often succeed in acquiring computing devices, but they commonly lack the resources needed for the acquisition of relevant hardware and software accessories; train staff to utilize the procured ICT facilities; service and upgrade the facilities acquired and replace them when they become obsolete; and meet recurrent costs of electricity and network subscriptions (Ssempebwa, 2007). This is evidence of under facilitation, which is due to lack of awareness about the TCO of functional IS.

Hence, there is need for a strategic framework within which the total cost of owning a functional IS might be identified and articulated to pertinent higher education institutional managers and policy makers.

2.5 Total Cost of Ownership Models

The Federal Electronics Challenge (FEC) (2007) a partnership program that encourages USA federal facilities and agencies to reduce the impacts of electronics during use defines TCO modeling as a tool that systematically accounts for all costs related to an IT management decision. It suggests that TCO includes all costs, direct and indirect, incurred throughout the life cycle of an asset. A good TCO model incorporates hardware and software costs, installation and license tracking, warranties and maintenance agreements, as well as vendor financing options. It must also include operational expenditure such as power, testing, deployment costs, training, education costs, as well as security assurances and upgrades. Other major considerations are long term expenses versus up-front costs, replacement of equipment costs, and future scalability requirements (Griliches, 2009).

Gartner in 2006 provided a ten step process to produce a reliable estimate of the cost and the duration of ERP implementation projects (Phelan, 2006). They include:

i) Process design

ii) Core and supplemental staffing needs

iii) Data conversion

iv) Customization and interface development

v) User training

vi) Project management

vii) Organizational change management

viii) Pilot deployment and rollout to remote sites

Gartner's ten step process is limited to costs associated with the implementation process and more studies are required to capture the costs associated with the operation and maintenance phase of ERP deployment to come up with a comprehensive TCO of ERP model.

2.5.1 Enterprise Resource Planning Total Cost of Ownership Models

In mid-2004 SAP the world's largest inter-enterprise software company and the world's fourth-largest independent software supplier, undertook a major revision of its thinking on TCO and developed a comprehensive TCO Model (SAP, 2005). The SAP TCO model has a total of 22 level-three parameters that cover the key cost factors in enterprise software implementations as shown in the Figure 2.

The SAP model is very comprehensive and captures most of the cost associated with the deployment of ERP system. However the SAP TCO model is vendor dependent and only available to SAP customers. This limits its adoptions to non SAP ERP systems.

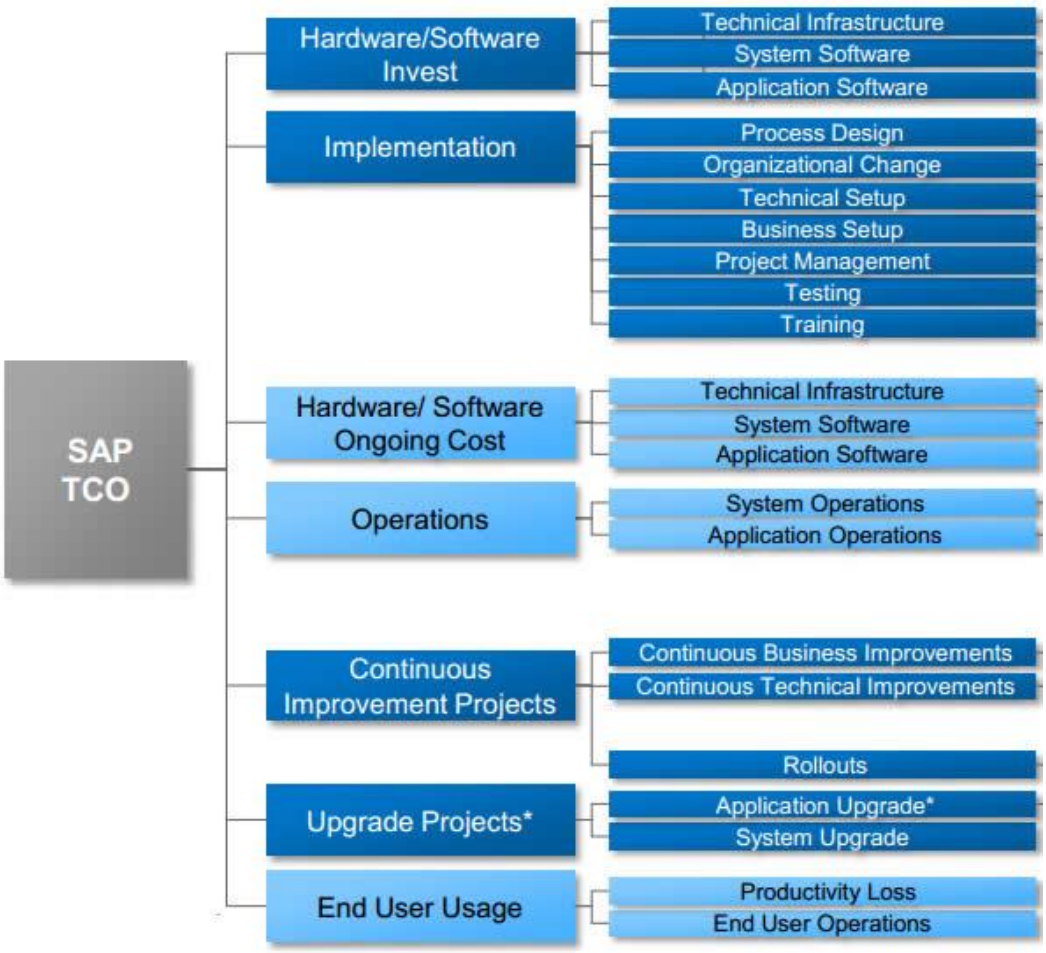

Figure 2: SAP TCO Framework (Adopted from: SAP, 2005)

Another comprehensive framework for assessing the cost of IT investment in organizations was developed by Närman, Sommestad, Sandgren, & Ekstedt in 2009. Their framework is intended to support IT investment decisions by estimating total life cycle costs and the background factors that influence the costs. The authors suggest that organizational factors play a significant role in the life cycle costs of IT deployment. The framework incorporates both the technical and organizational factors in the cost analysis of IT investment. The organizational factors include change management costs,

training costs, personnel restructuring costs, restructuring costs for operations and maintenance of organization and post implementation productivity loss.

On the other hand technical costs are incurred through technical implementation of the system. The framework goes an extra mile to include 79 background factors. Background factors are cost drivers that impact the cost nodes of the framework one way or another. The cost taxonomy in the framework consists of 21 elements, as illustrated in Figure 3.

The model is for a general IT deployment and does not target specifically standard ERP implementation projects. However the developers posit the model is suitable for any Commercial off-the shelf (COTS) software as they have predictive deployment costs. However, integration costs and business process re-engineering costs become more notable cost drivers in such implementations. The authors also stress the importance of taking the varying uncertainty of the predictions into account, so that decision makers are able to determine the risk associated with the investment decision (Närman et al. 2009).

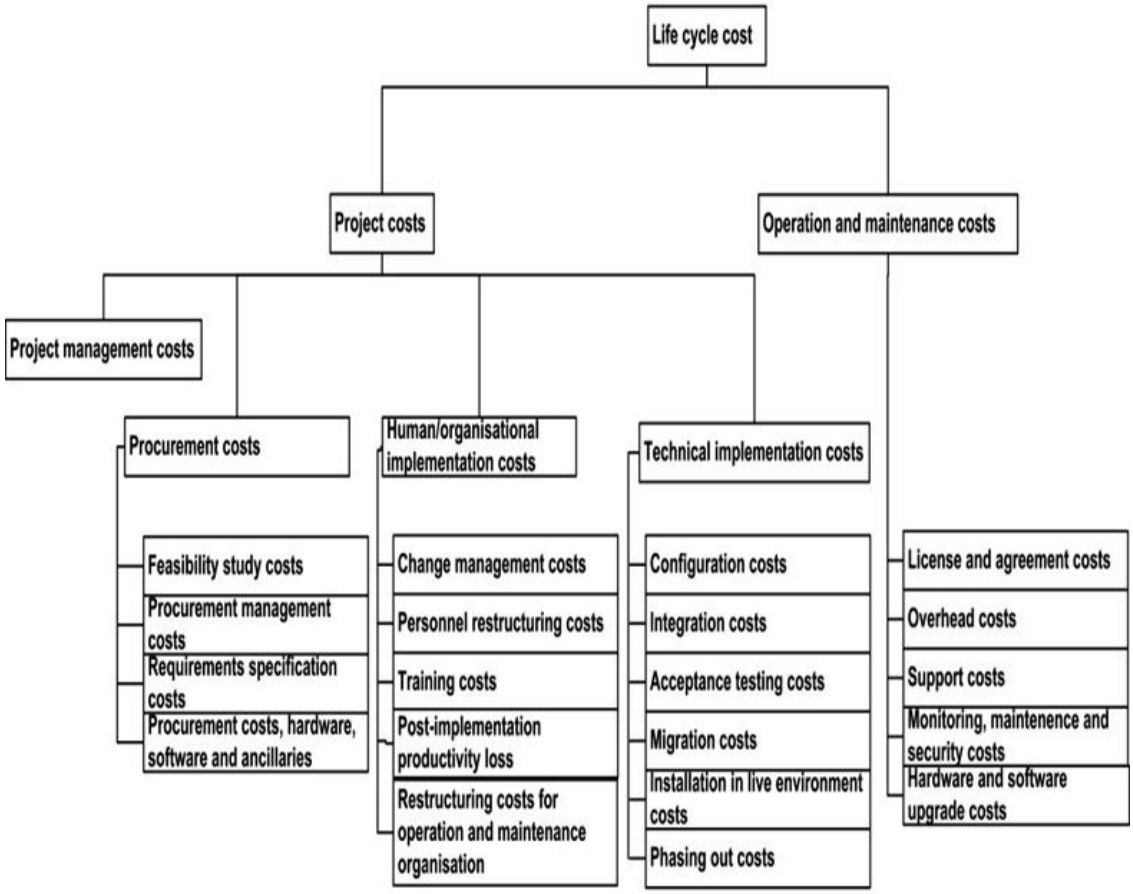

Figure 3: Cost Taxonomy (Source: Närman et al.'s, 2009)

Most of the data on TCO are drawn from the private, corporate sector (West & Daigle, 2004). The management, procurement and processing of the nonprofit, academic culture may be quite different. There are two layers of bureaucracy i.e. academic and public that is not in private and corporate sectors where the TCO data are drawn. The stake holders in universities especially public universities are more diverse and their interests may conflict. The university may want the best value while the government may require the lowest bid. Faced with such challenges the vendor or consultant developed TCO may not be fit for the TCO of university ERP analysis. Furthermore there is no generic TCO

model and the cost estimation method should be customized to local conditions. In support of Fischer et al.,(2006), Ferrin (2002) asserts that research has shown that it is in general very difficult to make TCO-calculations, and that there is a need for more case based research to increase knowledge of how cost drivers work in different settings.

2.6 Enterprise Resource Planning Life Cycle

ERP life cycle includes management from conception to obsolescence, including ERP revisions and upgrades. Aloini (2007) identified the phases of ERP life cycle as concept, implementation and post implementation. In general, an ERP life cycle consists of three major phases: pre-implementation, implementation, and post-implementation. The pre-implementation phase is also known in slightly varied forms and names such as the planning phase, the acquisition phase, or the procurement phase. West & Daigle (2004) identified five major ERP life-cycle component of TCO analysis as acquisition, implementation, operations, maintenance and replacement as shown in figure 1. The shape of graph depicts how the costs are spread over the ERP life cycle.

In this study the ERP life cycle is discussed under three phases, which are acquisition (pre-implementation), implementation and operations and maintenance (post-implementation).

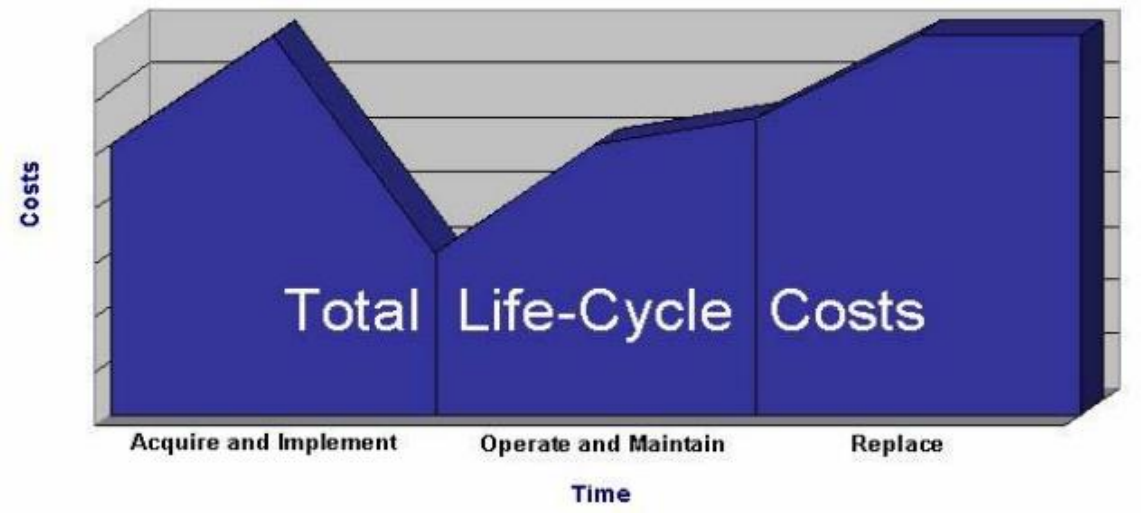

Figure 4: TCO in ERP: Life-cycle Cost (Adopted from: West & Daigle, 2004)

2.6.1 Enterprise Resource Planning Acquisition

The acquisition phase is typically kicked off soon after the idea of ERP adoption is initiated, which may originate from the perceived business needs of the institution, or be inspired by an external party such as a business or IT consultant. Verville & Halingten, (2003) identifies five activities that occur during ERP acquisition phase as planning, information search, selection, evaluation and negotiation. Another study identified formation of acquisition team, examination of business requirements and constraints, formulation of evaluation criteria, and evaluation and selection as the four stages of acquisition phase (Poon & Yu, 2006) while Bradford (2009) grouped planning and selection as the two main activities that take place during pre-implementation phase of ERP life cycle. This study decomposes the pre-implementation into four broad categories as feasibility study, requirement specifications, procurement management and project management.

i) Feasibility Study

Feasibility study can be defined as the process of collecting information and data about a proposed project, then analyzing the same from the financial, operational, economic and technical aspects, in addition to sensitivity analysis, in order to be aware of the extent of such project success, under the prevailing circumstances in the market (Alehremi, 2009). The purpose of a feasibility study is to determine if a business opportunity is possible, practical, and viable (Hoagland & Williamson, 2000). Expenses incurred in this stage are influenced by vendor maturity, integration issues and established vendor relationship. For mature vendor, implemented products will be easily found and their profile determined as compared to immature vendor. Established vendor relationship may also lower the cost of feasibility study since reliability of the vendor can be ascertained from past transactions.

ii) Software Requirement Specification

ERP requirements specification is a comprehensive description of the intended purpose and environment for ERP software under development. It fully describes what the ERP system software will do and how it will be expected to perform. The purpose of requirement specification is to:

a. **Communicate** – explain the application domain under and the system to be developed.

b. **Contractual** - may be legally binding and expresses agreement and a commitment

c. **Baseline for evaluating the software** - supports testing and provides basis upon which to verify whether delivered system meets requirements.

d. **Baseline for change control**

ERP project costs associated with this stage are those costs that manage requirements specification. Requirements specification costs are driven by the number of systems included in the scenario, departments and units involved, and the number and depth of function changes.

iii) Project Managements

Effective project management is critical to the success of ERP implementation (Nah & Delgado, 2006). Due to the large number of parties involved in an ERP implementation, it is critical to coordinate project activities across all affected parties. Project management involves activities necessary to ensure the successful completion of the project. Project management activities include project control, project planning, status reporting, issue management, change management, risk management, and quality management.

iv) Procurement management

Procurement management is a process by which items are purchased from external suppliers. The procurement management process involves managing the ordering, receipt, review and approval of items from suppliers. It includes the contract

management and change control processes required to develop and administer contracts or purchase orders issued by authorized ERP project team members. Schapper, et al., (2006) asserts that common procurement management policies are generally constructed from public confidence, efficiency and effectiveness, policy compliance elemental objectives.

The ERP project costs in this stage are related to evaluating offers and drafting agreements. Procurement management costs are determined by the number of potential vendors. The higher the number of potential vendors the more resources will be required in the procurement process.

2.6.2 Enterprise Resource Planning Implementation

ERP implementation is a very complex body of work, which includes several closely related processes (selection, analysis, customization, support) and demands both IT and business knowledge. The implementation stage of the ERP life cycle involves a number of activities that must be managed effectively in order for the project to be a success. Bradford (2009) identified installation, configuration, customization, testing, change management, interfacing with other systems and training as the major steps in ERP implementation phase. Närman et al., (2009) identified activities that take place during implementation phase as change management, personnel restructuring, training, configuration, integration, acceptance testing, migration, installation in live environment, and phasing out the old system. This study considered

organizational change management, technical setup, personnel restructuring, and training as the main stages that are performed during implementation phase.

i) Organizational Change Management

Organizational Change management is a human side of ERP implementation. It is a structured approach to managing change in individuals, teams, organizations, and societies that enables the transition from a current state to a desired future state (Bradford, 2009). As argued by Umble et al. (2003), ERP implementation is not just a software project but an organizational change project. As changes take place, employees should be coached on why the change is important. This appreciation will require education; not just how to execute the new processes, but also why the new processes are important to the institution and the employee. Change management costs are affected by the complexity of business process redesign, the geographical spread of the business locations and the number of units involved.

ii) Technical Setup

Technical setup focuses on the technical aspects of the implementation which includes installation, configuration, customization, and testing (unit, integration, customer acceptance, security and performance load testing). It is important to note that installation and implementation are two different concepts. Bradford (2009) defines installation as the mechanism of changing from one software package to another while keeping problems at a minimum and implementation as the methods an

organization uses to achieve their goals by transforming the way they carry out operations.

ERP cannot be installed unless there is an instance to run it. An instance is an installation of ERP software and related components. Organizations use a sandbox instance (development instance) so that configurations and customization can begin as quickly as possible. Often, when a company is widely geographically dispersed or operates as a number of distinctly autonomous departments, divisions, or entities, separate instances of the ERP software is required (Bradford, 2009). The ERP software may support the same processes and the same roles, but may be configured and customized differently for a variety of reasons. Bradford argues that when separate instances emerge it means that the system is going to be really expensive and become fragmented quickly and another reengineering effort is right around the corner.

Once the sandbox instance of ERP has been installed, configuration work begins. Configuration is a major implementation task in which business and functional settings in the ERP system are changed to make the "out of the box" software support the customer's business needs. Configuration does not make any changes to the core software code, but instead updates tables with settings and entries specific to the customer's business.

Customization follows system configuration. Nicolaou, (2004) describes customization as the changing of the software to fit the already existing business processes in order to cater for organization specific and/or country-specific requirements. Customization requires programming, which must be performed by a programmer/developer, whether in-house (if expertise exists within the company), or external by a consultant. Customization is generally done in order to fill gaps found in requirements analysis or to extend functionality. This enables organizations to get exactly what they require.

Once the system has been installed, configured and maybe customized, it must be tested prior to deployment. Testing confirms that the software behaves as expected and customer expectations are met. During testing the project team fine-tunes the configuration of the software and refines the models for new business processes. They confirm the software can meet the previously specified requirements, identifying gaps not found during the package selection phase.

Loen, (2007) identified costs incurred during the entire ERP implementation phase and grouped them into two categories. The first group includes insufficiently identified costs related to an incorrect calculation of the direct amount of project work: customization, interaction and testing, data conversion, data analysis. The second group is related to interruption possibilities and work efficiency fluctuations of internal staff members during the ERP implementation project: trainings, brain drain (employee turnover), and

ongoing maintenance. Other costs that incurred in this phase are configuration, integration, organization change management, personnel restructuring and consultancy costs. Monk & Wagner (2006) observes that the total cost of implementation could be three to five times the purchase price of the software.

2.6.3 Operation and Maintenance

Operations and maintenance are the main phases of the ERP lifecycle, as they incur heavy recurring costs over the ERP's lifecycle. Both of these phases are process and people oriented, hence it is difficult to assess hidden costs, yet in these phases most of the indirect costs reside and direct costs are shifted away (Havrici, 2011). Some of the activities that are undertaken in ERP operation and maintenance phase are license agreement management, overhead management, monitoring, maintenance and security management, system support and upgrade.

Maintenance activities begin shortly after go-live. Typical maintenance activities include:

i. Preventive maintenance – regular scheduled tasks that must be performed to keep the system functioning properly.

ii. Emergency maintenance – restoration work that must be performed immediately.

iii. Adaptive maintenance – ERP vendors constantly fix bugs, implement best practices and incorporate the feedback of their customers in their software.

Organizations choose to upgrade their ERP systems due to various reasons such as (Bradford, 2009):

i. Competitive advantage - New features and capabilities give the company an edge over its competitors.
ii. Globalization - Features and updates designed to increase the flow of information to customers and business partners can increase the ability to operate globally.
iii. Integration - Enhancing the flow of information between the ERP system and other systems within the company increases operational efficiency and improves communication.
iv. Best practices - Incorporating new best practices allows the firm to operate more efficiently.
v. Cost reduction - Lowering administrative overhead and improving the support offered by the ERP vendor results in lower operating costs.

The costs incurred in this phase are both direct and hidden. End-user training, development of a properly skilled and trained IT team for internal support, use of the most suitable implementation strategy, availability and cost of new upgrades and benchmarking of daily operations are few centers which require special focus when trying to identify the hidden costs of the operations and maintenance phases. Bradford (2009) argues that according to research, up to 70% of companies' total ERP costs relate to service and maintenance. In SAP ERP maintenance and support contracts, the

annual maintenance fee is calculated as a percentage of the software contract value, which is the total value of all package and named user licenses minus applicable discounts (SAP, 2013). Annual maintenance expenses for ERP systems cost approximately 20% of initial ERP implementation costs and upgrade costs as much as 25-33% of the initial implementation (Bradford, 2009).

2.6.4 Enterprise Resource Planning End User Usage

End user usage is part of operation and maintenance phase. Major activities worth noting under end user usage are people and technology downtime. Downtime as defined by ITIL is, "The time when a Configuration Item or IT Service is not available during its Agreed Service Time. The Availability of an IT Service is often calculated from Agreed Service Time and Downtime" (ITIL, 11 May 2007). According to Gartner (2001), downtime is a hidden cost which results in lost productivity.

Downtime costs in ERP end user usage include lost business with customers (both short term and long term), employee time diverted from other tasks to get the IT systems running again, the value of any lost data, emergency maintenance fees (particularly if the outage occurs during off hours) and additional repair costs that may go on even after service has been restored. Downtime can have subtle, difficult to measure effects on productivity. Patterson (2007) asks the question "do employees just do other work during downtime, or does downtime result in lost work, psychological impact, so that it takes longer than the downtime to recover?" The significant downtime cost is lost

employee productivity, which can be measured in terms of the salaries, wages and benefits of idled people. The estimate might be somewhat lower if some employees are still able to do a portion of their work manually or switch to tasks that require only systems that are still available. Nonetheless, many organizations have become so dependent on IT that an unavailable system totally idles a significant portion of the enterprise, when the old manual processes often no longer exist.

Productivity loss due to end-user downtime is calculated using burdened salary figures. Burdened salary includes user compensation, plus the burden of taxes and benefits. The downtime productivity loss calculation is typically represented as number of users affected multiplied by the percent effect on productivity multiplied by the average burdened salary per hour multiplied by the duration of end-user downtime (Pisello, 2004), (Martinez, 2009). (Vision, 2008). Mathematically this can be represented as shown in Equation 1.

$$\text{Labor cost} = P \times E \times R \times H$$ ---------- Equation 1

Where:

P = number of end-users affected

E = average percentage of time end-users depend on IT system

R = average employee cost per hour

H = number of hours of unproductive end-user activities

Percentage of user dependency is the percentage of time an end-user uses the ERP system in a day and number of hours of productivity loss is the total time spent on non productive activities.

Another factor that might affect the cost of operation and maintenance is familiarity with technology among users. Familiarity measures the user's perception of how intuitive the application feels, how easy is to learn, how quick they can become proficient with application, and how comfortable they feel using it (Iansiti, 2007).

2.7 Total Cost of Ownership Model Development Framework

Ellram and Siferd (1993) proposed a framework of development and implementation of TCO concept. According to Ellram et al., first stage is to identify the need and interest of TCO which must be driven by internal interest or external pressure. The second stage is to determine the items of interest. The third stage is to form a TCO team that represents different expertise of the organization. The fourth includes identification of relevant costs, which could be done through a brainstorming session or a cause and effect diagram. In search for costs which should be included in TCO model, Ellram et al., (1993) suggests that it could be helpful to study specific activities. For example when defining the cost of acquisition, activities which can be related to the investment of the equipment should be studied. She further proposed that activities that are performed during the lifetime of an asset can be studied in order to specify the cost of ownership. Ellram et al.'s (1993) framework fell short of linking the cost breakdown

structures (CBS) with project work breakdown structure (WBS) to capture all events and activities and resources that can have hidden costs in a project life cycle. Linking the WBS and CBS makes it easy to identify the relevant cost items associated with the project. The CBS can be used to analyze the life cycle costs of the project to come up with the TCO model.

2.8 Maseno University ICT Context

The University has a large and complex ICT infrastructure that utilizes both proprietary and open source software. The university experiences 'brown outs' and 'black outs' to the electricity supply frequently and so the power supply is protected by uninterruptible power supply units. Before the deployment of the ERP system the university did not have an integrated IS in place and ICT related services were being offered by the Department of Computer Science.

Upon receiving ERP system funding from the World Bank, the university sourced for and acquired Microsoft Dynamics Nav in the year 2007. Coretec Systems & Solutions, a Microsoft Dynamics partner in East Africa were given the onus of supplying and implementing the system.

The Directorate of ICT Services is under staffed with personnel of ten people with most positions in the University ICT 'organogram' vacant. Figure 5 shows the University ICT Directorate 'organogram'. Filled positions are indicated by bold labels.

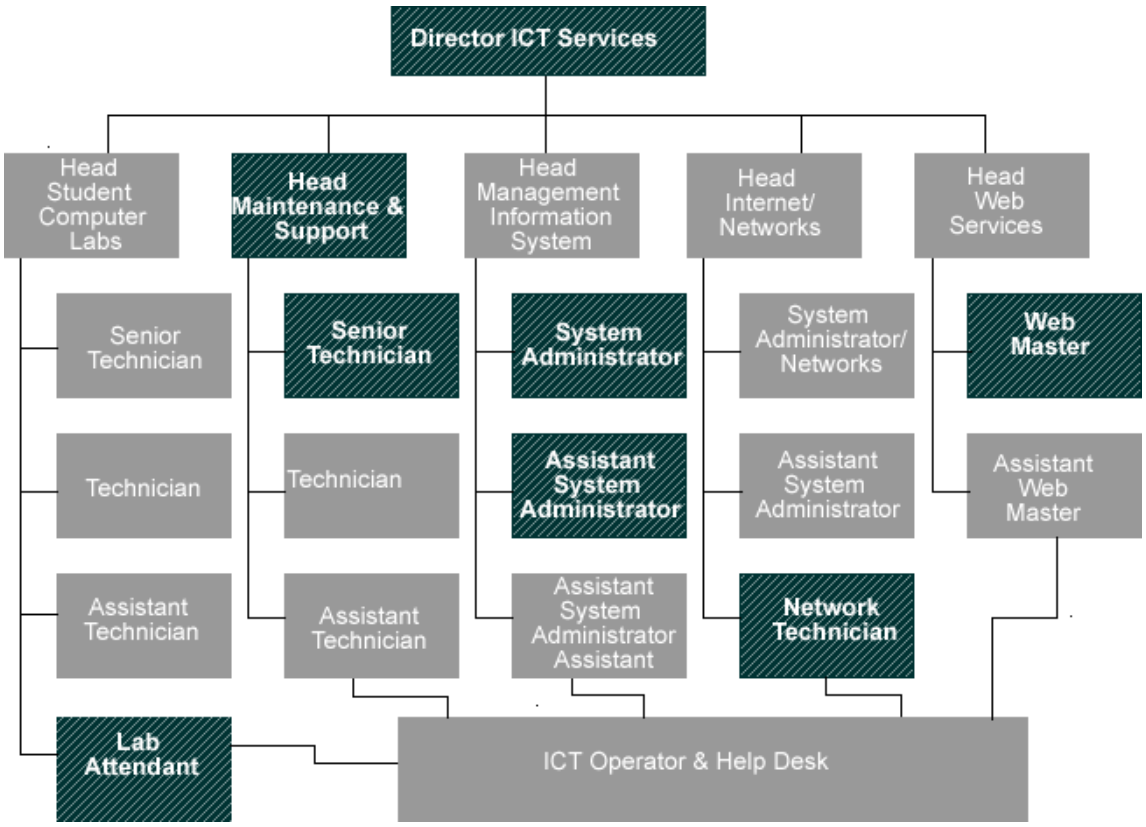

Figure 5: Maseno University ICT 'Organogram' (Source: Author)

The web master and lab attendants are not directly involved with the ERP system and therefore were not included in the study. Maseno University has five student computer labs of which only two were networked at the time of the research and no computer labs was connected to the ERP system at the time of the study and therefore they were not covered in the study. The unfilled positions in the 'organogram' were being supported by System Administrator and Assistant Administrator.

2.8.1 Maseno University ERP System

Maseno University implemented the Microsoft Business Solution- Microsoft Dynamic in 2007-08, which was the latest version of Microsoft Dynamics ERP at that time. Microsoft Dynamics Nav is an ERP solution for small and mid-sized organizations that automates and streamlines business processes (Coretec, 2013). The on-premise delivery model was used in which the University bought the ERP software license and installed in the University server within their compound. The university was responsible for buying computer hardware and software for these solutions. They were also responsible for applying any software upgrades, patches or fixes provided by the software vendor. Maseno University employed thin client/server technology where end users through terminal clients request services from application servers, which in turn get the requested service-related information from the database servers.

2.9 Theoretical Framework

This study was modeled on the Gartner TCO Model for distributed computing advanced by Gartner Inc. in 1987 and has been the leading advocate for its use in IT, as well as a major developer of TCO methodological tools. The Gartner TCO model utilizes two major categories to organize costs. These are direct (budgeted) costs and indirect (unbudgeted) costs (Gartner, 2001). Direct costs consist of the capital, fees, and labor costs spent by the corporate IS department, and business unit IS groups in delivering IT services and solutions to the organization and users. The direct cost models typical costs and captures actual costs for all direct expenses related to the clients (mobile and

desktop), servers, peripherals, and network in the distributed computing environment and serving the distributed computing users. Also modeled are the indirect (unbudgeted) costs which are hidden in most organizations and are not measured or tracked. Indirect costs include end user time spent in casual learning, problem determination and lost productivity during downtime. Gartner's TCO model is the industry standard framework and methodology for cost management (West & Daigle, 2004). The model has been used in US schools for case studies of California, Minnesota, Utah, Texas, Wisconsin, Missouri, Pennsylvania and Virginia school Districts (CoSN, 2011). The TCO model postulates that the indirect (unbudgeted) costs measure the efficiency of IS in delivering expected services to end users. If the IS management and solutions are efficient, end users are less likely to be burdened with self and peer support, as well as downtime. If the IS management and solutions are inefficient, end users typically must spend more time supporting themselves and each other (self and peer support), and are impacted by more downtime. This model was preferred over the SAP TCO framework model which the researcher felt was a single vendor TCO model. SAP TCO Framework is a comprehensive approach to a single vendor TCO model that can be applied to answer questions about TCO for customers and prospective users of SAP ERP systems. (Greenbaum, 2005).

As applied to this study, the budgeted costs are a direct measure of ERP system spending. Unbudgeted costs can be viewed as a second order effect of the direct spending, and as a result of spending too much or too little in budgeted costs,

unbudgeted costs are affected. However, because unbudgeted costs are a second order effect, a causal relationship, although likely, is not directly measurable or true. There is logical evidence of the correlation of best practice direct expenditures and reduced indirect costs. For example, in a study carried by Intel Corporation in 2009 revealed that delaying PC deployments shifted costs into later periods and failed to optimize cash flow from a discounted cash flow perspective (Mahvi & Zarfaty, 2009). The short-term gain in delaying PC purchases conserves cash in the short run but actually is more expensive in the long run, producing a higher total cost of the life of a PC. Investing in end-user professional development or product training for users lowers the TCO. According to Gartner research, untrained or poorly trained users will cost significantly more to support than well-trained workers (Gartner, 2007).

In adopting the Gartner TCO model, the researcher was conscious of the fact that generic model needs to be detailed and focused for specific projects or area of study, as opposed to Garner's TCO model that is not focused on a specific project. For instance, the TCO model for determining the TCO for data centers will not be appropriate model for determination of the TCO of a desktop computer or a TCO model for cloud based ERP system will not be suitable for an on-premise based ERP system. By getting the development data from Maseno University in Kenya makes the developed TCO model to differ from those in existence which used different data. Ferrin et al. (2002) asserts that there is a need for more case based research to increase knowledge of how cost drivers work in different settings.

2.10 Summary

Literature presented in this chapter indicates there are emerging interests in the TCO of ERP systems. Literature reviewed highlights issues that warrant further consideration with respect to TCO in the context on ERP cost identification, management, and estimation. The insights gained from the literature should be interpreted in the light of a number of limitations. The major limitation, to the researcher's knowledge, there are few studies that have been conducted in less developed countries, particularly in Kenya, to address TCO of ERP systems. These points to the urgent need for understanding TCO of ERP system analysis in developing countries since ERP systems are still in early stages in these countries and face additional challenges related to economic, cultural and basic infrastructure issues.

Secondly, it is not possible to come up with a generic TCO model that can be used to address the cost analysis of ERP systems in different settings, there in need to for more case based studies that are detailed and specifics to different ERP system settings.

Lastly, literature review points that only 20% of TCO lies in initial acquisition costs which cannot be controlled to gain competitive advantage since they are used in purchase of technology, but organizations have significantly greater control of over 80% of IT expenditure they direct toward administering their IT system. This calls for comprehensive insight into the background factors that can be controlled to better manage the operation and maintenance costs of ERP system.

In light of the gaps identified in literature, this research aims at filling the gap by developing a TCO model of ERP system in universities in the local context, (Maseno University -Kenya).

CHAPTER THREE

METHODOLOGY

3.1 Overview

This chapter covers the research design that was used to conduct the study. It begins with a brief overview of the research design and looks at case study. Population sampling, target population, sample size and the sample are closely examined as well as the sampling techniques. This is followed by a discussion on data collection, data collection tools and research procedure. Then quality control is examined in terms of validity and reliability followed by data analysis and ethical consideration and the chapter ends with the proposed TCO model.

3.2 Research Design

This study employed both qualitative and quantitative data collection methods. Yin (2004) considers qualitative data as non-numeric data and quantitative data as numeric data. The research was conducted through case study research design. Compared to other methods, the strength of the case study method is its ability to examine, in-depth, a "case" within its "real-life" context (Yin, 2003). The case study research design is intensive, descriptive and holistic analysis of a single entity or a bounded case (Oso, 2009). It provides up-to-date information, making it suitable for the study of contemporary issues (Al-Shehab, 2005). Clearly, the case study research method is particularly well-suited to IS research, since the object of our discipline is the study of

information systems in organizations, and interest has shifted to organizational rather than technical issues (Benbasat, 1987).

3.3 Case Study

With the objective of conducting cost analysis of ERP systems in universities, a single case study was conducted in Maseno University. The use of single case study allowed in-depth understanding of ERP costs. The major concern for a single case study is whether the findings can be generalized. Klein & Myers (1999) in "principle of Abstraction and Generalization" argue that it is possible to generalize if the reasoning is logically correct. The plausibility and strength of the logical reasoning is according to this view much more important than the number of samples. A single case study that is supported by other case studies is usually considered more dependable. When another case reaches the same conclusions, it confirms the findings of the first case. Does a case study of one ERP system implementation transfer to another ERP implementation? The answer is that it depends on how similar the two implementations are. For the use of a single case study in TCO analysis Fischer & Lugg, (2006) argue that there is no generic TCO model and the cost estimation method should be customized to local conditions. In support of Fischer & Lugg, (2006), Ferrin & Plank (2002) asserts that research has shown that it is in general very difficult to make TCO-calculations, and that there is a need for more case based research to increase knowledge of how cost drivers work in different settings. For studies of single cases, judgment should not be made by the evaluator. Instead, it should be made by those individuals who wish to apply the

evaluation finding to their own situations. That is, the evaluator should produce and share the information, but the receiver of the information must determine whether it applies to their own situation. Because the evaluator cannot know who his receivers are, he/she must, therefore, be quite specific both in his description of the attributes of his case and in his description of the way in which the treatment influences this case (Kennedy, 1979). This can be likened to "case law" which refers to that portion of the law that is built up from specific cases rather than statutes. These specific cases are resolved on the basis of statutes, but their interpretations of statutes that are made in each case set precedence for future cases. Therefore, for this study no attempt is made to make generalizations concerning the costs in the TCOs. Instead, it is shown how factors have affected costs in the examined case, and it is up to the reader to determine where these lessons can be applied in projects outside of the sample of this research. Hopefully, some of the insights made in this process can be applied in future projects that are tolerably similar to the ones under study.

3.4 Population and Sampling

This section considers the target population, the sample, sample size and sampling techniques

3.4.1 Target Population

The target population for the study consisted of all the 60 ERP end users, eight technical IT staff who interact with the ERP system directly, the procurement officer and finance

officer of Maseno University. This gives a total of 70 staff that the study targeted. ERP end-user as used in this study refers to Maseno university employees who rely on the ERP system to perform their job roles. Table 4 shows the ERP end user distribution in the university at the time of the study.

Table 3: Maseno University ERP System end users (Source: Author)

Section	Number of end users
Audit	6
Finance	32
Computer Science	2
Academic	3
Procurement	4
Store	2
Kisumu Hotel	11
Total	60

3.4.2 The Sample

All the eight IT technical staff, procurement officer and finance officer were interviewed. Questionnaires were used to gather data from the 60 ERP system end users.

3.4.3 Sample Size

Slovin's formula was used to calculate the sample size to be issued with questionnaires from the end users target population of 60 (Ariola, 2006). According to Ariola, 5% is an allowable error for smaller sample.

$$n = \frac{N}{1+Ne^2}$$

n = number of samples

N = total population

e = error tolerance

With

n = 53

N = 60

e = 0.05

3.4.4 Sampling Techniques

This study employed purposive sampling technique to select the sample. The researcher consciously decided who to include in the sample. Purposive sampling technique is mainly used to collect focused information (Oso, 2008). It was used to select typical and useful cases only. Purposive sampling also saves time. The researcher was convinced that the target population consists of both IT professionals as well as non IT professionals. As such the target population and accessible population cannot be regarded as homogeneous and they may not have the relevant information required in the study. Purposive sampling technique was employed as it guaranteed that the target population held the information that was useful to the study.

3.5 Data Collection

Data is anything given or admitted as a fact and on which a research inference is based (Oso & Onen, 2009). It is anything actual, or assumed, used as a basis for reckoning. This section describes the instrumentation and research procedure.

3.5.1 Instruments

The study used semi-structured interviews, document analysis, questionnaires and observation to collect both quantitative and qualitative data. The selection for these tools was guided by the nature of the data to be collected, the time available as well as the objective of the study. The overall aim of this study was to conduct cost analysis of a university ERP. The study was mainly concerned with the procurement process in IT department, acquisition costs of computing hardware and software and maintenance. Information on downtime both technological and on end-user, end-user training, consultancy services, as well as the salaries of IT support personnel was collected. Data on policy on the disposal of computing devices was also captured.

The interviews enabled depth, nuance and complexity in data to be captured and were generative in that new knowledge was uncovered. Its popularity is linked to its ability to obtain a range of informant views and to communicate multiple perspectives on a phenomenon. It provided an undiluted focus on the informant and offered opportunity for clarification and greater understanding through use of follow-up questions (Carcary, 2008).

Supporting documentation is valuable in corroborating the evidence collected in semi-structured interviews. Kontio (2004) suggested that interviews provide insightful observations, while documents provide stable, unobtrusive and exact case information (Kontio, 2004). These documents provided a means of triangulation in that they supplied specific details, and augment and substantiate interview data. The other data collection method used was structured questionnaire. This ensured proper completion of the questionnaire. Section A of the questionnaire contained basic details of the respondents. Section B contained questions related to the ERP System end-user training. Section C contained questions related to ERP system downtime, section D dealt with ERP system end-user support.

3.6 Research Procedure

Data both qualitative and quantitative were collected from the respondents in the period between the months of January and April the year 2013 using interviews, document analysis, questionnaires and observation. The data was collected by the researcher himself to eliminate biasness and also to be in control of the study. This data was then reviewed, validated and the findings synthesized.

Questionnaires were sent to 53 end users as calculated in section 4.4.3 using Slovin's formulae and forty two respondents filled and returned. This is a response rate of 70% which is acceptable in research. The Journal of American Medical Association stipulates a sufficient response rate of at least 60% (JAMA, 2008). The researcher conducted face-

to-face interviews with ten respondents who were involved in the acquisition, implementation and operation and maintenance process of the ERP system and presumably had firsthand knowledge of the costs involved. Those interviewed, eight were from IT technical staff, a Procurement Officer and a Finance Officer.

3.7 Quality Control

To control quality, the researcher endeavored to attain validity and reliability coefficient of at least 0.7. Validity refers to the ability of an instrument to measure what it is designed to measure. Validity is defined as the degree to which the researcher has measured what he has set out to measure (Kumar, 1999), while reliability is related to the accuracy of the actual measuring methods. Reliability is defined as the extent to which a questionnaire, test, observation or any measurement procedure produces the same results on repeated trials (Kumar, 1999). In short, it is the stability or consistency of scores over time or across raters. These instruments were piloted in the departments that were not included in the study sample and modified to improve their validity and reliability coefficient to at least 0.70. Items with validity and reliability coefficient with at least 0.70 are accepted as valid and reliable in research (Kathuri, 1993). The survey included a combination of personal interviews, which were conducted first so that any changes that were needed were made to the forms, followed by paper-based and electronic surveys (email).

3.7.1 Validity

To establish validity, the instrument was given to two experts to evaluate the relevance of each item on the scale: very relevant (4), quiet relevant (3), somewhat relevant (2), and not relevant (1). Validity was determined using Content Validity Index (CVI). CVI is item rated 3 or 4 by both judges divided by the total number of items in the questionnaire. The CVI obtained was 0.78 which is acceptable in research.

3.7.2 Reliability

The internal reliability coefficient of the instrument was ascertained through the Inter-rater Reliability. Kumar (1999) defines reliability as the degree to which a measure supplies consistent results. The reliability was assessed by having two independent judges score the test. The scores were then compared to determine the consistency of the rater's estimates. Correlation between the two ratings was calculated to determine the level of inter-rater reliability. Internal reliability of 0.8 was obtained.

3.8 Data Analysis and Presentation

Mathematical, sometimes referred to as classical data analysis is a methodology in which mathematical models are applied and used as the basis for analysis. Statistical tools to be used include:-

Tabulation

Pie charts

A statistical software program, SPSS (Statistical Package for Social Sciences) was also used for in-depth data analyses.

3.9 Ethical Considerations

The following ethical concerns were addressed when conducting research:-

i. Voluntary participation
ii. No harm to respondents
iii. Anonymity and confidentiality
iv. Purpose and sponsor
v. Analysis and reporting

First, the researcher ensured that participation is voluntary. Though this can result in low return rate the researcher used multiple contacts to encourage high response rate. A cover letter explaining the study objective in more depth was sent to the possible participants as first contact. E-mails were sent to respondents who had not responded in a week's time as the second contact. A third email was sent to participants who had not responded a week later after the end of the survey to inform them that the study was drawing to a close and that their input was valuable to the results of the study.

Second ethical guideline is to avoid possible harm to respondents. This included embarrassment or feeling uncomfortable about questions. This study did not include sensitive questions that could have caused embarrassment or uncomfortable feelings.

A third ethical guideline was to protect a respondent's identity. This was accomplished by exercising anonymity and confidentiality. A survey is anonymous when a respondent cannot be identified on the basis of a response. A survey is confidential when a response can be identified with a subject, but the researcher promised not to disclose the individual's identity. To avoid confusion, the cover letter was clearly indicated that the study was to be confidential in regards to responses and the reporting of results. Participant identification was to be kept confidential and was only to be used in determining who had not responded for follow-up purposes.

The fourth ethical guideline was to let all prospective respondents know the purpose of the study and the organization that is sponsoring it. The purpose of the study was provided in the cover letter indicating a need to develop a TCO model for university ERP. The cover letter also explained that the results of the study were to used in a dissertation as partial fulfillment for a master's degree.

The fifth ethical guideline was to accurately report both the methods and the results of the study. Because advancements in academic fields come through honesty and openness, the researcher assumed the responsibility to report the study results objectively.

3.10 Summary

Methodology is seen as the cornerstone in every research project; the way it is understood and handled in a research project determines its (study) credibility or validity. This chapter presented a detailed description of the research methodology. It highlighted the detailed procedure followed to realize the research objectives. It included the description of the research design, sampling techniques, instrumentation as well as data analysis techniques and ethical considerations. The chapter identified the different data sources that were utilized in this research and the overall research plan that was used in answering the research questions.

CHAPTER FOUR

PRESENTATION AND INTERPRETATION OF RESULTS

4.1 Overview

This study investigated the total cost of owning a university Enterprise Resource Planning case of Maseno University. This was in light of little data on the cost of ownership of university ERPs. This chapter presents analysis and interpretations of study findings using content analysis. Narrative approach has been used to present responses from interviewees. The chapter is divided into four parts in line with the objectives of the study. The first part deals with the cost drivers that can influence TCO of a university ERP system. The second part focuses on the TCO analysis of Maseno University ERP system. The last section explores the development of TCO model.

4.2 Basic Details of the Respondents

This section highlights the basic details of the respondents in term of age distribution, department, gender and academic qualifications.

4.2.1 Age Distribution of the Respondents

Table 4 shows the age distribution of the research respondents.

Table 4: Age Distribution of Respondents (Source: Author)

Age	Frequency	Percentage
21-30 years	19	45.2
31-40 years	21	50.0
41-50 years	1	2.4
Above 50 years	1	2.4
Total	**42**	**100**

4.2.2 Departments of the Research Respondents

The researcher collected data from the departments which were using the ERP system and the distribution of the respondents is as shown in Table 4. Finance department recorded the highest number of respondents accounting for 47.6% (20) followed by Kisumu Hotel with 23.8%. Hostels had only one respondent while academics and procurements accounted for 11.9% and 9.5% respectively. Human Resources department accounted for 4.8% (2) of the respondents.

Table 5: Departments (Source: Author)

Department	Frequency	Percentage
Academics	5	11.9 %
Finance	20	47.6 %
Human Resources	2	4.8 %
Procurement	4	9.5 %
Kisumu Hotel	10	23.8 %
Hostels	1	2.4 %
Total	42	100 %

4.2.3 Gender of Respondents

The ten IT technical staff interviewed ware all male while in the questionnaire survey 57.2% (24) were male and 42.8% (18) were female.

4.2.4 Level of Education of the Respondents

Table 6 shows the level of education for the research respondents. Diploma holders were the majority with 45.2% (19) with the Masters holders accounting for 11.9% (5).

Table 6: Academic Qualifications of the Respondents (Source: Author)

Qualification	Frequency	Percentage
Tertiary/Middle-Level College	7	16.7 %
Diploma	19	45.2 %
Bachelors	11	26.2 %
Masters	5	11.9 %
Total	42	100 %

4.3 Major Cost Factors Influencing TCO in University ERP System

The first objective of the study was to identify the major cost driver that can influence TCO in university ERP. To achieve this objective, the researcher conducted ten in-depth interviews with Maseno University IT technical staff, procurement officer, and finance officer. As the researcher needed informants with a background of the costs, installed hardware and software involved in the ERP adoptions, all the interviewees were from the ICT, Procurement and Finance department. The interview topics covered the ERP selection processes, feasibility studies, budget estimation process, and ex-post investment evaluation. Forty two end-users were also surveyed to establish end-user usage. Document analysis and observation data collection techniques were also employed to supplement and triangulate the data collected through interviews. Document analyzed included the ICT department 'organogram', the years 2012/2013 and 2013/2014 ICT Directorate budget, the ERP project team meetings minutes, the ERP project progress reports as well as the hardware and software documentations. Observation was carried out to gather information on the physical security of the server room, the installed servers and the system degradations and outages. In the literature

review section 2.6, over 60 TCO cost drivers were identified. The study used ERP system expenditure documents, the annual ICT directorate budget, end user survey, and literature review to establish the major cost drivers. The study identified 5 major cost drivers of university ERP system shown in Figure 6.

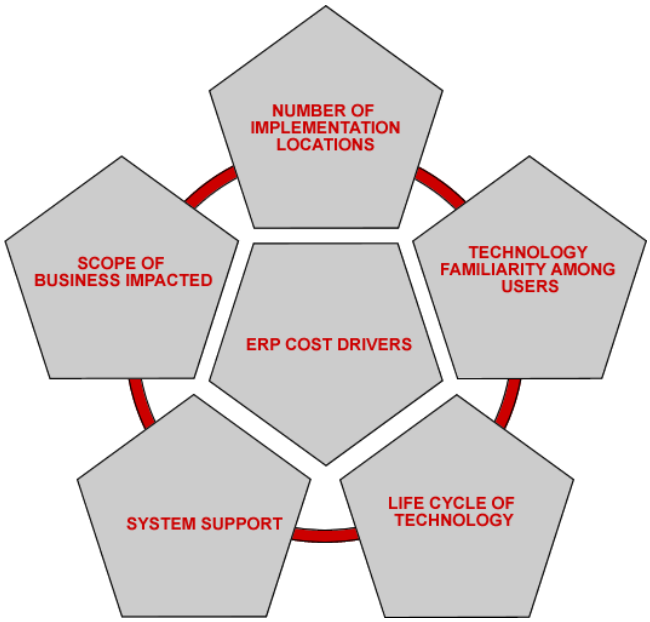

Figure 6: University ERP Cost Drivers (Source: Author)

These are the factors that significantly affected the magnitude of TCO of Maseno University ERP system and are discussed in details below.

4.3.1 Number of Implementation Locations

The greater the number of sites, the higher the TCO. Maseno University currently has four campuses; Main Campus, College Campus, Town Campus and Homa Bay Campus. The ERP system at the time of the study was being used in Main Campus, College Campus, City Campus and Kisumu Hotel. The Main Campus and College Campus are

connected using a fiber optic cable which was acquired at a cost of KES 800,000. Virtual Private Network (VPN) to link City Campus and Kisumu Hotel with the Main Campuses in Maseno Township was being developed at the time of the study which will also affect the cost of the ERP positively. As discussed in section 2.2, when a organization is widely geographically dispersed or operates as a number of distinctly autonomous departments, divisions, or entities, separate instances of the ERP software is required. Separate instances of ERP system makes the system to be really expensive and become fragmented quickly; and requires reengineering effort sooner. Cost of network connectivity and networking devices that link up the campuses served by the same ERP instance increases the ERP TCO significantly.

4.3.2 Scope of Business to be Impacted

The more the modules implemented, the greater the TCO. The university implemented five modules consisting of:

i. Finance management
ii. Student management
iii. Human resource management
iv. Hotel management add-on
v. Hospital management add-on.

Maseno University paid KES 11,867,240 as software acquisition for five modules and KES 7,139,287 as professional fee for technical setup of the five modules. This attracted

KES 1,142,285 as VAT on professional services at the rate of 16%. The ERP system software acquisition cost and the corresponding professional fees and VAT are shown in Table 7.

Table 7:Microsoft Dynamics Nav acquisition cost (Source: Author)

Module	Module Cost (KES)	Professional fees (KES)	VAT (KES)	Total (KES)
Financial Management	3,619,000	1,628,550	260,568	5,508,118
Student Management	4,821,740	3,134,131	501,461	8,457,332
Human Resource Management	1,116,500	636,405	101,825	1,854,730
Hotel Management Add-Ons	1,116,500	725,725	116,116	1,958,341
Hospital Managements Add-Ons	1,193,500	1,014,475	162,316	2,370,291
Total	**11,867,240**	**7,139,286**	**1,142,286**	**20,148,812**

The Professional fee was for ERP system technical setup which comprised of installation, integration, migration, configuration testing and training. It is evident that the greater the number of modules implemented the higher the cost of acquisition and technical setup.

4.3.3 Life Cycle of Technology

The life cycle of the technologies themselves is another critical component. TCO is about life cycle cost of an asset. Depreciable life, the number of years over which an asset will be depreciated influences the TCO. Shorter refresh cycle increases the

magnitude of depreciation charged yearly increasing the TCO but the benefits that come with shorter refresh cycle offset the cost due to reduced downtime and maintenance cost and increased uptime thus increased productivity. Through interview with the Systems Administrator it was established that Maseno University does have technology refresh policy but it is not adhere to. The university has never carried out the analysis of the deployed IT hardware landscape. Change in technology is closely associated with life cycle of technology and will affect the TCO in one way or another. Abrupt changes before maturity of a particular technology has the effect of increasing the TCO.

4.3.4 Technology Familiarity among Users

The study sought to establish how familiar the end-users were with IT. This was done through a survey and Table 8 shows the outcome of questions on computer basic maintenance tasks.

Table 8: Basic computer maintenance skills survey results (Source: Author)

Task	I don't need to know this for my job	I don't understand what this is	I feel confident	More knowledge needed
Setup a new PC	0%	0%	67.6%	32.4%
Check existing setup of system	0%	0%	64.7%	25.5%
Understand licensing requirement	0%	0%	38.2%	68.1%
Check network connection	0%	0%	79.4%	17.6%
Change display mode	0%	0%	95.2%	4.8%
Test printing functions	0%	0%	97.1%	2.9%

All the end-users surveyed responses show that they needed to know all the tasks asked and that they understood what the tasks were about. However 67.6% indicated that they had confidence in setting up a new PC while 32.4% felt they needed more knowledge. Checking existing setup of computer system task showed that 64.7% had confidence and 25.5% needed more knowledge. Concerning license issues 38.2% had confidence in their knowledge on license requirement while 61.8% felt more knowledge was required. Those who needed more knowledge on network connection were 17.6% while 79.4% had confidence in their ability to execute the task while 97.1% had confidence in their ability to change display mode and test printing functionality and 2.9% indicated that more knowledge was needed for the two tasks. These statistics show that end-users of Maseno University ERP were familiar with common PC maintenance tasks. This has the effect of reducing the support requests from help desk but might create user downtime due self/peer support activities. It was further established through interview with Systems Administrator that the university uses Microsoft Windows OS and Microsoft Office Suite application programs which have the similar user interfaces as the deployed ERP system, Microsoft Dynamics Nav. This lowers will lower TCO of ERP as it reduces the gradient of the learning curve.

4.3.5 System Support

System support comprises supporting the technical aspect of the system so that availability approaches the recommended five nine (99.999 %) and end-user support so that user downtime is minimized. End-user training survey of Maseno University

indicates that 73.5% were trained before the system was implemented while 26.5% were not trained. Through interview with the IT technical staff, the researcher established that the end-users were trained only once and it was one year earlier before the commencement of ERP system implementation. Inadequate end-user training increases the TCO. There is a lot of user downtime. Untrained users may end up needing three to six times as much support as end-users who have been trained. Lack of proper training and education can result in loss of productivity. The untrained person will either get help from the help desk or from colleagues. This will either increase the help desk work load or affect the productivity of the person who is disturbed by the untrained person.

Respondents were also asked if they had received any form of end-user ERP training in the past six months and the results indicate that only 8.8% had trained while 91.2% said they have not trained. Interviews with IT staff showed that the University does not have a program for regular retraining/training of end-users. The mode of training available is on on-demand basis and induction for new employees. Through interviews the researcher also established that no end-user training was carried out in live environments, i.e. after system testing and go-live. Go-live is the implementation phase where the ERP system is opened for use. Some 20.6% of the respondents joined the university after ERP implementation and 100% of them indicated that they were inducted into the ERP system usage. The respondents were asked to rate their overall level competency with the ERP system and the results were as shown in Table 9.

Table 9: Competency Level of the Respondents (Source: Author)

	Frequency	**Percent**
Not very competent	0	0 %
Low level competency	0	0 %
Moderate level competency	24	57.1%
High level competency	18	42.9 %
Expert	0	0 %
Total	42	100 %

Not very competent and low level competency both registered 0% whereas moderate level competency and high level competency had 57.1% and 42.9% respectively. There was no respondent who returned the level of competency as expert. These statistics shows that the competency level of the end-users is within acceptable standards though there being no expert among the user can be taken to indicate that some ERP tasks will require help desk assistance. This has the effect of increasing the TCO of ERP. On the question of ERP end-user training adequacy, the survey shows that 57% felt the training was not adequate while 43% were of the view that the training was adequate. Given that more than half the respondents are of the opinion that training was not adequate implies further regular training is necessary and the absence of regular training will put more burden on the end users who will seek self/peer support which increases the user downtime affecting the TCO negatively. In-depth interview with the IT staff revealed that the end-user support had no dedicated staff. Because of the shortage of staff end-

user support came from system administrator and his assistant. The survey results show that 100% of the respondents encounter job tasks that they require technical support.

i) End-user Downtime

End-users were surveyed on how much time they spent on performing unproductive activities in the computer during work time and the results are as shown in the Table 10.

Table 10: Average Hours of an End-user's downtime (Source: Author)

Downtime	Average Hours of an end-user's Downtime per month	Average Hours of an end-user's Downtime per year
Self Maintenance	1.67	20
Self Support	1.93	23
Casual Learning	1.18	14
Peer Support	1.45	17
Getting Support	1.34	16
Total	**7.57**	**91**

ii) Technology Downtime

Downtime expenses are the annual losses in productivity due to the unavailability of the desktop computer, servers, network, printers, and applications. Cost is measured as lost wages (productivity). Through end-user survey it was established that on average the university experiences technology downtime of 4 hours and 3 minutes month. Service degradation experienced by the university on average lasts for 3hours and 7 minutes a month. This translates to 48 hours and 36 minutes of downtime and 37 hours and 24

minutes of service degradation per year. Technological downtime affects the employees who rely on the ERP to perform their job roles. If there is no work around way of doing the task, then the employee will not be able to perform his/her duty, then employee downtime will occur. Downtime increases unbudgeted costs thus increases the TCO of ERP system.

4.4 The Total Cost Ownership of Maseno University ERP System

The second objective of the study was to determine the total cost of owning Maseno university ERP system. One of the challenges in determining the cost of owning Maseno University ERP system was collecting accurate, reliable data due to a lack of formal information technology asset management (ITAM) repository in place to provide data for the study. The university has no prior cost modeling experience for TCO process.

This total cost of ownership scenario focused on the cost of ERP in the university and did not include computing devices not running the ERP system found within the university. For example, there are five computer laboratories used for teaching and learning activities of which three labs are not networked. The two networked labs are also not connected to the ERP system and, therefore, were not included in the TCO project. This TCO scenario did not include internet and the university website in the analysis. It covered the wide area network that the ERP system runs on.

4.4.1 Procurement of the ERP System

Feasibility study was carried out where a team of thirteen committee members visited 3 universities that had successful implementation of the ERP system. The committee visited United States International University, KCA University and Daystar University all located in Nairobi Kenya. ERP system specification was developed by a committee of thirteen members. Maseno University is a public university and the due process of procurement was conducted in compliance with the Public Procurement and Disposal Act of 2005 of the Laws of Kenya. The university settled on Coretec Systems & Solutions to supply Microsoft Dynamics Nav and the project charter was signed on 11th December 2007. Feasibility study, requirement specification, procurement management and project management from expenditure estimates and projection in five years will cost the university KES 3,300,000. This accounts for 3% of the projected TCO of ERP in a five year period.

4.4.2 Hardware and Software Acquisition

The university had in place most of the hardware that was required for the ERP software to run and only acquired what was not available. There has been continuous investment in the hardware to optimize the IT productivity of the ERP system. The university acquired 25 km of fiber optic to enhance the network efficiency.

The ERP software was acquired at a cost of KES 11,867,240 as shown in Table 7. The client computers were already in place and where upgrade was needed it was done. The

operating systems for the desktops and laptops was Microsoft Windows (Microsoft Windows XP and 7) and Application software were Microsoft Office Suite (Microsoft Office 2007 and 2010). The university server runs on FreeBSD, Microsoft Server 2003 and 2008. Microsoft Server 2003 and 2008 have valid licenses while FreeBSD is open source software (OSS). Another OSS implemented is Mail Zimbra which is used for storage and backup and the network monitoring software is also OSS. Other application software are PDF reader and WinZip. Tables 11 and 12 shows the installed hardware and software.

Table 11: Installed Hardware in Maseno University ICT Infrastructure (Source: Author)

	Hardware	**Quantity**
i.	Servers	2
ii.	Routers	2
iii.	Switches (intelligent)	13
iv.	Fiber optic cables	25 km
v.	Air conditioner	1
vi.	48 U Cabinets	2
vii.	30 U Cabinets	2
viii.	2 U Cabinets	12
ix.	Network printers	8
x.	Desktops	60
xi.	Laptops	3
xii.	Firewalls	1
xiii.	Proxy gateway	1

Table 12: Installed Software in Maseno University IS (Source: Author)

System Software	**Desktop System Software**	**Application Software**
SQL server 2008	Windows 7	Microsoft Dynamics Nav
Windows server 2003	Windows XP	Microsoft Office 2010
Windows server 2008		Microsoft Office 2007
FreeBSD (OSS)		WinZip
Mail server		
Mail Zimbra (OSS)		

4.4.3 Implementation

Full implementation of the ERP system was to cover a total of eleven modules and to be implemented in a period of 14 week from the time the contract charter was signed. The project charter was signed on 11th December 2007 and the implementation of the system was delayed due to the post election violence that occurred in early 2008. Below is a listed of the sub-modules that were to be implemented.

i. Student Finance
ii. Credit Ledger System
iii. Cash Office
iv. Human Resource Module
v. Academic/ Registration Module
vi. Examination Module
vii. Timetable Module
viii. Hostel Module
ix. Welfare Module
x. Instructor/ Student Evaluation Module
xi. Stores Control System

Fourteen weeks with effect from the first week of April 2008 elapsed in the first week of August 2008. Interviews with the ICT technical staff indicate that most of the ERP modules have not been implemented fully to date (April 2013) five years later. Out of the eleven modules that were earmarked for implementation; four are fully implemented representing 36% implementation. Coretec Systems & Solutions, the system vendors

were part of the implementation team but they did not participate till full implementation was completed. The ongoing implementation is being conducted by the technical IT staff of the university. The implementation status as at the time the interviews were conducted is as shown in the Table 14.

Table 13: Implementation Status of Maseno University ERP System (Source: Author)

	Module System	**Implementation Status**
a)	Student Finance	80%
b)	Creditors Ledger	100%
c)	Cash Office	100%
d)	Human Resource	50%
e)	Admissions/ Registration	40%
f)	Examination	40%
g)	Timetable	0%
h)	Hostel	100%
i)	Welfare	0%
j)	Instructor /Student Evaluation	0%
k)	Stores Control	100%

The ERP implementation process as stipulated in the contract was to take fourteen week from the time the project charter was signed. This however turned out not to be the case as the implementation process was still going on five years after the project charter signing. The vendor left the site before the all the modules were installed and ongoing implementation is being conducted by the ICT staff. Microsoft Business Solution –

Microsoft Dynamics Nav, the latest version at that time was delivered to the University on original CD and license files and the university was to supply:

i. Qualified staff to implement the system
ii. Project management and control staff
iii. Hardware
iv. Telephone
v. Internet
vi. Test Data

The contract included a twelve month warranty. The cost of implementation was KES 8,281,572. Implementation fees comprised installation, customization, configuration and training.

4.4.4 Operation and Maintenance

The ICT directorate of Maseno University had a staff of nine people at the time of this study. The staff consisted of ICT Director, System Administrator and his assistant, three technicians in the network administrations office, and two technicians in-charge of the city campus. The end-user support has no dedicated staff and is supported by the System Administrator. The network support staff has been trained three times, once during ERP implementation and on two occasions sponsored by the internet service providers (ISP). The university has no regular training program for technical staff and end-users. The System Administrator is responsible for the training of the end-users on

demand basis such as when a new employee is recruited or when there are changes on the system.

In the budget of ICT directorate of Maseno University, maintenance had an annual budget of KES 8,100,000 in the financial year of 2012-2013 and KES 4.5 million in the budget of 2013-2014. The ERP system contract had an annual maintenance fee of KES 125,000. The maintenance fee is to cover annual software maintenance and support; future updates, off-site and on-site support and off-site backup services

Overhead costs such as electricity, air conditioning and physical space cost were not captured in this study as they were not easy to get. The system is secured by a firewall and antivirus software both installed in the servers and the terminals. The server room is physically secured using burglar proof doors and windows and has two night guards.

Hardware and software upgrades are carried out on the need basis. Software is upgraded whenever there are new releases. The ERP system software has been undergoing upgrade whenever a new release is out as that is covered under maintenance contract.

4.4.5 End-user Usage

Questionnaires were used to collect the data on the end-user activities. The questionnaire had items that asked the end-user the average duration spent on the ERP system per day and to estimate the average time they spent on the following activities per month at work:

i. **Self support** (activities, such as backups, loading software, and organizing files on hard drives).

ii. **Peer support** - Peer support is the reliance on a knowledgeable resource, typically the unofficial "expert" in providing support answers and in resolving technical issues.. Typical tasks performed by the end users include troubleshooting and repair, support, maintenance, installation, training, and backup management.

iii. **Casual learning** – this is the time taken by end-users in activities such as reading manuals, using on-line help, trial and error, and other self-learning methods to learn programs and resolve issues.

iv. **Time to resolution –** When stuck on a job related task, time spent waiting for problems to be resolved.

Futz factors and application customization information was not sought since they are not easily quantifiable. Futz factor is where an end-user uses corporate technology for his/her own personal use. This cost lies not in the system itself (it is already purchased) but in the time employees spend using the system for non work-related activities.

The total cost of owning Maseno University ERP system TCO was computed using the model developed in the study. Using the proformas included in Appendix C, and

the ICT Directorate budget shown in appendix E, the following first set of TCO figures were collected and the model populated to give the results shown in the Table 14. The cost of downtime was computed using equations 1 in section 2.6.4.

Table 14: Five Year TCO of Maseno University ERP System (Source: Author)

	Nodes Costs (KES)	**Elements Costs (KES)**
Procurement Costs		3,300,000 **(3%)**
Feasibility Study	800,000	
Requirement Specification	300,000	
Procurement Management	1,000,000	
Project Management	1,200,000	
Hardware/Software		20,175,600 **(16%)**
Application Software	3,249,000	
System Software	8,476,600	
Hardware	8,450,000	
Implementation Costs		9,541,572 **(7%)**
Technical Setup	8,281,572	
Change Management	200,000	
Personnel Restructuring	400,000	
Testing	60,000	
Training	600,000	
Operations and Maintenance Costs		66,324,720 **(51%)**
Licenses Agreement	925,000	
Overheads	4,527,063	
Maintenance	31,500,000	
Support	28,672,657	
Monitoring	300,000	
Upgrade	400,000	
End-User Usage		29,735,346 **(23%)**
End-user Operations	5,786,604	
Downtime	23,948,742	
Total	129,077,238	

Figure 7 was generated from the Five Year TCO of Maseno University ERP System presented in table 14, which shows that the leading cost drivers are operations and maintenance and end-user usage.

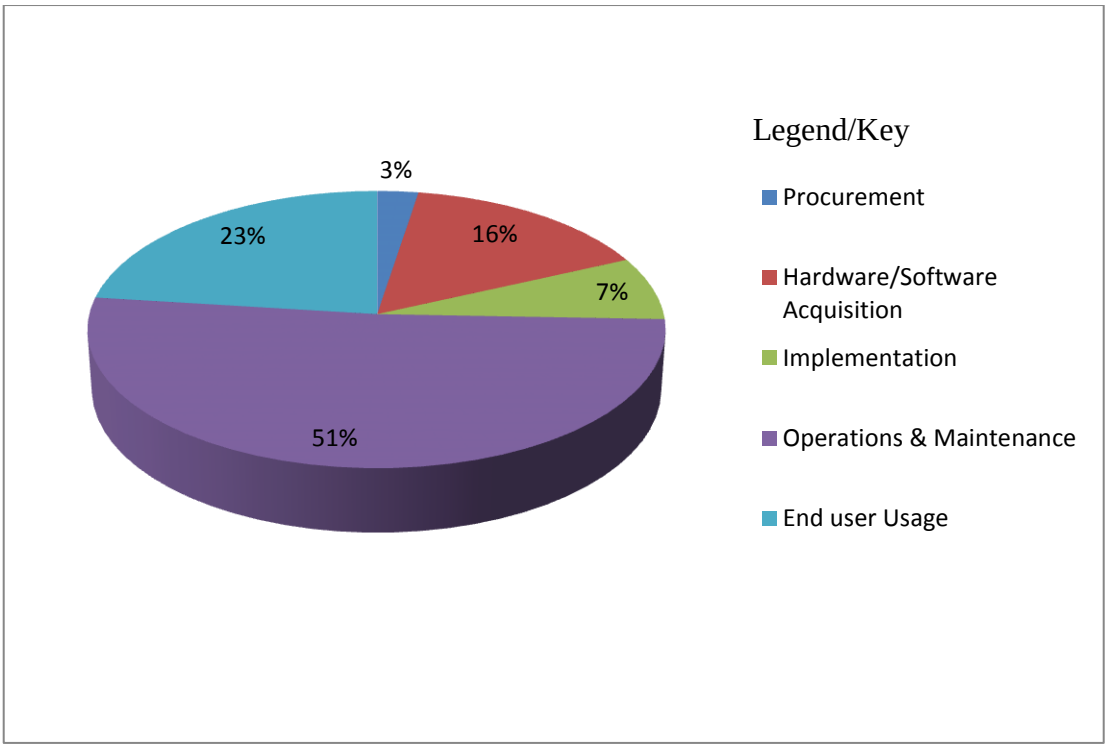

Figure 7: Five years TCO of Maseno University ERP System (Source: Author)

Straight line method was used to depreciate hardware while software cost was apportioned equally over the expected software life cycle. The breakdown of TCO calculations are shown in appendix E.

4.5 Development of the TCO of University ERP Model

Following Ellram et al.'s framework of TCO model development discussed in section 2.8, the researcher in his TCO analysis involved the ICT Director, three network technicians, Systems Administrator and his Deputy, two maintenance officers, two IT technicians, Procurement Officer, and a Finance Officer. The researcher conducted in-depth interviews with the above staff one-on-one on different occasions between December 2012 and May 2013. The interviews sought to get information regarding the ERP system right from feasibility study till the state it was at the time of interview.

Documents that were analyzed included project team minutes, ERP System documentations, ERP system contract, the correspondents between the vendor and the university, hardware documentation and license agreements.

The researcher used information gather from the interviews and literature review to come up with the ERP project WBS and the corresponding CBS. These WBS and CBS were analyzed to come up with the cost elements, cost nodes and the background factors. A cost node is a breakdown of TCO cost element into smaller cost category in line with the project work breakdown structure (WBS), indicating where costs are allocated (Lee, 2007). The breakdown can sometimes be in line with the organization's Chart of Accounts, indicating "what" the costs are for. In theory, cost could be in line with "who" is spending the cost, "when" costs are being spent, etc. The background factors are activities and events that can influence the cost nodes in one way or another.

4.5.1 The Proposed ERP TCO Model

The basic structure of the TCO model developed has five cost elements; procurement, hardware/software acquisition, implementation, operations and maintenance and end user usage. It has 17 cost nodes and 65 background factors. Figure 8 show the developed TCO model.

4.5.2 Background Factors

The background factors influence the cost nodes of the model in one way or another. These background factors were found during the interviews with the IT technical staff while some came from literature and others came from the identified WBS and CBS.

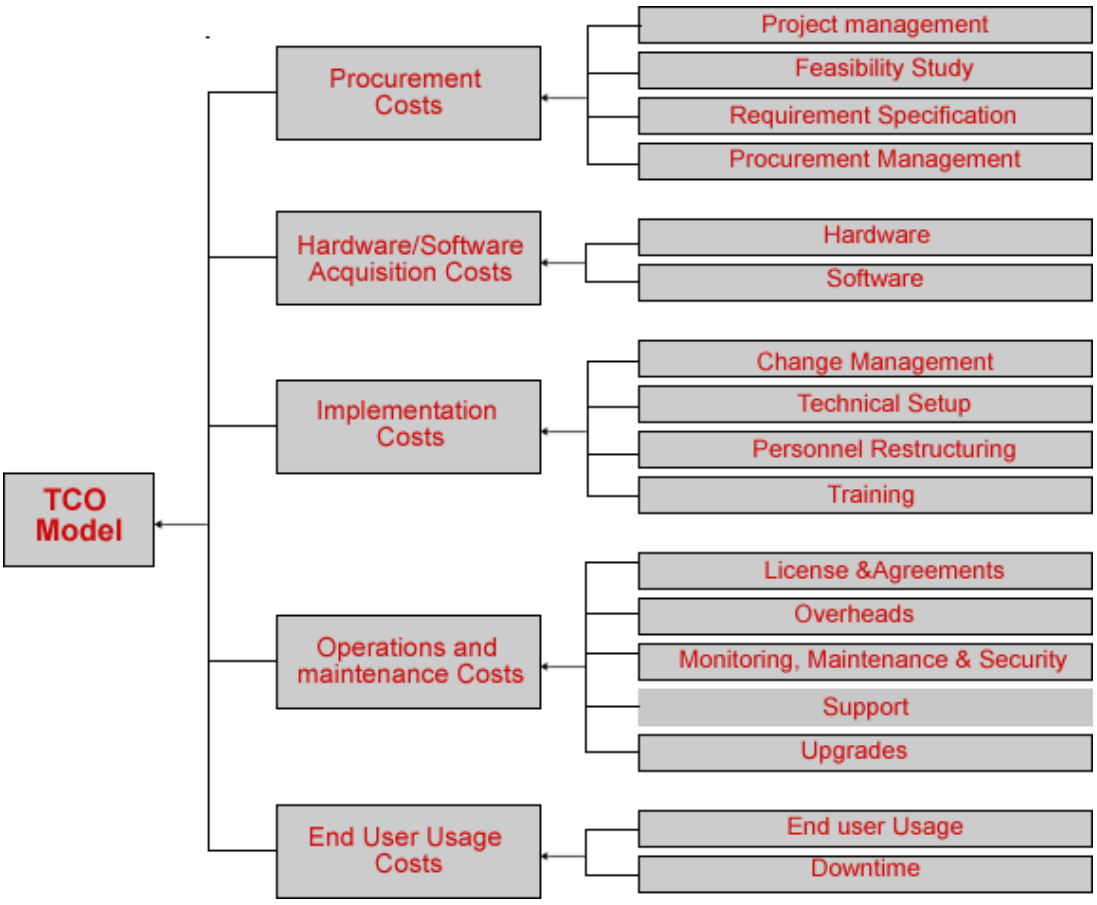

Figure 8: Proposed TCO Model (Source Author)

4.5.3 Procurement Costs

The procurement life cycle of IT assets begins with strategic planning and continues through procurement and on into the planned obsolescence of both hardware and software. The costs cover a system's life cycle, from initial concept to the end of the system's useful life or the end of a contract. Cost activities that are undertaken in system life cycle include:

i. Concept initiation

ii. Procurement strategy, planning and initiation

iii. Solicitation process

iv. Cost and payment structure

v. Contract issuance and management

vi. Project launch, implementation and close out.

4.5.4 Project Management Costs

Project management costs involve activities necessary to ensure the successful completion of the project. Project management activities include:

i. Project Planning

ii. Project Control

iii. Status Reporting

iv. Issue Management

v. Change Management

vi. Risk Management

vii. Quality Management.

4.5.5 Feasibility study costs

Feasibility study costs are costs that are used to conduct the feasibility study. Vendor maturity, integration issues and the established vendor relationships are the background cost drivers that determine the feasibility costs..

4.5.6 Requirements Specification Costs

Requirements specification costs these are costs that manage requirements specification. Requirements specification costs are driven by the number of systems included in the scenario, departments and units involved, and the number and depth of function changes.

4.5.7 Procurement Management Costs

Procurement management costs are incurred in evaluating offers and drafting agreements. The procurement management costs are determined by the number of potential vendors. The higher the number of potential vendors the more resources will be required in the procurement process. Figure 9 shows the procurement management background factors.

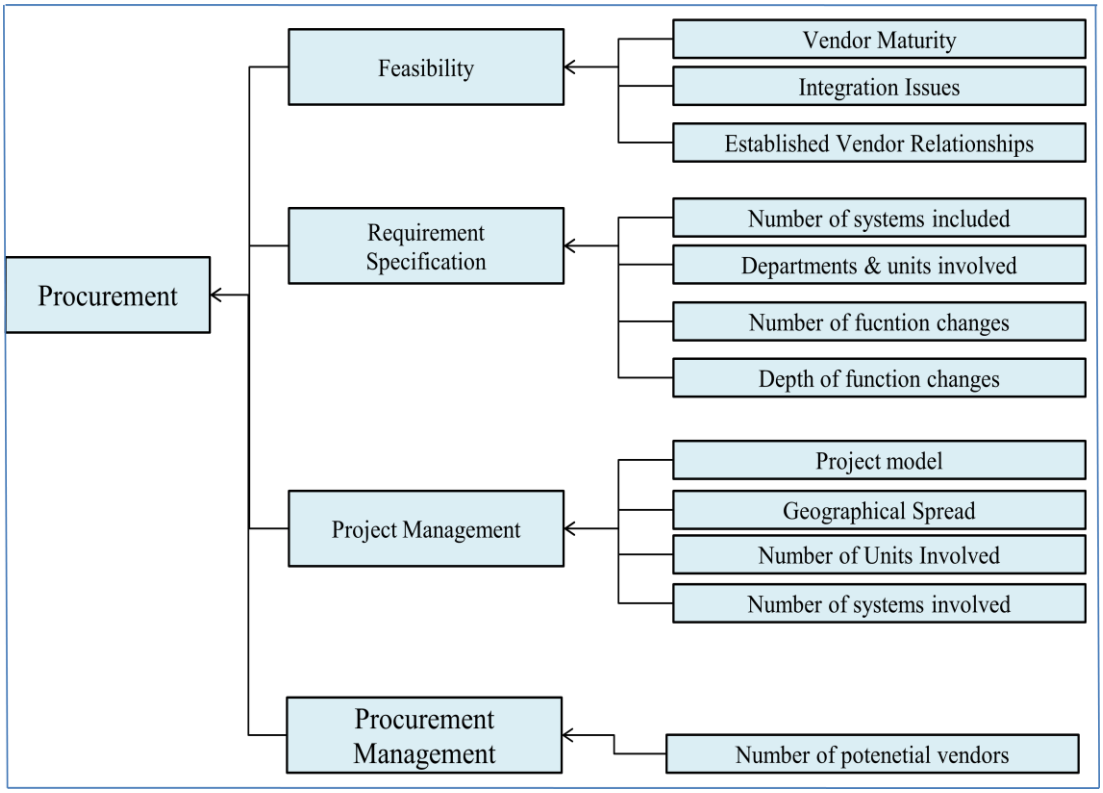

Figure 9: Procurement Background Factors (Source: Author)

4.5.8 Hardware/Software Acquisition Costs

Hardware/Software acquisition costs are initial costs incurred in procurement of system hardware, System Software and Application Software. The hardware consists of network devices such as switches, routers, firewalls, proxies, servers and client devices such as desktops, laptops, printers, and so on. The background factors that influence the cost of technical infrastructure are the depreciable life and refresh cycle of the hardware.

The system software acquisition costs are influenced by the number of ERP modules deployed, economic life and the third party software. Economic life refers to the number

of years in which the software acquisition returns more value to the owner than it costs to own, operate, and maintain. When these costs exceed returns, the acquisition is beyond its economic life. Third party software such as credit card processing, performance monitoring tool, data mining, just to name a few may influence the cost of system software.

The application software background factors that influence the costs include license type and number of application software installed. Figure 10 shows the Hardware and Software acquisition background factors.

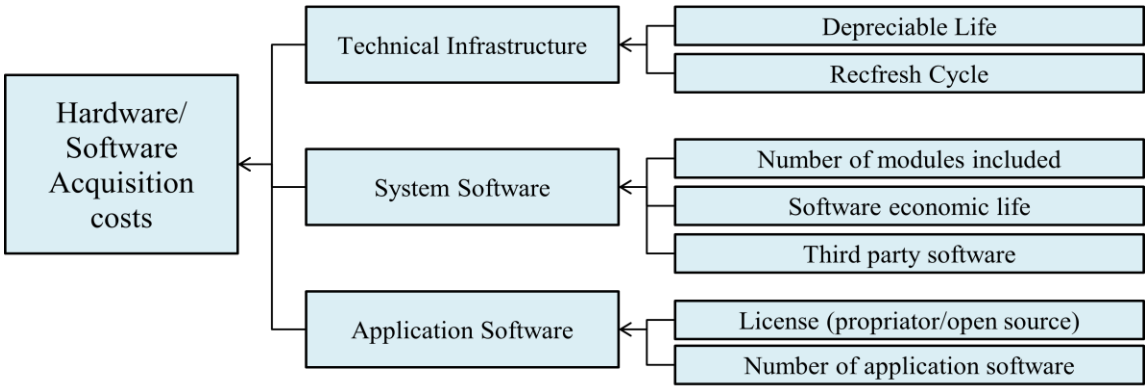

Figure 10: Hardware/Software Acquisition Background Factors (Source: Author)

4.5.9 Implementation Costs

The cost nodes of ERP implementation are organizational change management, technical setup, personnel restructuring and training

4.5.10 Change Management

Change management costs are affected by the complexity of business process redesign, the geographical spread of the business locations and the number of units involved.

4.5.11 Technical Setup

Technical setup is influenced by the integration costs, migration costs, configuration costs, customization costs, testing costs, as well as the cost of phasing out the old system.

4.5.12 Personnel Restructuring

Personnel restructuring is the process of reconstituting the employee to accommodate new skills and capabilities needed to meet expected operational requirements brought about by ERP system which changes workflow and production processes. Personnel restructuring costs depends on the extent of training needed, complexity of process redesign and technology familiarity among users.

4.5.13 Training

Training is influenced by the mode of training, amount of training needed and availability of relevant skills within the organization. Inclusion of training in the system software license also reduces the training costs. Figure 11 shows the implementation background factors

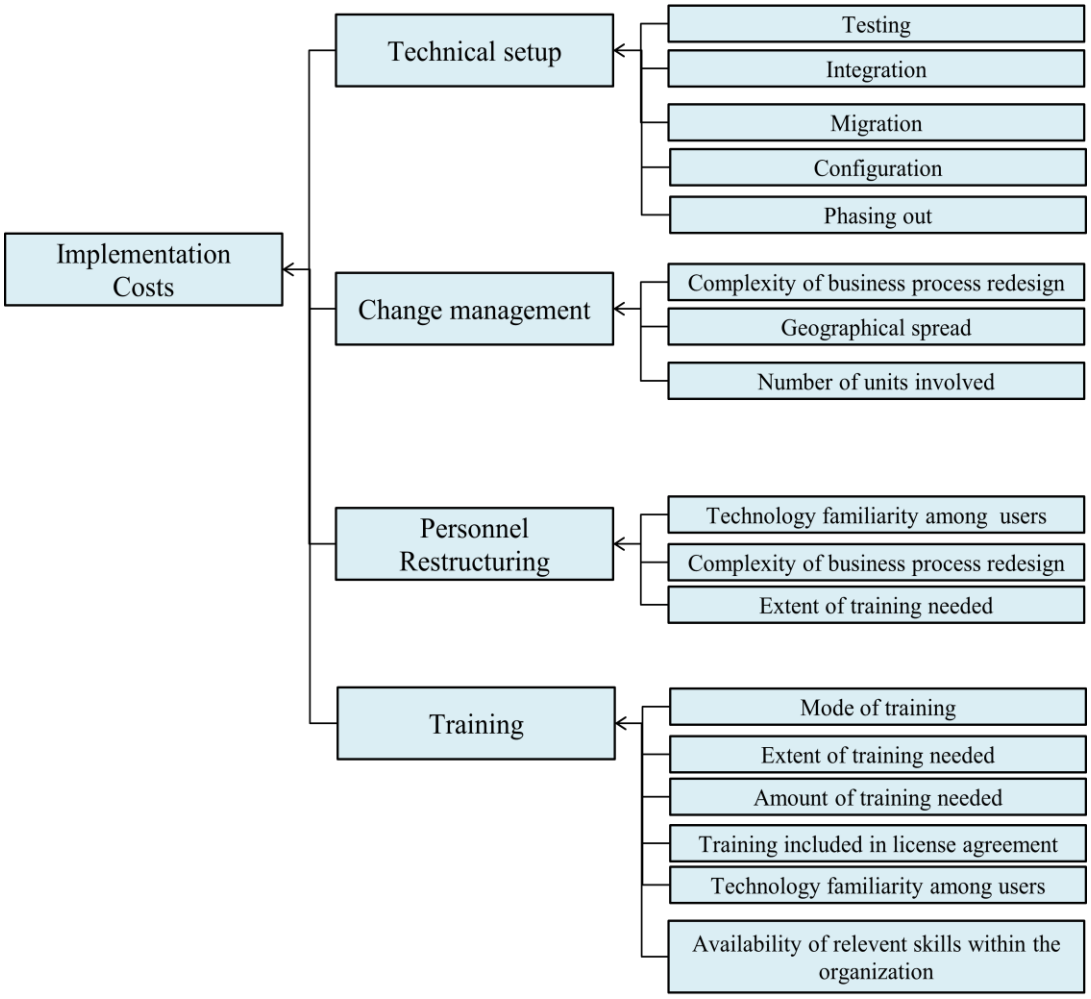

Figure 11: Implementation Costs Background Factors (Source: Author)

4.5.14 Operation and Maintenance Costs

The model decomposes operation and maintenance costs to:

i. License agreement costs

ii. Overheads costs

iii. Monitoring, maintenance and security costs

iv. Support costs

v. Upgrade costs

4.5.15 License Agreements

License agreements are contracts between the producer and the consumer of a hardware and/or software, granting the consumer the right to use the product under specific conditions. License agreement costs have scope of license agreement and applicability of enterprise wide license agreements as the background factors

4.5.16 Overheads

Overhead or overhead costs refers to an ongoing expense of operating an information system. The term overhead is usually used when grouping expenses that are necessary to the continued functioning of the IS but cannot be immediately associated with the products or services being offered. Overhead costs are influenced by the amount of overhead included in license agreement and changes in hardware.

4.5.17 Monitoring, Maintenance and Security

Monitoring, maintenance and security costs depends on amount of special adjustments required, service level agreement and scenario complexity.

4.5.18 Support

Support costs arise from technology familiarity among users, support, SLA, support included in the license, amount of special adjustments required and availability of relevant skills within the organization.

4.5.19 Upgrade Costs

Upgrade costs involves costs of replacing systems or system components/modules with a newer version resulting in a fully functional system satisfying all tests and requirements. The cost of upgrading for hardware and software depends on whether future requirements were considered in the new architecture and the degree of customization conducted in the ERP system. Figure 12 shows the operation and maintenance background factors.

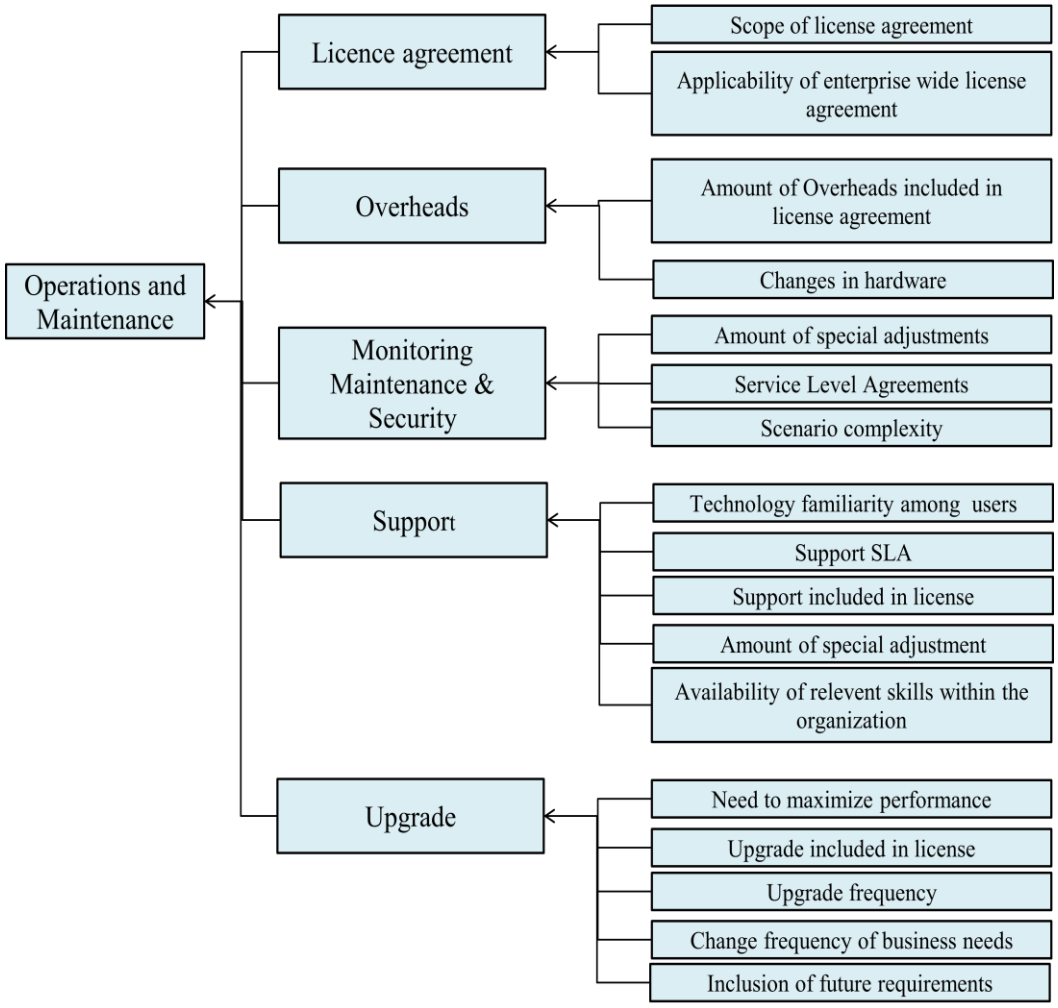

Figure 12: Operations & Maintenance Costs Background Factors (Source: Author)

4.5.20 End-User Usage

End-user usage cost element has two nodes, end-user operations and downtime and fourteen background factors. End-user operations costs are influenced by the efficiency of technical support provided to the user, efficiency of training, efficiency of change management, resistance to change, and technology familiarity among users.

Unplanned downtime is downtime that occurs as a result of a failure (for example, a hardware failure or a system failure caused by improper server configuration) while planned downtime is downtime that occurs when an administrator shuts down the system at a scheduled time.

Downtime costs arise from the costs of:

i. Detection,
ii. Containment,
iii. Recovery,
iv. Ex post response,
v. IT productivity loss,
vi. User productivity loss
vii. Gonsequences of business disruption
viii. Lost revenues

Figure 13 shows end-user usage background factors.

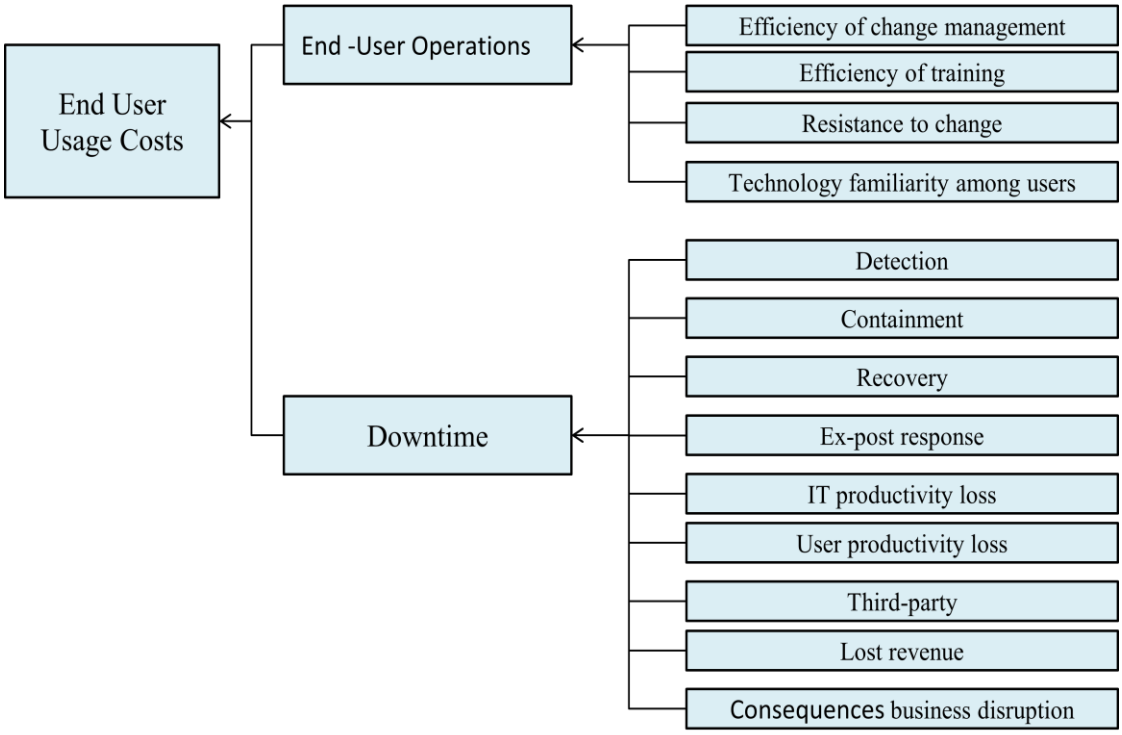

Figure 13: End-user Usage Costs Background Factors (Source: Author)

4.5.21 Summary

In this chapter, data analyses presentation and interpretation was carried out. The proposed TCO model was also presented together with the background factors. The findings of this chapter will form the foundation of Chapter 5.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter discusses the summary of major research findings conclusions, recommendations and suggestions for further research.

5.2 Summary of Major Findings

This study was carried out to evaluate the total cost of ownership of university enterprise resource planning with Maseno University as a case study. A sample of ten IT staff selected from ICT Directorate, Finance and Procurement department who also took part in ERP implementation were chosen for the purpose of the study. An interview guide was used to collect views and opinions from the sample on procurement, implementation, and operation of the ERP system. Forty two questionnaires were also given out to the ERP end-user to collect their views and opinion on the usability of the system. Documents were also analyzed to triangulate the information collected through interviews. The responses were analyzed and narrated.

The first objective of the study was to identify the major cost drivers of TCO in a university ERP. Data analysis revealed the five major findings under this objective. It revealed that major cost drivers that influence the TCO of a university ERP are:

i. Number of implementation locations
ii. Scope of business to be implemented

iii. Life cycle of technology

iv. End-user familiarity with technology

v. System Support

The first cost driver, the number of implementation locations is in agreement with the major cost drivers identified by West & Daigle, (2004) discussed in section 2.3 in which they state that the ERP TCO depends on the nature of the organization (large, public verses small private). The second cost driver, is dependent on the number of modules was also established by in a study of ERP implementation costs in Swiss SMEs discussed in section 2.3.

Unicom, an information technology solutions provider suggests that establishing a refresh schedule based on historical performance and usage requirements in 2 to 5 year cycles will improve overall IT infrastructure performance by reducing downtime and decreasing costs (GTSI Corp, 2008). Reduction in downtime reduces the magnitude of TCO and decreasing operation and maintenance costs also lowers TCO. This position is in agreement with the third cost drive, life cycle of technology.

The second objective of the study sought to determine the total cost of owning the Maseno University ERP system. The study revealed that the ERP system will cost the university over a five year period a sum of KES 129,077,238. Procurement costs accounted for 3%, while hardware and software acquisition costs tool 16%,

implementation costs took 7% while operations and maintenance took lion's share of 51% and end user usage accounted for 23%. This is in agreement with Gartner's findings discussed in section 2.3 where Gartner assets that initial acquisition costs accounts for only 20%. The initial acquisition cost for this study is procurement and hardware and software acquisition costs which account for 19% of the five year TCO. This indicates that the university has significant control of 81% of the TCO since these costs are administrative which can be optimized by employing sound management practices. Operations and maintenance accounts for 51% and is where the highest spending lies in agreement with the literature in section 2.3.

End user usage accounted for 23% of the five years TCO of ERP, which is more than the percentage taken by initial acquisition of hardware and software. The theoretical framework postulated that cutting cost of hardware/software and system support transfers the costs to the end-users. The absence of dedicated system support staff and non adherence to technology refresh cycle explains why the end-user usage cost is higher than initial hardware/software acquisition costs.

The third objective of the study was to develop a model for computing the total cost of ownership of a university ERP system. The developed TCO model has five cost elements, 17 cost nodes and sixty-five background factors. The background factors are included in the model to enable the decision makers to effectively and efficiently

manage the cost driver with the goal of not just lowering the TCO but also having an IS that is functioning optimally.

5.3 Conclusion

This study investigated a model for evaluating TCO of university ERP, case of Maseno University. It was intended to develop a model for evaluating the TCO of ERP system in a university and to provide basis upon which to monitor costs over time. This was in relation to the existence of clear gap in ERP cost identification, management and estimation. The study specifically sought to identify the major cost drivers that can influence TCO in university ERP system, analyze the total cost of owning a university ERP system and develop a model for estimating the TCO of ERP in a university.

The first objective of the study sought to identify the major cost drivers that can influence TCO in university ERP system. The study established that the major cost drivers that can influence TCO of ERP in a university are; the number of implementation locations, the scope of business impacted, technology familiarity among users, life-cycle of technology and ERP system support.

The second objective sought to analyze the total cost of owning a university ERP system. The study revealed that the procurement costs accounted for 3% of TCO of Maseno University ERP System while hardware and software acquisition accounted for

16% and operations and maintenance took a lion's share of 51% and implementation took 7% while end user usage accounted for 23%.

The third objective of the study was to develop a model for estimating the TCO of ERP in a university. This study has presented a model for evaluating total cost of ownership for University Enterprise Resource Planning. The model has five cost elements consisting of procurement costs, hardware and software acquisition costs, implementation costs, operations and maintenance costs and end-user usage costs.
The model also has seventeen nodes and sixty five background factors.

In view of these findings the study concludes that the developed model for TCO of ERP in a university provides a solid foundation for making sound decisions concerning ERP investments in universities.

5.4 Recommendations

The researcher has argued in this report that TCO of ERP goes beyond purchase price to comprehensively examine all costs from purchase price to the cost of taking an asset out of service. The study has also shown that the bulk (84%) of TCO costs lie in operations and maintenance and end-user usage. It is against this background that the recommendations below are made. Despite the limitations, this study should be applied in future projects that are tolerably similar to the one under study. Basing generalization

on the findings of this study, the researcher recommends the reduction of TCO through people, processes and technology as discussed next.

i) **People** – Institution should invest in its staff by conducting regular training to end-users and IT staff to make optimal use of cost-management of processes and technologies.

ii) **Processes** – To minimize technology and end-user downtime, the institutions should automate some tasks and streamlining others, such as asset tracking by using ITAM system to software updating.

iii) **Technologies** – Since labor consumed more than half of the TCO of ERP cost, institutions should pump more resources in deploying information technologies that minimize and in some cases eliminate the widest range of labor-intensive tasks as well as employ best practices in deployment of technology.

5.5 Suggestions for Further Research

This study focused on a single university that was had implemented ERP system. Study may be appropriate in future to:

i. Determine the factors that cause ERP implementation go beyond the projected time frame.

ii. Develop a model for evaluation of TCO of Cloud based ERP system.

iii. Assess universities the impact of TCO analysis in universities.

iv. Develop a model to evaluate the Return on Investment of ERP investment in universities

5.6 Summary

This chapter highlighted the study summary, conclusion and gave recommendation on how to minimize TCO by universities and ends by suggesting research areas that can be looked at in future.

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APPENDICES

Appendix A: Interview Guideline

Below is a brief interview guideline.

This interview is intended to assist the researcher in collecting data on the Enterprise Resource Planning (ERP) Implementation. You have been identified purposely as an important respondent to the interview questions. The information you will provide will be treated with utmost confidentiality and will be used solely for purposes of this research. If need be, the findings of the research will be shared. The researcher is a student of Masinde Muliro University of Science & Technology pursuing Master of Science in Information Technology.

The interviews sought to get the interviewee's facts and opinions on the following:

i. Cost elements that should be included in a TCO model.
ii. Cost drivers that can influence the cost elements in a TCO.
iii. Sequence of activities that take places in the procurement of hardware and software.
iv. Elements to be include in ERP TCO.
v. Elements to be included in cost of maintenance and the necessary activities that are performed.
vi. The yearly budget allocated to ICT department and its breakdown.
vii. The hardware and software installed in the ERP system.
viii. The organogram of Maseno University ICT department.

ix. System support

x. The end-user activities.

xi. The university asset disposal policy.

xii. Past TCO analysis on the university information system.

Appendix B: Research Questionnaire

Below is the questionnaire that was used to collect research data from end-users.

Patrick Owoche
P. O. Box 2685
Kisumu
6-Feb-13

Dear Sir/Madam

RE: RESEARCH QUESTIONNAIRE

I am a Masters of Information Technology student at Masinde Muliro University of Science and Technology. My research topic is "TCO Model for ERP System: Case of Maseno University". In order to gather data for research I have prepared a questionnaire to be filled by Maseno University ERP end users. I kindly request your assistance in this academic endeavor by filling in the questionnaire. I would like to emphasize that your responses are extremely valuable to me and I would greatly appreciate your answering all questions. I assure you that the data collected here will be held in confidence. The results of the study would be used in a thesis as partial fulfillment for a Master degree.

Thanks in advance.

Kind regards,

Patrick Owoche
owochep@yahoo.co.uk
Phone +254722843180

Please tick (✓) where appropriate

SECTION A: Basic Details

1. Which department do you work in?

- □ Academics
- □ Finance
- □ Human Resource
- □ Procurement
- □ Hospital
- □ Kisumu Hotel
- □ Hostel
- □ Others (specify): ……

2. Gender

- □ Male
- □ Female

3. Age

- □ Less than 20 yrs
- □ 21-30 yrs
- □ 31-40 yrs
- □ 41-50 yrs
- □ Above 50 yrs

4. Level of Education

- □ Doctorate
- □ Masters
- □ Bachelors
- □ Diploma
- □ Tertiary/Middle-level College
- □ Others (specify): ……

5. An Enterprise Resource Planning (ERP) is an integrated information system that serves all departments within an enterprise/institution. How long have you been using the Maseno University ERP system?

- □ Less than 6 months
- □ 6-12 months
- □ 12-18 months
- □ 18-24 months
- □ More than 24 months
- □

6. Maseno University implemented the Microsoft Dynamics NAV, an ERP software product from Microsoft. Which module of the ERP system do you use? (select ALL that apply)

- □ Academic Management System
- □ Financial System
- □ Procurement System
- □ Hotel Management System
- □ Hospital System
- □ Hostels Booking System
- □ Others (specify): ……

Section B: ERP System End-User Training

7. Have you ever received computer training : (select ALL that apply)

- □ I have never received any training
- □ I trained in high school
- □ I trained at the university
- □ I trained in a private computer college
- □ I trained through computer based training
- □ I trained at work
- □ I trained through friends
- □ Others (specify): ……

8. When it comes to learning computers, I would prefer to: (select ALL that apply)

- □ Not learn any more
- □ Teach myself
- □ Work one on one with someone
- □ Attend classes in a college
- □ Use tutorial software
- □ Be taught by colleagues at work
- □ Others (Specify): ……

9. Select a statement that best describes your ability to execute the listed tasks. Please tick (✓) where appropriate

		I don't need to know this for my job	I feel confident	More knowledge needed	I don't understand what this is
	Can you:				
i)	Set up a new pc	□	□	□	□
ii)	Check set up of existing pc system	□	□	□	□
iii)	Understand licensing requirement	□	□	□	□
iv)	Check network connection	□	□	□	□
v)	Change display mode	□	□	□	□
vi)	Test printing function	□	□	□	□

10. Which phrase below describes your OVERALL level of technical skill and knowledge with the ERP system:

□ Not Very Competent
□ Low Level Competency
□ Moderate Level Competency
□ High Level Competency
□ Expert
□

11. Averagely, how many hours in a day do you use the ERP system at work:

□ 0-1
□ 2-3
□ 4-5
□ 5 or more

12. During the ERP system implementation, did you undergo user training?

□ Yes □ No

13. (i) In the past six months, have you received any form of ERP end user training? If no skip to item number 14.

□ Yes □ No

(ii) If yes, what did it entail? ……

14. (i)Did you join Maseno University after the ERP system implementation? If no skip to item 15

□ Yes □ No

(ii) If yes, did you undergo ERP end-user induction training?

□ Yes □ No

15. If you have ever received ERP end user training, was it adequate for your job role?

□ Yes □ No

16. If you have never received ERP user training, then how did you learn/how are you learning to use the ERP system?

□ Computer based training □ Help desk

□ Through workmates □ Others (specify): ……

SECTION C: ERP System Downtime

The term downtime refers to periods when an information system is unavailable to users.

17. Outage is when network resources are unavailable to users. Please estimate the number of outages that occur per month at your place of work (Fill in numbers) ☐

18. On average, how long (in hours) does each outage last? Fill in numbers ☐

19. Service degradation occurs when there is a severe decrease in performance on the network - it is available to users only on a limited basis. Please estimate the number of service degradation that occur per month at your place of work (Fill in numbers) ☐

20. On average, how long (in hours) does each service degradation last? (Fill in numbers) ☐

21. When a computer or network is down what percentage of the time do you do the following? (Responses should add to 100%) ☐
    (a) Work on other tasks ☐
    (b) Wait ☐
    (c) Do the same task using manual, work around procedures

SECTION D: ERP System End-User Activities

22. (i) Do you encounter situations where you need help when using the ERP system? If no skip to item number 24.

☐ Yes ☐ No

23. How many hours cumulatively per month do spend on your own computer for maintenance activities, such as backups, loading software, and organizing files on hard drives? ☐

24. How many hours cumulatively per month do you spend attempting to resolve your own system and application issues unaided (without service/service desk support or co-worker assistance)? ☐

25. How many hours cumulatively per month do you spend on casual learning activities such as reading manuals or using on-line help? ☐

26. How many hours cumulatively per month do you spend receiving help from workmates, ERP support to solve system, application and network issues? ☐

27. Whenever you are stuck in a work related ERP task, averagely how long (in hours) does it take you to get assistance? (Fill in numbers) ☐

THANK YOU FOR TAKING YOUR TIME TO

RESPOND TO THIS QUESTIONNAIRE

------ END -----

Appendix C: Data Collection Proforma

Total Cost Of Ownership Data Collection Proforma for Software acquisition

COMPONENTS	**Name**	**Vendor**	**Date Acquired**	**Unit Cost**	**Qnty**	**Amount**
Bundled operating systems software						
Server operating systems software						
Server operating systems software upgrades						
Desktop operating systems software						
Desktop operating systems software upgrades						
Laptop operating systems software						
Laptop operating systems software upgrades						
Applications software						
Applications software maintenance & upgrade costs						
Middleware						
Database software						
Connectivity and communication software						
Storage back-up software						
Utilities software						
Others						
SUBTOTAL						

Software compliance costs

COMPONENTS	Name	Vendor	Date Acquired	Unit Cost	Qnty	Total Cost
Systems monitoring software						
License management						
Legal costs						
'True up' costs						
Software audit costs						
Vendor management						
Software upgrade management costs						
Software migration management costs						
SUBTOTAL						

Hardware

Components	No.	Name/Model	Vendor	Date Acquired	Unit Cost	Qnty	Total Cost
Servers	1						
	2						
	3						
	4						
Clients	1						
	2						
	3						
	4						
Laptops	1						
	2						
	3						
	4						
Peripheral devices	1						
	2						
	3						
Printers	1						
	2						
	3						
	4						
Storage	**1**						
	2						
Memory	**1**						
	2						

Network connectivity hardware	**1**						
	2						
	3						
SUBTOTAL							

Hardware procurement and deployment costs

Component				
Turnover				
Legal costs				
Vendor management				
SUBTOTAL				

Combined direct IT labor support costs

COMPONENTS				
Central management				
Central help desk				
Technical support officers				
University management				
University help desk/in-house technical support officers				
Asset management				
Security and virus management				
SUBTOTAL				

Network IT access and management

COMPONENTS				
Caching hardware				
Caching software				
Bandwidth				
Legal costs				
Vendor management				
SUBTOTAL				

Services and Lease Costs

COMPONENTS				
Network service and management fees				
Bundled telecommunication services				
SUBTOTAL				

Dedicated IT Running and 'Housing' Costs

COMPONENTS				
Electricity				
Air-conditioning				
Cabinets				
Consumables				
Downtime				
SUBTOTAL				

Formal training and professional development

COMPONENTS				
Technical training				
Professional development of end users				
SUBTOTAL				

Appendix D: Maseno University ICT Budget and TCO Costs Breakdown

MASENO UNIVERSITY ICT DIRECTORATE BUDGET FOR 2012/2013 & 2013/2014				
	2012/2013	**2013/2014**	**Ave**	**Five Years**
Overheads				
Electricity	28,800	60,000	44,400	222,000
Stationary	50,000	50,000	50,000	250,000
Tel	200,000	192,500	196,250	981,250
Computer Material	500,000	500,000	500,000	2,500,000
Tel	84,000	84,000	84,000	420,000
Uniforms	0	7,500	3,750	18,750
Transport	0	50,000	25,000	125,000
Total Overhead	864,812	946,013	905,413	4,527,063
Maintenance				
Software License		1,200,000	1,200,000	6,000,000
Software Maintenance		1,500,000	1,500,000	7,500,000
Maintenance of Office Equipment	100,000	1,000,000	550,000	2,750,000
Network Expansion	8,000,000	800,000	4,400,000	22,000,000
Total Maintenance	8,100,000	4,500,000	6,300,000	31,500,000
Capital Expenditure	500,000	10,000,000	5,250,000	26,250,000
Salaries & Emoluments	**16,700,000**	**19,000,000**	17,850,000	
Totals	**9,464,812**	**10,946,013**	**10,205,413**	**51,027,063**

Salaries + Emoluments	**2012/2013**	**2013/2014**	**Ave**	**Five Years**
Director		1,109,724	1,109,724	5,548,620
Training manager		569,556	569,556	2,847,780
Coordinator		569,556	569,556	2,847,780
Sub-Total		**2,248,836**	2,248,836	11,244,180
Systems Admin	485,904	337,728	411,816	2,059,080
Network Admin	325,632		325,632	1,628,160
Hardware Maintenance	347,088	485,904	416,496	2,082,480
Website Designer		269,688	269,688	1,348,440
Ass Web Master	290,856	238,488	264,672	1,323,360
Senior Technician	219,252	172,488	195,870	979,350
Senior Technician	313,536	196,488	255,012	1,275,060

Technician	835,952	172488	504,220	2,521,100
Cyber Assistant		879,504	879,504	4,397,520
Office Assistant		125,724	125,724	628,620
Total	**2,818,220**	**2,878,500**	2,848,360	14,241,800
Overall	**10,918,220**		**10,918,220**	**54,591,100**

Others				
	2012/2013	**2013/2014**	**Ave**	**Five Years**
Gratituity & Retirement	1101759	614539	858,149	4,290,745
Non Use of official car		192000	192,000	960,000
Entertainment	84000	216000	150,000	750,000
Responsibility allowance	84000	180000	132,000	660,000
Tel	60000	72000	66,000	330,000
Leave	12800	12800	12,800	64,000
Commuting & Millage	52400	1014000	533,200	2,666,000
Total	**1394959**	**2301339**	**1,848,149**	**9,240,745**
Grand Total	**4,213,179**	**5,179,839**	**4,696,509**	**23,482,545**

Hardware			
Device	**Quantity**	**Unit Cost**	**Amount**
Personal Computers	65	70,000	3,000,000
Laptops	3	80,000	240,000
Peripheral Devices	180	2,000	360,000
Printers	8	100,000	800,000
Servers	2	400,000	800,000
Server Rack	1	80,000	80,000
Network Connectivity hardware			800,000
Routers	2	40,000	80,000
Switches	13	6,000	78,000
Bandwidth cost	0	85	-
Proxy Gateway			80,000
Firewall	1	200,000	200,000
Cabinet- 48 U	2	96,000	192,000
Cabinet- 30 U	2	45,000	90,000
Cabinet- 2 U	12	10,000	120,000

Air Conditioner	1	120,000	120,000
Cabling			500,000
UPS	65	8,000	520,000
Memory	5	6,000	30,000
Storage	3	120,000	360,000
Total (Hardware)			**8,450,000**

Software			
Software	**Quantity**	**Unit Cost**	**Amount**
Server Software	2	340,000	680,000
Desktop Operating Systems	60	17,500	1,050,000
Ms Office	60	8,500	510,000
Laptop Operating Systems	2	17,500	35,000
Application Software	60	2,000	120,000
Middleware			-
Database Software			544,000
Connectivity &Communication Software	1	120,000	120,000
Storage Backup Software	2	5,000	10,000
Anti Virus	-	1,500	-
Utility Software	60	3,000	80,000
Total (Software)			**,249,000**

Procurement Costs		**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Feasibility Study	800,000	160,000	160,000	160,000	160,000	160,000
Requirement Specification	300,000	60,000	60,000	60,000	60,000	60,000
Procurement Management	1,000,000	200,000	200,000	200,000	200,000	200,000
Project Management	1,200,000	240,000	240,000	240,000	240,000	240,000
Hardware/Software						
Application Software	3,249,000	649,800	649,800	649,800	649,800	649,800
System Software	11,867,240	1,695,320	1,695,320	1,695,320	1,695,320	1,695,320
Hardware	8,450,000	8,450,000	6,760,000	5,408,000	4,326,400	3,461,120
Implementation Costs						
Technical Setup	8,281,571	1,656,314	1,656,314	1,656,314	1,656,314	1,656,314
Change Management	200,000	40,000	40,000	40,000	40,000	40,000
Personnel Restructuring	400,000	80,000	80,000	80,000	80,000	80,000
Testing	60,000	12,000	12,000	12,000	12,000	12,000

Training	600,000	120,000	120,000	120,000	120,000	120,000
Operation $ Maintenance costs		**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Licenses Agreement	185,000	185,000	185,000	185,000	185,000	185,000
Overheads	905,412	905,413	905,413	905,413	905,413	905,413
Maintenance	6,300,000	6,300,000	6,300,000	6,300,000	6,300,000	6,300,000
Support	4,696,509	4,696,509	5,166,160	5,682,776	6,251,053	6,876,159
Monitoring	60,000	60,000	60,000	60,000	60,000	60,000
Upgrade	80,000	80,000	80,000	80,000	80,000	80,000
End-User Usage						
End-user Operations	1,157,320	1,157,321	1,157,321	1,157,321	1,157,321	1,157,321
Downtime	4,789,748	4,789,748	4,789,748	4,789,748	4,789,748	4,789,748
Total	**54,581,803**	**31,537,425**	**30,317,076**	**29,481,692**	**28,968,370**	**28,728,195**

Appendix E: Research Approval Letters

MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

Tel: 056-30870
Fax: 056-30153
E-mail: sgs@mmust.ac.ke
Website: www.mmust.ac.ke

P.O Box 190
Kakamega – 50100
Kenya

Office of the Dean (School of Graduate Studies)

Ref: MMU/COR: 509079

Date: 12th December, 2012

Mr. Patrick Oduor Owoche
(SIT/G/06/10)
P.O. Box 190-50100
KAKAMEGA

Dear Mr. Owoche,

RE: APPROVAL OF PROPOSAL

I am pleased to inform you that the Senate of Masinde Muliro University of Science and Technology acting on the advice of the Board of the School of Graduate Studies approved your proposal entitled: '***Model for Evaluating Total Cost of Ownership for University Enterprise Resource Planning: Case of Maseno University,***" and appointed the following as supervisors:

1. Dr. Gregory Wanyembi
2. Mr. Juma Kilwake

You will be required to submit through your supervisor(s) progress reports every three months to the Dean SGS. Such reports should be copied to the following: Chairman, Faculty of Science Graduate Studies Committee and Chairman, Computer Science Graduate Studies Committee.

It is the policy and regulations of the University that you observe a deadline of two years from the date of registration to complete your Masters thesis. Do not hesitate to consult this office incase of any problem encountered in the coursed of your work.

I once more congratulate you for the approval of your proposal and wish you a successful research.

Yours Sincerely,

Dr. H.K. Were
for **DEAN, SCHOOL OF GRADUATE STUDIES**

Copy to:
- Vice Chancellor
- Deputy Vice Chancellor (AA)
- Registrar (AA)
- Dean, Faculty of Science
- COD, Computer Science

ZIA/

REPUBLIC OF KENYA

NATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGY

Telephone: 254-020-2213471,2241349
254-020-310571,2213123, 2219420
Fax: 254-020-318245,318249
when replying please quote
secretary@ncst.go.ke

P.O. Box 30623-00100
NAIROBI-KENYA
Website: www.ncst.go.ke

Our Ref: NCST/RCD/14/012/1467

Date: 26th October 2012

Patrick Oduor Owoche
Masinde Muliro University of
Science and Technology
P.O.Box 190-50100,
Kakamega.

RE: RESEARCH AUTHORIZATION

Following your application for authority dated *12th October, 2012* to carry out research on "***Model for evaluating total cost of ownership for university enterprise resource planning: Case of Maseno University,"*** I am pleased to inform you that you have been authorized to undertake research in **Kisumu North District** for a period ending **12th May, *2013.***

You are advised to report to **the Vice Chancellor, Maseno University** before embarking on the research project.

On completion of the research, you are expected to submit **two hard copies and one soft copy in pdf** of the research report/thesis to our office.

DR M.K. RUGUTT, PhD, HSC.
DEPUTY COUNCIL SECRETARY

Copy to:

The Vice Chancellor
Maseno University.

MASENO UNIVERSITY
OFFICE OF THE DEPUTY VICE CHANCELLOR
PLANNING, RESEARCH & EXTENSION SERVICES
(PRES)

Tel: 254-057-351622, 351620, 351008, 3511011
Fax: 254-057-351221, 351153
e-mail: *dvcpres@maseno.ac.ke*

Private Bag
MASENO
KENYA

Our Ref: ACA 7/13/VOL. 1/(111)

Date: 3rd December, 2012

Patrick Oduor Owoche
Masinde Muliro University of
Science & Technology
P. O. Box 190-50100
KAKAMEGA

Dear Mr. Owoche,

REF: REQUEST TO CONDUCT RESEARCH

Reference is made to a letter from the National Council for Science & Technology dated 26th October, 2012 addressed to you and copied to us on the above subject matter.

I am pleased to inform you that your request to conduct Research on ***"University Enterprise Resource Planning: Case of Maseno University"*** in our institution has been approved.

For further arrangements please get in touch with the undersigned. Please note that upon completion of your research, you are expected to submit a copy of your research report to the University.

Thank you.

MASENO UNIVERSITY
DEPUTY VICE CHANCELLOR
- 4 DEC 2012
PLANNING, RESEARCH & EXTENSION SERVICES (PRES)
PRIVATE BAG MASENO

Prof. George M. [illegible]
DEPUTY VICE CHANCELLOR (PLANNING, RESEARCH & EXTENSION SERVICES)

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