UNIVERSITY OF NAIROBI

DEPARTMENT OF COMPUTING AND INFORMATICS

CHALLENGES OF IMPLEMENTING CLOUD TECHNOLOGIES IN KENYAN UNIVERSITIES

BY

P54/85535/2016: DENNIS SAFARI WAEMA

SUPERVISOR: PROF. AGNES WAUSI

JULY, 2022

Submitted in partial fulfillment of the requirements for the award of Master of Science degree in Information Technology Management

DECLARATION

I declare that this project is my original work and has not being previously published or presented in any institution.

Signed:  Date: 30th August, 2022

Dennis Safari Waema

P54/85535/2016.

The research project is submitted as part of the fulfilment of the requirements for the award of Master of Science in Information Technology Management degree at the University of Nairobi with my approval as University supervisor.

Signed:  Date: 30th August, 2022

Prof. Agnes Wausi

Department of Computing and Informatics

University of Nairobi.

ACKNOWLEDGEMENT

I thank God for the grace and the gift of knowledge throughout the study. Special thanks to all my friends and guardians for continuous support and encouragement. Finally, I thank all my lecturers and my supervisor Professor Agnes Nduku Wausi.

ABSTRACT

The cloud computing phenomenon has contributed to the development and deployment of various cloud technologies that are improving business value by promoting perfect competition, flexibility, accessibility, efficiency in operations and cost-saving. Several commercial and strategic reasons encourage greater use of cloud applications and services in order to maintain a competitive digital economy. Nowadays, numerous cloud-based technologies are available and used widely. In this era, technology, economic perspectives and business models are the key drivers for cloud innovations. The e-infrastructures on the cloud offers advanced and scalable services such as crowdsourcing platforms, central storage and backup, multimedia services, web-based email and project management tools. The main aim of the study is to identify challenges hindering the implementation of cloud technologies in Kenyan universities. The study was conducted at the Nairobi metropolitan site where six universities were sampled. The data was captured online where a total of 150 questionnaires were sent out to the selected universities, the response rate was 82.7%. The study used the TOE theoretical framework to model the key elements such as technology, organization and environment that lens through the phenomena under study to identify variables that influence cloud implementation. TOE was used as the foundation for the conceptual framework to model research problems, questions, data gathering, analysis techniques and interpretation. The study identified the following cloud implementation challenges: technology aspects, network connections, reliability of solution providers, portability, security, privacy, ICT skills and lack of computers. Other factors that influence cloud technologies implementation are privacy issues, competitive pressure, social pressure, speed and performance, availability, scalability, cyber threats, management, organizational culture and compatibility. Kenyan universities should establish a mechanism and guidelines that protect access and sharing of data on the cloud, source comprehensive and cost-effective cloud solutions, maintain service level agreements to improve performance and quality of services, deploy competent and experienced personnel and maintain continuous capacity-building programs.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ACRONYMS AND ABBREVIATIONS

IT- Information Technology

IS- Information Systems

ICT- Information and Communication Technology

IaaS- Infrastructure as a Service

PaaS- Platform as a Service

SaaS- Software as a Service

NIST- National Institute of Science and Technology

SLA- Service Level Agreement

PI- Personal Information

CT- Cloud Technologies

PII- Personal Identifiable Information

TOE- Technology, Organization and Environment

GoK- Government of Kenya

CSC- Cloud Service Customer

CSP- Cloud Service Provider

CSC- Cloud Service Contracts

CSA- Cloud Service Administrator

CSU- Cloud Service User

CT- Cloud Technologies

CSM- Cloud Service managers

CSFs- Critical Success Factors

CSR- Corporate Responsibility

MFA- Multi-Factor Authentication

1.0 CHAPTER ONE: PROBLEM STATEMENT

1.1 Background

Cloud technologies are transforming business processes by offering specialized customer-centric platforms with continuous value enhancement that produces high-performance solutions that increases sustainability. (Venters & Whitley, 2012) In a cloud environment, users utilize e-infrastructure as a service via the network at one or more layers of abstraction where cloud users pay only for the services they require, which is cost-effective. Various cloud technologies (CT) are available and widely used, like AWS, Google products, Zoom, Microsoft Azure, Oracle Cloud, Skype Cloud, etc. The use of cloud-based applications and services offers enormous opportunities like scalable data centers, improved standardization, reduced ICT expenditure and operational costs, improved business value, easy to manage data and improved customer experience due to real-time accessibility, availability and global support. Despite the benefits, cyber attacks compromises cloud implementation process and deny access to key services, other issues are compliance constraints, data lock-in, network connections, data jurisdictions and privacy. (Marston et al., 2011) Implementing cloud technologies is perceived as an innovation that has transformed the way of doing business from physical to virtual. Before implementing cloud applications it is important to plan on how to aid knowledge management and how to align learning with the business goals. Human resources should be taken into consideration because they influence cloud implementation process, determine performance and success. (M.S.Pang et al., 2014) relevant studies in information systems adoption have observed the importance of human capital in developing and enhancing value for firms. Employees are eager to learn on technical aspects; therefore, management should strive to initiate capacity-building programs that train on crowdsourcing, virtualization/ remote computing, open source and collaboration tools. (M.S. Salwani et al., 2009) Migrating services to the cloud environment is not easy. Institutions should plan wisely, invest in cloud solutions, training and IS integration.

Globally, cloud computing usage is improving at a rate of 4.5 times from 2009 while it increased higher six times more than the rate of IT spending from 2015 to 2020. In 2010, the global cloud services grew from $21.5 billion to $72.9 billion in 2015 with a compound annual growth rate (CAGR) of 27.6%. Cloud computing global growth rate is four times than the projected growth rate for the worldwide IT market that stands at 6.7% (“IDC Cloud,” 2013). There is an exponential

growth in the global cloud services market from 2016 to 2017 at a rate of 18% in Infrastructure as a Service (IaaS), 36.8% in Software as a Service (SaaS) and 20.1% in Platform as a service (PaaS). In 2019, the most improving segment in the market was infrastructure as a service (IaaS) at a rate of 27.5% (Gartner, 2019). The survey conducted by Cisco and World Wide Worx show that South Africa, Kenya and Nigeria are the best nation in Africa that lead in cloud usage in Sub-Saharan Africa as of 2013. 50% of South Africa's medium and large firms use cloud services compared to 48% in Kenya and 36% in Nigeria. (Omwenga et al., 2014) In Kenya, private cloud is used widely than the public cloud; several institutions have implemented private cloud at a 39% higher rate than the public cloud at a 22% rate. To some extent, a few institutions were using both private and public clouds while the rest had not adopted cloud computing technology.

The National Institute of Standards and Technology (NIST) describe cloud computing as a model where resources are shared virtually (networks, servers, storage, applications and services) and managed by cloud service managers (NIST, 2011). The key services of cloud computing are; resource collection, rapid flexibility, real-time self-service and broad network access (NIST). Service models in cloud computing are Platform as a Service (PaaS), Software as a Service (SaaS) and Infrastructure as a Service (IaaS). (Mell and Grance, 2011) Deployment models can be either private, public or community clouds. In the cloud, there is flexibility, economical data centers, real-time access to resources and services and capability to scale up and down computing power based on organizational needs (Pocatilu, 2009).

Cloud computing is expected to increase the rapid use of technology and transform the ways of doing business by improving processing, enhancing efficiency and effectiveness in service delivery and improving business value, cut operational costs, link businesses globally, and support clients remotely. For example, the use of cloud technologies enables institutions to offer services virtually e.g. marketing, classes, research and seminars and open days. Cloud computing usage contributes to the rapid growth due to globalization which broadens the client base; while it encourages diversification and development of agile cloud solutions that address the niche, focuses on different portfolios, reduces risk, improve performance and flexibility. The important aspect of implementing cloud computing is the ability to align technology with the core business which allows institutions to embrace change, improve processing, increase profitability, reduces cost and bridges the global gap.

Threats such as security, privacy and portability issues influence cloud implementation (Feuerlicht et al., 2011). Data in the cloud can be compromised or stolen since resources are hosted on

dedicated servers managed by external vendors. Evaluating risk likelihood enables to assess consequences of risk events like financial, technical and compliance that might occur when implementing cloud technologies (Oliveira et al, 2014), the results of the assessment classifies threats to ascertain the most to least of critical importance; ranking risks in terms of their criticality presents an insights to the project managers on where resources are critical and on how to prevent high possibilities. Before implementing cloud applications it is necessary to consider risks like privacy, trustworthiness and cyber threats. (Wei et al, 2010) describe privacy and security as the major implementation challenges. (Mather et al, 2009) Trust is essential in the implementation process as it provides a sense of safety and eliminates division in teamwork. Thus, cloud service users and cloud service contracts must guarantee the privacy of information.

Despite the economies of scale, implementing cloud technologies incurs additional costs such as compliance costs, service costs and support costs. (Chang at al, 2016) The main concerns in the cloud are network connection and coverage, computers and technical aspects. Technical agility impacts the cloud implementation process. Therefore, institutions should be prepared to embrace change and manage change by devising ways of enhancing capacity-building initiatives that equip and propel personnel to keep pace with technology dynamics. Regulations should be addressed because they enforce guidelines, practices and policies. To ensure that cloud resources conform to the standards, it is necessary to perform an audit on processes, software and workflows. Compliance issues should be taken into consideration, and ensure there is an effective risk management plan in action that streamlines business operations to overcome issues like penalties, lawsuits and reputation damage.

1.2 Problem Statement

Security and privacy impact cloud implementations since all the resources are hosted on central dedicated servers (Buyya, Goscinski, & Broberg, 2011). Cyber attacks challenge cloud technologies in many ways; e.g. an attack on institutions' servers denies access to information systems, telecommunication channels and databases. Attacks such as phishing, fraud and cracking of software for credentials are serious security threats that manipulate data and cause unauthorized access to private information. Data breaches compromise privacy, data consistency or theft and can lead to financial loss, reputation damage, operational downtime and legal action. Therefore, data should be protected in the cloud to ensure secure gathering, storing and sharing of information in real-time because viruses and malware corrupt files on servers, computing equipment, information

systems and operating systems denying access and use of cloud-based applications. Cost influences cloud implementation especially on service cost support cost and compliance cost, the challenge is the move from a fixed-cost operating model to a variable-cost model that is based on a pay-as-you-use model that makes it difficult to predict and estimate variable costs in a long-term pricing strategy. Poor management leads projects to fail; therefore, the management should be prepared to oversee cloud projects, budget and prepare for potential risks. Poor SLA creates unrealistic expectations that lead to inefficient production, delays, termination of services or project failure. For efficiency in service delivery, cloud service contracts should ensure both parties sign an SLA that provides a description of the service, where it is provided, by whom and when is due. For security purposes, SLAs should capture privacy and confidentiality. Organizational issues like processing management, human capital, unpredictable network failures, organizational culture and resistance to change influence cloud implementation. Therefore, management should create an enabling environment that fosters a positive culture of innovation, teamwork, experimentation and learning. (Chen & Lin, 2005) Companies should invest in human capital to promote skills, agility in technology and nature talents for competitive advantage. Regulatory frameworks impact the implementation of cloud technologies in many ways, e.g. on taxes, licenses, permits, patents and trademarks. Failure to comply with the set regulations imposes penalties, compromises business operations or can cause license revocation. Network connectivity is crucial in a cloud environment; institutions should invest in networking in order to have a reliable and stable connection. Network successfully connects cloud-based services and provides on-demand services that provision computing capabilities such as servers, operating systems and storage. Network connections support resource pooling, remote support, virtualization and application mobility. In that regard, poor network connectivity will lead the cloud implementation process to fail. Portability is an issue in the cloud environment especially when transferring data or services between cloud providers on either a public cloud or a private cloud. The concern is that it may take time to transform applications or data on a source application to the form required by the target system. The main challenge is that there are no standards for interfaces and APIs for the cloud, while different cloud service providers use different APIs.

1.3 Research Objectives

a) Identify challenges encountered when implementing cloud technologies in Kenyan universities.
b) Develop a recommendation outlining actions and guidance.

1.4 Research Questions

The questions captures cloud technologies implementation challenges;

a) What are the key issues affecting the implementation of cloud technologies in Kenyan universities?

b) Find how technology, institutional factors, regulatory frameworks and ICT strategies impact the implementation of cloud technologies in Kenyan universities?

c) Does competitive pressure and social pressure influence the implementation of cloud technologies?

1.5 Significance

The generalization of the study would be of great contribution in addressing cloud implementation challenges. The results of the investigation will be of great significance in;

a) Helping institutions to consider investing in ICT and cloud-based applications.

b) Choosing the right cloud-based technologies and deployment models that are secure, cost effective and beneficial to the institution.

c) Setting standards that promote the development of efficient, reliable and secure platforms.

d) Enhancing authentication and role-based access control of resources on the cloud.

1.6 Research Scope

The study was to identify cloud technologies implementation challenges in Kenyan universities; the study was narrowed to universities that are within the Nairobi metropolitan site where several universities are intense. The magnitude of the survey was selected in universities based on status (private or public). The model for identifying key respondents was based on the purpose. The sample was selected from the management, ICT Directors, ICT personnel and users (lectures) who were concerned in the implementation process.

2.0 CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

Assessing literature ascertains what other researchers have undertaken in the area under study and also provides an overview of theoretical explanations used. The literature assessment presents a theoretical structure that forms a basis of the research (Oates, 2006). The rationale for the review discovers potential study area and assesses material for feasible research subject that proves there is a new insight. Evaluating literature consists of reading existing articles in the area of the study to compare and draw conclusions.

2.2 Cloud Service Models

Cloud computing comprises various service models (Sriram & Khajeh-Hosseini, 2011) that captures service layers (S. Yang & Hsu, 2011; Zhang et al, 2010) Cloud business models and (Stanoevska-Slabeva & Wozniak, 2010) Architectural layers. The service models are concerned with data transmission, delivery and security.

a) SaaS models develop and maintain cloud application software's and offers best security on the network. Users exploit launched application on the cloud infrastructure. (Winkler, 2011) SaaS model is known for having extreme degree of incorporated functionality with the least control and extensibility.

a) PaaS models allow team to develop, test and deploy applications. PaaS shares the responsibility with the vendor and cloud users and offers better extensibility and control with fewer higher-level features. In this model, cloud service consumers are responsible for securing their applications like data and user access while SaaS provide secure operating system and physical infrastructures.

b) IaaS models provide virtualized computing resources where cloud service users have access to servers, networking, storage and other applications (khan et al., 2012). As a result of low degree of abstraction it is easy to control clients and cyber threats in IaaS compared to PaaS and SaaS, In IaaS consumers secure their applications, data, user access, operating systems and network traffic. Security issues in IaaS are addressed on the deployment model e.g. public cloud have a greater risk while private cloud has a slighter impact.

2.3 Security Models

CSA analyzed and suggested the following cloud security models like CSA cloud controls matrix ,CSA enterprise architecture and NIST cloud computing security reference architecture which consists of the conceptual models, reference architectures and control frameworks. (CSA, 2010) The importance of security standards is to provide guidance on how to approach challenges. (Bernd et al, 2010) explored intrusions that threaten cloud-based applications. (Dubey, A, 2016) addressed challenges like security, data placement, storage, integrity, confidentiality and availability. (Kresimir et al., 2010) Explored top notch security issues like trust, payment, privacy and confidentiality of information. Security and privacy concerns should be considered when designing and implementing cloud architecture so as to capture requirements and avoid underlying issues that might occur when implementing cloud technologies. Open virtualization is the most promising security standard for the future as it addresses secure, portable, efficient and flexible format for packaging and implementing software's virtually using various technologies such as VMware. Controlling access between virtual guests and host hardware is determined by the hypervisor e.g. many virtualizations exploit the target hypervisor because it controls computing resources between host and guests or guest and guest.

2.4 Access Control Methods

In cloud computing access controls state contextual permissions or prohibitions that limit access to the resources (GAO, 2011). Access control protects resources from security threats both internal and external intrusions. The controls are guided by organizational principles and rules that protect particular types of information e.g. personal and other types. To properly manage access control, implement multi-factor authentication (MFA) in order to guarantee maximum security in the cloud environment such as preventive controls, detective controls and corrective controls.

2.5 Scalability

Scalability promotes flexibility in cloud environment that enables institutions to scale up and down processing power based on their needs. (Grossman, 2009) Scalability allows the expansion of computing power to accommodate future developments and arising business needs. (Marston et al., 2011) Scalable environment promotes a chance for growth and development and also advances institution computing power. In cloud computing e-infrastructures are extended to improve

processing, capture more activities/services and accommodate future developments (Benlian and Hess, 2011). It is possible to maintain the scale-up and scale-down of computing power in the cloud models, e.g. private, public and hybrid cloud. (Blaisdell, 2012) Scalability enables institution to incorporate resourceful modules and solutions that improve processing and meet future computing demands.

2.6 Vendor Lock-In

Lock-in is a major barrier in cloud environment since cloud service users are dependent on a certain provider and it is not easy to switch to another provider or integrate with other applications due to standardization issues (Buyya R et al, 2009). Vendor lock-in strategies should be implemented to mitigate a lock-in risk that occurs when implementing cloud-based technologies. (Silva et al, 2013) explored interoperability issues in cloud computing and discussed portability issues like standard interfaces, open APIs, open standards for VM formats and formats for data interchange. (Ferry et al., 2014) discussed critical issues such as the lack of global standards for leveraging the dynamics of cloud technologies and poor management criteria. It is a challenge when there are no defined appropriate standards and formats that support portability or do not comply with the set regulations. (Odero-Merino et al, 2010) Heterogeneity, cloud semantics and application program interfaces form technical inconsistency that causes interoperability, deadlock or malfunction.

2.7 Management

Management plays an important role in mobilizing funds, policy and strategy formulation, planning, organizing and coordinating activities to achieve predetermined goals and objectives (Li-Hsieh, 2014). (Rimal et al., 2009) describe management as a critical concern. Management should be prepared to address security issues, maintain the availability of cloud resources and manage change. To achieve cloud implementation success, fundamental policy issues and critical challenges must be addressed. Therefore, management should assess the situation by asking the following questions: what type of deployment model or service model suits the institution, cost, risk involved, how to address change, technical capability, competence level and how to prevent resistance. Management should also understand employee needs and motivation because there is a close relationship between motivation and needs since a person's requirements for satisfaction constitute an internal motive. For that reason, human capital must be addressed in order to have experienced personnel who can support and manage cloud applications (A. Lin and N.C, Chen,

2012). Risks must be addressed appropriately for success. (P. G. Dorey and A. Leite, 2011) A risk mitigation plan should be adopted and implemented to avoid any risk occurrences that might hinder the implementation process. A cloud strategy is critical in setting the guidelines and steps to be followed, determining how to source the best cloud technologies and how learning will impact business goals.

2.8 TOE Theoretical Framework

The study will use the TOE theoretical framework to identify aspects that influence the implementation of cloud technologies. (Tornatzky et al, 1990) The framework is used in the study because it forms the foundation and describes key aspects such as technological, organizational and environmental. Technological factors consist of the characters like innovation, availability, complexity and compatibility (Low et al, 2011). Environmental factors consist of internal and external aspects that are critical to the organization (Doolin et al, 2007). Organizational aspect describe characters that are essential in an institution like size, operational structure, management hierarchy, resources, human capital, policies and strategies. Implementation of cloud computing is influenced by technological context that describes aspects of technology, organizational context that describes aspects of enterprises, and environmental context that represents third party entities (Low et al, 2011).

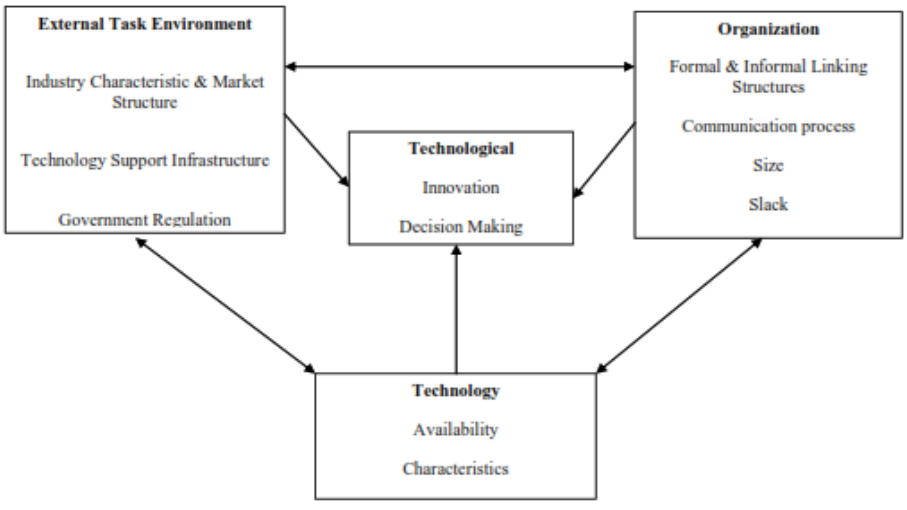


Figure 1: TOE Frameworks (Tornatzky & Fleischer, 1990)

2.8.1 Technology Context

Describe factors related to the invention and innovation, technical agility, scalability, availability, compatibility, complexity, network connectivity, security issues and training.

a) **Security**

Cloud resources are vulnerable because they are hosted centrally and managed by external vendors. The large-scale nature of the cloud system makes it impossible to identify and distinguish different types of information, which makes it susceptible to an attack, while the high interactions on the cloud e-infrastructure slow performance, corrupt systems or create a deadlock. Attacks such as cyber threats, denial of services and vulnerabilities compromises cloud applications. (CAS's, 2010) The report identifies the following cloud risks like insecure interfaces and API, technology issues, account hijacking, abuse of cloud computing, malicious insiders, data loss and unfamiliar risk profile. (OWASP's, 2011) The report identifies top cloud security risks like accountability and data privacy, identity, regulatory concerns, business continuity, compatibility, multi-tenancy and security. Cloud service managers and cloud service administrators must address security issues by deploying secure security mechanisms that authenticate access; maintain accountability and business continuity (katzan, 2010).

b) **Invention and innovation**

Institutions that are innovative develop solutions that address a niche and maintain competitiveness in the market. The use of cloud-based applications has led to the diversification of numerous cloud technologies that handle multi-cloud or on-premise clouds. Research on IS innovation enables institutions to identify the gap and develop solutions that satisfy it (Fichman, 2004). The only possible way of bridging the gap is by innovating (Weick& Sutcliffe, 2001). Management should encourage and support a culture of innovation by empowering employees, creating conducive environment, embracing diversity, introducing modern tools and collaborations. (Swanson & Ramiller, 2004) Proper management and decision-making determine the quality of the product or solutions to be developed.

c) **Technological capability**

In an institution technical capability defines the rate at which an institution is adopting or implementing technologies, it also comprehends the capacity to acquire long-term systems, e-infrastructure, human capital and ICT strategy. (S. Chuang, 2004 and H. Sun et al., 2015) Technology resources include hardware, software, communication channels, IT applications and personnel.

2.8.2 Organizational Context

Organizational context consist of variables like scope, size and resources that influence cloud implementation. (Eze et al., 2013; Pang & Jang, 2008) concentrated on social influences in an organization like individual's attitudes, beliefs or behavior that influence business performance. (Rogers, 2003; Venkatesh & Davis, 2000) addressed personal differences like learning style, aptitude and personality that enables management to understand employees better. (Awa et al., 2010) concentrated on top management, expertise, products, organizational culture, structure, information sources and communication channels.

a) Recovery Planning and Business Continuity

To maintain cloud security, recovery strategies are developed and implemented in data centers to restore operations to a minimally acceptable level in the event of a distressful event. (KPMG, 2011) In cloud computing, disaster management processes should be in tandem with technology trends. (Buyya et al., 2011) In service level agreements, establishing QoS requirements among customers and the cloud service manager's acts as a warranty that guarantees the safety of cloud resources and services from defects. The details of the service provided by SLA should be specified, as well as the availability and performance guarantees. A recovery planning strategy should comprehend analysis of the cloud computing value proposition versus cloud computing strategy planning.

b) Governance and Policy

Policies and procedures are necessary for decision-making as they show the direction and ensure institutions maintain and comply with the set regulations and streamline cloud processes to maintain integrity, transparency and accountability. (IDC, 2015) Regulatory frameworks oversee organizational performance by imposing professionalism,

transparency, openness, setting ethical standards and creating a level playing field for all institutions. Failure to comply with the set regulations impacts business by imposing penalties; conformance issues like permits, licenses, and taxes influence business performance. (K'obonyo. P. et al, 1999). Regulatory frameworks challenge business operations because there are licenses and permits that are mandatory (Mullei et al., 1999). Policies address relevant issues that constitute acceptable behavior and requirements that affect business performance such as organizational rules and regulations, standing orders, accountability, cyber law, IT strategies, patents and privacy. (ERNST & YOUNG, 2011; Kim, 2009) To maintain the integrity of services, cloud service users and cloud vendors must comply with cyber laws and established standards. Due to globalization, the issue of cross-jurisdictional is a challenge that derails the cloud implementation process, especially when contending with different jurisprudence.

c) Knowledge Awareness.

In cloud computing, ICT skills enhance efficiency and effectiveness in day-to-day operations. Therefore, it is necessary to plan ways of acquiring and retaining knowledge in an organization through frequent training, seminars, workshops and other capacity-building initiatives. (Ans De Vos et al., 2011) Managing developments, functionality, learning and career competencies enhances creativity, innovation and maintains competitiveness in the cloud market. In that regard, change management is critical in the cloud environment to align resources with organizational needs and ignite organizational transformation. To assess the knowledge level in an organization, first identify the competency level, then understand the current knowledge and compare it to the changing needs and trends in order to capture the required skills. It is important to determine how learning will influence the achievement of business goals by creating awareness, increasing enthusiasm and stimulating self-mobilization and action that marshals local knowledge by linking know-how and positioning stakeholders for the future. The following are ways of managing knowledge:

a) Acquiring knowledge and competence goals, e.g., determining cloud service customer and cloud service contract expectations and requirements for particular products and services.

b) Map how cloud service customers and cloud service contracts will achieve goals and objectives, e.g., through SLAs, training, learning on the job, and conferences or seminars.

d) Change Management

Cloud-based applications and services should be upgraded to match with the current technology in order to satisfy cloud service users' demands, meet institutional requirements and set standards (C. Fershtman and N. Gandal, 2012 & Marston et al., 2012). Innovation enables institutions to achieve transformational change. (Razda & Murad, 2014) Innovations are the only critical developments that enable institutions to maintain competitiveness in the market and promote future developments. Technical agility is an important aspect for change in an organization that determine the status and capability for change. Change management can be achieved by defining change and aligning change to the business goal, implementing strategies, deploying competent and experienced personnel, supporting structures, evaluating and monitoring change. Proper project management and human capital achieves cloud implementation success. (O. Kerimoglu et al, 2008). Institutions should have the capability to understand and match their core business processes with the current environment, products, services, customer demands and stakeholders.

e) Service Level Agreement (SLA)

Cloud-based applications are hosted centrally on remote servers administered by cloud service managers; therefore it is necessary to enforce service level agreements (SLA) to define the expected deliverables and timeline. Poor SLAs impact cloud implementation process by delaying or terminating services. In SLAs it is necessary to capture security, privacy and confidentiality of information and set out the legal basis of an agreement. The SLAs should include other matters such as:

a) *Contract Management:* concerned parties require a review of their services and information on reporting, meetings and escalation procedures.

b) *Change Control:* SLAs contain a change control procedure that set out a mechanism for agreeing and maintaining changes. In any agreement, it is usual for changes to be made to the services agreed and properly implemented.

c) *Pricing:* varies depending on the weight of the service on hand, SLAs therefore ought to include a pricing review mechanism.

2.8.3 Environmental Context

Describe macro and micro environmental aspects that are directly related to the infrastructures, tangible properties and limitations regarding the environment and contribute to innovation and strategic decision. (Awa et al., 2010) environmental factors include operational effectiveness, strategic alignment, market forces, competitive advantage, government policies, suppliers, vendors, trading partners and customers, etc. Environmental factors are addressed in decision making to explore external and internal environmental aspects that are applied within an organization to capture underlying issues challenging cloud technologies implementation like management, polices, resources, corporate image and brand equity, employee's satisfaction, team work, organizational culture, decisions, human capital and value proposition. External environment elements are critical in decision-making like market forces, customers, suppliers, trading partners, competitors, technology, regulatory frameworks and social conditions.

a) Trading Partner Pressure

Trading pressure between cloud service contracts and cloud service customers occurs when there is no viable service level agreement (SLA). A cooperative relationship with CSP must be maintained to streamline smooth operations and prompt support when required. An agreement with cloud vendors and cloud service users minimizes pressures and other issues that might compromise or delay the work. Dan (2004), Paschke (2006), Trzec (2003), and Yuanming (2008) Document and automate SLA in the workplace to enable dynamic provision of services between entities.

b) Government Pressure and Support

The government regulates cloud computing by enforcing compliance requirements like licenses, permits, taxes and penalties. The government also supports cloud implementation

by regulating bandwidth costs, lowering the cost of computing equipment, funding cloud projects, monitoring and evaluating cloud activities. The government fosters an enabling environment that encourages all industry participants to embrace cloud applications and innovations in order to maintain standards and keep up with new technologies (H. T. Tsou and S. H. Y. Hsu, 2015) Compliance with the established laws promotes cloud technology development and implementation.

c) Vendor Support

In cloud computing, vendor support provides various services such as maintenance, training, management of the information systems and e-infrastructures. (Kim, 2009; Mather, Kumaraswamy, & Latif, 2009, p. 228) Data lock-in is among the major concerns that make customers more dependent on certain providers for support or solutions. To achieve success, cloud vendors define the ways of supporting cloud service users; the best fit is dependent on the profile of each organization based on its processes and needs. The vendor support performs the following tasks on the cloud:

a) *Technical agility:* Improves the rate at which institutions are deploying new technologies and creates an enabling environment where improvements and enhancements are made independently depending on the functionality of the applications and business needs.

b) *Enhance scalability:* Capability to scale up and down computing power depending on the organizational capacity and needs.

c) *High availability:* Ensures all services and applications are available and accessible in real time without interruptions, and a recovery and continuity plan is in place in case of any disaster.

d) *Continuous improvements:* The ability to upgrade modules and provide regular support for a specific module without having to update the entire system.

Table 1: Theory Constructs

Framework Construct	Construct Categories	Explanation	Cloud Operational Definitions
Implementation Context	Management Intervention	Managerial measures that create enabling environment.	-Resolve issues that can hinder cloud implementation. -Human capital (*deploy competent & experienced personnel*). -Predict actions that can promote cloud implementation. -Monitor and evaluate process.
		Adopt strategies and change management actions to counter resistance.	-Formulate strategies that promote cloud usage. -Enhance technical agility. -Enhance organizational devolvement and capacity building initiatives. -Embrace new technologies and opportunities. -Motivation and incentives.
Implementation Process. ***Technological***	Compatibility	Portability and interoperable platforms.	-Deploy systems that can integrate with other systems. -Enhance sharing of data, formats & applications. -Maintain standards.
	Scalability	Capability to extend computing power.	-Deploy scalable cloud-based applications with capability to expand computing power. -Improve processing and data center.
	Complexity	Ease of use applications.	-Develop and deploy cloud applications with user graphical user interfaces. -Continuous capacity building initiatives. -Invest in skilled & experienced personnel. -Provide documentation & tutorials for guidance.

	Availability & Accessibility	Efficient and effective cloud applications accessible 24/7.	- Continuous monitoring & evaluation. -Steady network connection. -Strong bandwidth. -Vendor support. -Buck-up & continuity plan.
	Security	Secure information and Guarantee trust, privacy, integrity and confidentiality	-Implement secure security mechanisms -Train & create awareness on security issues. -Monitor attacks and vulnerabilities. -Develop risk mitigation strategy. - Implement elaborate risk assessment practices. - Use prioritization security model to eradicate risk
Implementation Process. ***Organizational***	Size	Support different services & deployment models.	-Deploy systems that can accommodate several service models & deployment models. -Scalable e-infrastructure.
	Top Management Support	Managerial actions that promote enabling environment. Formulation of policies, guidelines and strategic objectives.	-Proper management of resources. -Deploy skilled and experienced human capital. -Use motives and incentives. -Implement set strategies. -Observe policies, regulatory frameworks and guiding principles.
	Human Capital / ICT Skills	Match skills and competencies. Capacity building initiatives like; (*training, seminars etc*)	-Adopt methodologies for training staff. -Stick to policies and guidelines when sub-contracting work to external bidders. -define how training and learning will impact cloud implementation process. -Document learning and development plan.
	Employee	Embrace lock in strategies.	-Define working terms (*casual, contact or permanent basis*).

	Buy-In	Communicate changes, decisions & Promote work engagement.	-Define the working modalities for employees. -Define the reporting structure. -Clear job description and agreement. -Clear policy and service level agreement (SLA). -Motivation and incentives
	Organizational Culture	Observe culture and resistance.	-Recognize desired values and behaviors. -Align culture with processes, strategy and objective. -Align culture with institution brand. - Link culture with accountability. -Ensure there are visible proponents. -Define non-negotiable.
Implementation Process. **(*Environmental)***	Implementation	Formulate strategies; develop frameworks, policies and guiding principles.	-Project the rate of cloud usage in Kenyan universities. -Implement laid down strategies. -Monitor and evaluate activities.
	Competitor	Maintain competitiveness globally.	-Device and Implement new strategies -Invention and innovation. -Identify niche & satisfy it. -Identify key performance indicators on numerous parameters (*World University Ranking)* -Implement virtual platforms
	Regulatory concerns	Conformance issues (*licenses & permit*)	-Ensure cloud applications conform to the regulatory requirements. -Observe laws, policies & guiding principles.
	Vendor Support	Enforce contractual rights and service level agreements (SLA).	-Choose a vendor with the references of accomplishment for security and business continuity. -Observe service level agreement (SLA) for smooth operation.

			-Contract a vendor with terms of service applicable to your University.
Outcome	Impacts	Overcoming Cloud implementation challenges.	-Implementation success at the institutional level, which is planned.

2.9 Empirical Evidence

Table 2: Existing Reviewed Evidence on TOE Theoretical Framework Success

Researcher	Method	Results	Conclusion
(Eze et al, 2013 and Chau and Tam 1997)	Implemented TOE theoretical model to study innovation attributes.	Study was useful in understanding how technology, organization & environmental factors influence innovation.	Explained and predicted how innovation influences adoption in an organization.
(Zhu and Kraemer, 2005)	Studied how the TOE framework influences adoption.	Used TOE to discover critical elements in adoption such as firm size, finance, competence, technology, finance, commitment, regulatory frameworks and competitive pressure. The study identifies how the TOE framework influences adoption.	Study was useful in understanding how technology, organization & environmental elements influence adoption in divergent perspective.
(Kuan and Chau, 2001)	Studied the usefulness of TOE theoretical model in small enterprises.	Identified six factors such as technical competence, cost, industry pressure, government pressure. The study found that the TOE frameworks suit large organizations.	The study discovered that the TOE framework constructs suit large organization.

(Gangwar et al., 2015)	Used TOE framework to study IT innovations.	The research integrated TAM framework with TOE model to utilize IT innovations in the organizational context. Perceived ease of use and perceived usefulness was used as the moderating variables.	The result found that organizational readiness, complexity, relative compatibility and top management commitment as the important aspects that influence IT innovations. Training and the level of education were identified as significant and influence IT Innovations.
(Borgman et al., 2013)	Used the TOE model to indentify factors impacting cloud computing adoption.	The study exposed factors that influence cloud adoption like competitiveness, networks coverage, technical agility and enhanced decision-making.	Organization and technology context were found as significant and influences cloud implementation decisions.

2.10 Critical Success Factors (CFSs)

Critical success factors (CSFs) impact performance and success of an organization. CSFs enable institutions to keep the project on track in line with the goals and objectives and lay down the key fundamentals that promote competitiveness (Raravi et al., 2013; Freund, 1988). The TOE framework was used in the study to model CSFs that are important for institutional success. CSF enhances an institution's development by pulling the work together to achieve the objective, mission and vision.

Table 3: Critical Success Factors

Aspects	***Critical Success Factors (CSFs)***	***Description***
	Reliability/ Availability	Deploy cloud technologies that are consistent and available 24/7 to guarantee customer confidence and

Technology		satisfaction. Adopt a recovery and business continuity plan (Raut et al., 2017).
	Security	Implement secure security mechanisms that protect information from any possible attack. Monitor and evaluate activities.
	Knowledge & Experience	Ability to invent and innovate. Upgrade features and functionalities to accommodate new developments (Ahorlu, 2014).
	Privacy	The degree to which a vendor addresses data privacy, confidentiality and integrity issues
	Standardization	Deploy interoperable cloud systems that integrate and support other features.
	Complexity and Compatibility	Ease of use applications with graphical user interfaces and capability to integrate with other systems to improve functionality (Gupta et al., 2013)
	Scalability	Implement cloud-based applications that can scale up computing power to accommodate institutional needs and innovations (Oliveira et al., 2011).
Organization	Cost Effective	Focus on economical deployment models, low-cost solutions, scalable and comprehensive applications, maintaining existing e-infrastructure. (Gottschalk et al, 2005).
	Organizational readiness	The rate of preparedness, awareness, availability of resources, commitment, governance and innovation. It encompasses both financial and technological readiness as well as human capital (Oliveira et al., 2014).
	Management Support	Formulate strategies and policies; oversee cloud project and activities, manage resources such as human capital, financial, technical aspects and establish contractual rights with the vendors.
Environment	Customer Satisfaction	Enhance consistency in service delivery, low cost offers and implement customer-centric applications.
	Government Policy /	Formulate & enforce laws, fund cloud initiatives,

	Regulatory Frameworks	subsidize ICT products and bandwidth and create awareness.
	Trading Partner / Supplier	Establish cooperative relationships through a service level agreement (SLA) that defines deliverables, expected obligations, time and requirements (Gamage, 2019).
	Competitive Pressure	Embrace invention & innovation culture, identify niche and satisfy it, differentiate cloud products and reduce cost, conduct business virtually and adopt robust marketing strategies, e.g. influencer marketing, use of social media platforms etc. (Kumar et al., 2017)
	Vendor Support	Maintain a positive relationship with the multiple vendors, enforce contractual rights and service level agreements (Sen, 2013).

2.11 Conceptual Frameworks

The conceptual framework is founded on the TOE theoretical framework. Technological factors and institutional factors are the independent variables. Moderating variables include ICT strategies and regulatory frameworks while dependent variables are significant cloud implementation challenges. Moderating variables denote the relationship between independent variable and cloud technologies implementation as denoted by X = independent variable (technological & institutional factors) and Y=dependent Variable (cloud implementation challenges).

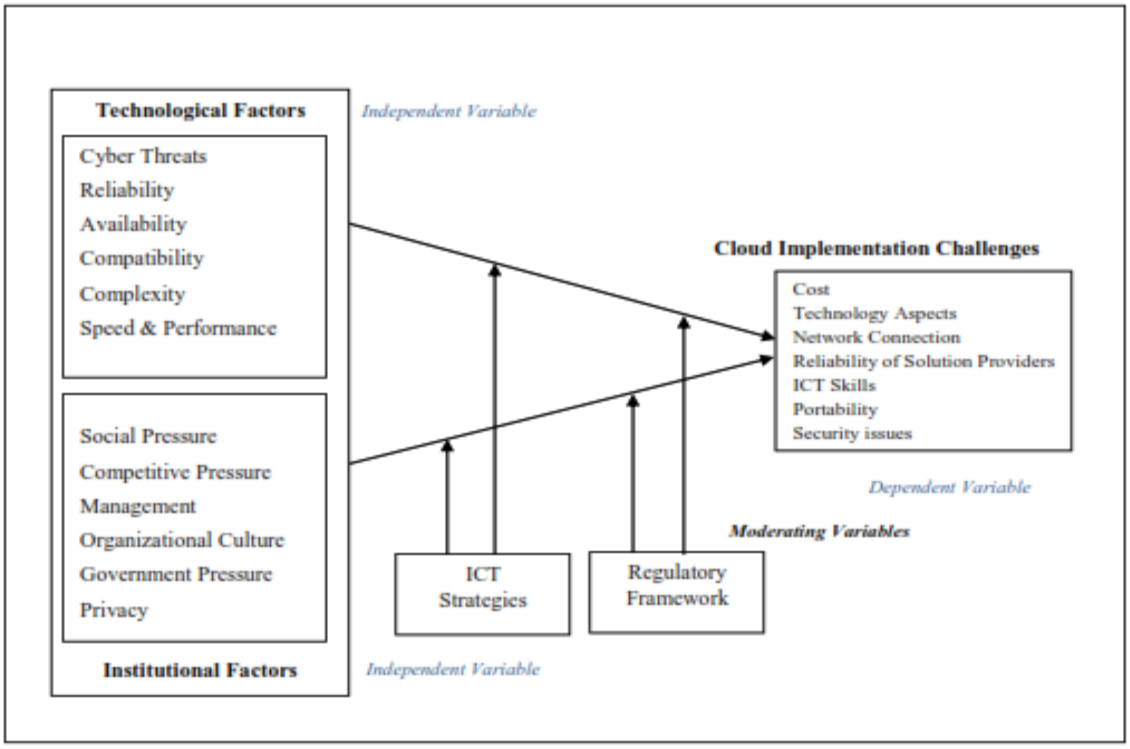


Figure 2: A conceptual Framework

2.11.1 Key Constructs

a) Cyber Security Threats

Cyber threats compromise cloud resources because cloud resources are managed centrally and accessed via the internet. Threats like security, privacy and portability challenge the implementation of cloud technologies. For that reason, cloud application developers should implement secure security mechanisms that decrypt and encrypt information to promote secure transmission of data on the cloud. (Younis and Kifayat, 2013; Vining & Di Maio, 2009). Implementing secure access control and multi-factor authentication guarantee security of resources in the cloud (Mishra et al., 2013).

b) Reliability & Availability

Reliability & availability is the quality of being dependable and accessible in real-time, reliability is a major concern in distributed systems. (Shooman ML, 2002) Reliability impacts cloud usage in an instance when a system or servers fail over time as a result of hardware failures, natural disasters, human errors, unexpected software failures and cyber attacks. (Buyya et al, 2011) Reliability depends on the consistency of resources that

demonstrate the quality of the system as envisaged with the capability and minimum downtime that guarantee constant execution without any failure. (ERNST & YOUNG, 2011) What is expected from the system is the availability of the services, its overall performance and the recovery plan. Thus a recovery plan should be adopted to restore data in case of any distressful occasion. (Dubrova E., 2013) Reliability ensures that a system operates in a time interval as required, while system accessibility on time 't' is the likelihood that the system is functioning promptly at all the points in time. (Snyder et al, 2015) Used Monte Carlo simulation to explore system reliability in dedicated data centers; the outcome demonstrated that the approach is practical and flexible for evaluation in the cloud when resources are discrete.

c) **Speed and Performance**

Speed and performance is determined by response time, elapsed time and throughput (Ioannis A., 2011). Factors that determine speed and performance in the cloud are bandwidth, processing power, redundancy, latency, scalability and storage capacity. (Miguel G., et al, 2012) Improved performance promotes business continuity and enhances accessibility. It is essential for cloud service users and providers to use cloud performance metrics in order to effectively monitor resources and maintain functionality as required. Cloud performance metrics measure input/output operations, file system performance and caching. Other factors that impact performance in cloud computing are the denial of services, server failure, cyber attacks and vulnerabilities such as viruses, malware and bots etc.

d) **Complexity and Compatibility**

A complex system has many dependencies and divergent properties that crop up with many relationships and spontaneous orders that discourage cloud usage. (Rogers, 2003) described complexity as a measure where by an innovation is perceived as intricate and not easy to understand and exploit. Extreme complexity is an obstacle. Therefore, a resourceful cloud-based system should be implemented with graphical interfaces features, easy to navigate and compatible with existing systems; cloud applications that are compatible import and export modules from other systems to extend computing capabilities and improve

performance. Interoperability and portability with other applications / systems is perceived as a major cloud computing implementation challenges (Oliveria and Steininger, 2014).

e) Social Pressure

Social pressure influences processes, decisions and perceptions that determine cloud technologies implementation. Describing three social influences such as compliance, identification and internalization; social influence changes depending on environmental conditions and trends (Kelman, H.C, 1958). Therefore, management decision-making to implement cloud-based applications is based on current technology trends and social conditions. Technology advancement and social economy contributes towards the development and deployment of diversified cloud technologies, business models and cloud payment models that support interoperable currencies executed via the internet to transform the ways of doing business and banking, e.g. online banking, mobile banking and cryptocurrency. Nowadays social media contribute immensely by offering scalable applications that provide a platform for marketing, broadcasting, sharing information and storing heavy multimedia content as well as providing a platform where people connect and share information globally. Technological revolution gradually increases prevalence of cyber bullying (Smith, Mahdavi, Carvalho, & Tippett, 2006). The misuse of social media can lead to the dissemination of false information, encourage masquerading and social engineering practices that establish flaw and render attacks that challenges the implementation of cloud technologies. Social innovation has revolutionized the media industry with developments that have improved the ways of gathering information, sharing and delivering content virtually. It also deploys effective solutions that address emerging issues. For example, social media bridges the gap and connects businesses with customers, markets the brand, and boosts leads and sales.

f) Competitive Pressure

The use of online business models and virtual platforms has forced companies, organizations and institutions to migrate services to the cloud environment for competitive advantage, accessibility, global reach, reduce costs and maximize profit. Institutions are

competing globally and are focusing on how to remain competitive in the market by implementing robust marketing strategies. (Adner and Zemsky, 2006) and Grahovac and Miller, 2009) A company with products that are competitive in the market captures consumers' minds first; customers lock in and dominate the market. An institution using cloud applications satisfies customer requirements, improves processing, accessibility and reduces cost which helps in maintaining competitiveness. A poor response to competition will lead to failure. Therefore, management should strategize on how to deal with the pressure triggered by competitors by focusing on customer-centric applications, differentiating products, branding and low-cost offers. Today, cloud technologies are on the edge to address the niche in the market by offering scalable computing services virtually; this is being driven by technological advancement, a steady economy, the availability of solution providers and global network connectivity. In this era, the emergence of freeware software and remote computing technologies is promoting perfect competition leading to the development and deployment of application platforms that are cost-effective and accessible.

g) Management

Poor governance leads to failure. Management should be prepared to address any technical, financial and managerial issues that can hinder achieving success. Resources in the cloud are financial, e-infrastructures, partnerships, processes, knowledge and techniques that are part of a company’s assets, either tangible or intangible. (Michie and West, 2004) Management oversees the project and formulates strategies that promote cloud implementation; best practice is produced by an organizational strategic plan that is designed to improve performance and promote better implementation decisions. It is enthusiasm for the management to understand business and the associated returns achieved by cloud computing and the ability to predict competition that leads to success.

h) Organizational Culture

Organizational culture comprises values and beliefs that dictate how people behave and work. Culture influences personnel to act and perceive a situation depending on certain conditions which is critical for success. (Z. Shao et al., 2012). Culture influences cloud implementation decisions either positively or negatively, for example; An organization that has a culture of invention and innovation develops new brands and solutions that enable it to maintain competitiveness in the market, this is encouraged by management support, training, enabling environment, openness, exploration and experimentation (W. Ke and K. Wei, 2005 & F. Damanpour and M. Schneider, 2009). Organizational culture is critical in determining organizational performance (Jaggi, 1985). Implementation of cloud technology is influenced by management support, training, business processes, perceptions and the fit between employees and the organization as a whole. The management should ensure that the cloud vision is realized by developing strategies, deploying competent and experienced personnel, training and sourcing the right cloud solutions. Corporate culture is perceived as a plan for management success that determines organizational success or failure (Values 1983). In an institution, culture dictates how people act, perceive and work things out or solve problems. (Brown and Leigh, 1996) it is true that motivation and organizational culture influence organizational performance. Culture resistance in an organization impacts the transition of services to the cloud environment.

i) Privacy

The concept of privacy varies widely depending on states, cultures and jurisdictions. Data privacy is determined by the accountability of an institution to data subjects as well as the transparency of practice on personal information. In a cloud environment, privacy rights are allied to data capturing, use, disclosure and storage. Privacy issues compromise cloud computing because operations are performed centrally and there are huge data sets. A system flaw unveils weaknesses that encourage attack. Therefore, management should implement secure security mechanisms and establish guiding principles that dictate how information will be shared and accessed on the cloud.

2.11.1 Moderating Variables

Moderating variables affect the validity of the research by assessing the independent variables and unfolding the associations between the independent variables, and determining how technology and institutional factors change the strength and nature of the relationship to explain how or why a certain effect will hold on to determine the issues challenging cloud implementation.

a) ICT Strategies

ICT strategies create technology capability by defining how the implementation of various cloud technologies will enable institutions to attain their vision and mission by setting direction and documenting steps to be followed, deliverables and timelines. A cloud strategy enables project managers to achieve cloud implementation success. (Gartner, 2019) In order to achieve cloud implementation success, first formulate a cloud strategy framework and set priorities and guidelines by choosing and adopting the right cloud management techniques, creating a consistent cloud management strategy and defining a systematic approach that sets needs and matches tools to these needs.

b) Regulatory Framework

In cloud computing, regulatory frameworks depict laws, regulations and policies approved to govern cloud computing based on best international practices. (KPMG, 2014, Coles et al., 2015, Northbridge, 2014 and IDC, 2015). Regulation and compliance are the key inhibitors when migrating to the cloud environment. (KPMG, 2015) described numerous concerns that hinder cloud implementation such as cost, regulatory frameworks, interoperability and data loss. (Coles et al., 2015) Complying with the existing laws and regulations creates an enabling environment for businesses and their operations.

2.12 Kenyan Universities

The use of cloud-based technologies improves teaching, learning, research, accessibility, and global connections. In this era, universities are disseminating knowledge to impact society positively, boost socio-economic development and promote human capital. Kenyan universities are implementing synchronous and asynchronous learning virtually; all degree courses for undergrads and postgrads in various disciplines are offered virtually. The key courses offered are Agriculture and Veterinary Medicine, Biological and Physical Sciences, Engineering and Architectural Design,

Education, Health Science and Medicine, and Humanities and Social Sciences. The Kenyan Universities Act of 2012 presents ways of enhancing the growth of higher education, founding, certification and control. The 2004 report on higher education demonstrates that university education is growing as a result of increased demand for higher learning.

2.13 Cloud Information Governance

The quality, availability and integrity of an institution's data are enhanced by information governance that promotes cross-institutional cooperation and policy making. The quality of data is achieved by maintaining accuracy, consistency, completeness, uniqueness, conformance, timely and validity. (Gartner et al., 2010) described information control as the requirement for decisions, accountability and right structures that promote pleasing conduct in the assessment, formation, storage, use, archival, and deletion of information. Governance comprises procedures, roles, standards and metrics that guarantee efficient and effective utilization of information that helps an institution achieve its objectives.

3.0 CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

Research methods identify, select, process, and analyze information for the research. (Brown, 2006) A methodology forms the foundation on which the research is conducted. As a blueprint, a methodology highlights methods used in the design, data collection, analysis, reporting and evaluates the overall validity and reliability of the research.

3.2 Research Design

The study used a quantitative research approach to gather and analyze data. Research design specifies the techniques and steps used in capturing data, cleaning, coding and analyzing it (Kothari, 2004). The design models integrate key components that explore cloud implementation challenges; it also outlines what a researcher does from hypothesis to analysis. Research design expresses the structure of research problems, frameworks, organization, relationships between variables and plans how surveys will be used to obtain empirical evidence on those relationships. The sample was drawn at random from ICT departments at selected universities. The survey strategy was devised to answer who, what, where, how and why questions. The data was collected on broad, sizable demographics:

a) To allow data to be standardized for easy comparison.
b) To ensure the generated data is easily understood and interpreted.
c) To allow a researcher to establish reasons for relationships between variables and establish models for these relationships.
d) To enable a researcher to generate findings that are representative of the entire population, the research follows a descriptive-explanatory philosophy typically associated with quantitative research, in which data is synthesized, analyzed and conclusions drawn from descriptive data.

The design used a wide variety of quantitative methods to investigate one or more variables and descriptive statistics in analysis to measure variations and correlations. The research combines its attributes précis and correlation figures with its focus based on research questions, techniques and results.

3.3 Hypothesis Testing

Hypothesis testing tests an assumption regarding a population parameter to ascertain if specific treatment affects individuals in a population (Søren Johansen, 1991). Testing accepts or rejects statistical hypotheses; it is recommended to observe the whole population in order to establish if a statistical hypothesis has a significant effect. When researchers randomly select a sample from a population, if the sample does not support the statistical hypothesis, the hypothesis is rejected. A regression test establishes significant linear association among independent variable X and dependent variable Y.

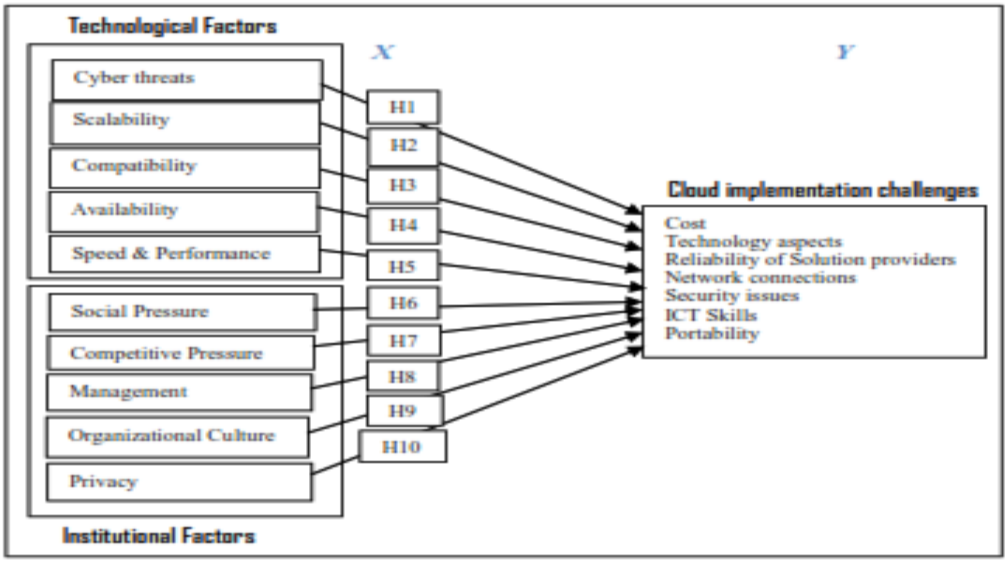


Figure 3: Hypothesis Testing

H1: There is a significant effect between cyber threats and network connection that influence cloud implementation.

H2: There is a significant effect between scalability and cost that influence cloud implementation.

H3: The relationship between compatibility and cloud technology aspects is significant and influence cloud implementation.

H4: There is a significant effect between availability and reliability of solution providers that influence cloud implementation.

H5: There relationship between speed and performance and technology aspects is significant and influence cloud implementation.

H6: There is a significant effect between social pressure and security issues that influence cloud implementation.

H7: There is a significant effect between competitive pressure and the reliability of solution providers that influence cloud implementation.

H8: There is a significant effect between management and ICT skills that influence cloud implementation.

H9: There association between organizational culture and ICT skills is significant and influence cloud implementation.

H10: There is a significant effect between privacy and security issues that influence cloud implementation.

3.4 Purposive Sampling

Purposive sampling methods (non-probability samples) were used in the survey. The elements were chosen from the population based on the purpose and research objective. In the study, the key and critical respondents were picked from the ICT Director, Head of ICT units, Chief Information Officers, Chief Information Security Officers, Network Managers, ICT Officers, Lecturers and Administrators.

3.5 Sampling Size

Sampling is done to ensure each constituent in a population being surveyed has an equal chance of being selected as a respondent in the study. The study sampled three public universities and three private universities in Nairobi Metropolitan; the target for the study was 150 respondents. The sampling frame for ICT in each university was 25 respondents. Purposive sampling is applied in research when sampling respondents with a particular level of experience or skills (Li et al. 2006, Prance 2004, Vargas & van Andel 2005) or when the population to study is not huge (Tran & Perry 2003). (Hair, et al, 2006) provided guidelines for estimating the size of the sample, one of the guidelines is that a sample size less than 500 and greater than 30 is considered appropriate for most researchers. In the study, a sample frame of 150 falls within the guidelines.

3.6 Data Collection

A quantitative technique with closed-ended questions was used in a survey to capture data because it’s simple to implement due to a high level of standardization that makes comparisons of findings easy. An online questionnaire was used to capture data from selected universities; the expected response rate was 98%.

3.7 Data Analysis

The analysis used quantitative data techniques to express data into numbers and graphs, to test or confirm theories and assumptions. Research establishes generalizable facts about a topic; it also expresses the distribution of data, detects outliers and typos and enables uncovering the connections among the variables. (Oates, 2006) the focus is on the research questions and data on the relevant headings and interconnections between the categories. The study used hypothesis testing to compare populations and assess relationships between variables. Inferential statistics were used in the analysis to make assumptions and forecasts about the population. The testing methods used are:

a) *T-Tests* - Contrasts the means of two grouping and assesses if they're statistically significantly different.
b) *Correlation analysis* - Assesses association among two variables and regression to identify the cause and effect among the variables.

3.8 Research Validity

The strength and reliability of the research is a significant concern (Silverman, 2011). Validity responds to the question of ascertaining whether the instrument measures what is required. (Thorndike, 2007) Measures are implemented to ascertain how valid the research is. (Downing, 2003) depicts validity as a unitary concept that contains structure, content, response-process, association among the variables and their consequences. Connecting theoretical and empirical data enables research to be informative and transparent. Connecting literature, interviewee's statements and research questions maintains the soundness of the research; always avoid personal views as they affect empirical materials. Research validity is enhanced by the use of theories, studies, scientific literature that have a strong connection to the problem area and respondent statement. Combining and comparing literature and empirical data will enhance the accuracy, comprehension and objectivity of the study.

4.0 CHAPTER FOUR: ANALYSIS OF RESULTS

4.1 Introduction

The results of the study are presented in this chapter; quantitative data was analyzed using descriptive statistics.

4.2 Data Response

The study used an online tool to capture data, 150 questionnaires were broadcasted to the selected respondents. The response rate was 82.7%. The turnout meets the research threshold and it is recommended for the study (Mugenda & Mugenda, 2003).

Table 5: Response rate

	Response	**Percentage**
Completed	124	82.7%
Not Completed	26	17.4%
Total	150	

4.3 General findings

The study was conducted in Kenyan universities where a total of six universities were sampled (three public and three private). When asked about the use of virtual platforms, 79.8% of all respondents agreed that using virtual platforms is a challenge to the university community, while 20.2% disagreed. When ranked according to university status, 54% of respondents from public universities acknowledged the use of virtual platforms is a challenge to the university community while private universities agreed with 46%, as shown below:

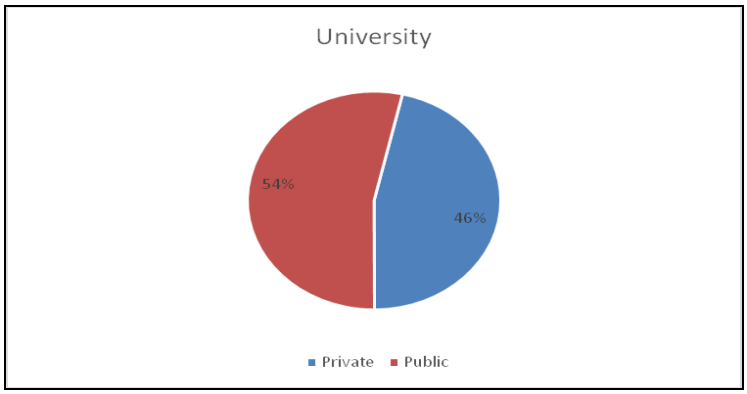


Figure 3: Using virtual platform is a challenge to the University community.

The research outcome identified technology aspects as the most significant barrier followed by network connections, reliability of solution providers, portability, security issues, ICT skills and lack of computers as shown below:

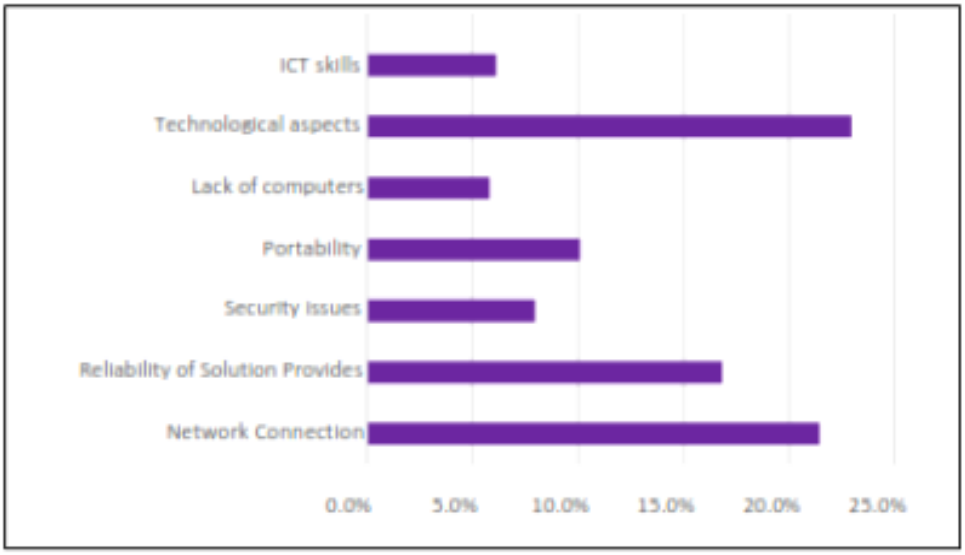


Figure 4: Key issues that challenge the implementation of CT in Kenyan universities.

4.4 Specific findings

The research question was structured guided by five-point Likert Scale as shown below:

Table 6: Response on Research Questions.

No	Research Questions	Strongly Agree	Somehow Agree	Not Sure	Somehow Disagree	Strongly Disagree
1.	Are cloud resources reliable and flexible, can students and staff access online services?	50.4%	39%	4.1%	5.7%	8%
2.	Using the pay-per-use model, will the universities have the potential to access the computing services they need?	21.1%	44.7%	28.5%	4.1%	1.6%
3.	Competitive pressure influence the implementation of cloud computing?	51.2%	33.3%	7.3%	7.3%	8%
4.	Social pressure influence the implementation of cloud computing?	42.7%	30.9%	8.9%	9.8%	3.3%
5.	The ICT strategies in my University challenge the implementation of cloud computing?	47.2%	29.3%	17.1%	4.1%	2.4%
6.	The regulatory frameworks in Kenya challenge the implementation of cloud	50%	20%	20%	2%	3%

	computing?					
7.	Should cloud computing in Universities be given a higher priority?	82.9%	12.2%	4.1%	8%	0

Table 7: Other Institutional Factors that Influence Cloud Implementation.

No	Factors challenging the implementation of CT	To a small extent	To some extent	Moderate	To a great extent	To a very great extent
1.	Privacy	34%	37%	20%	5%	2%
3.	SLA	13.8%	36.6%	36,6%	11.4%	1.6%
4.	Management	8%	9.8%	14.6%	25.2%	49.6%
5.	Organizational Culture	0	9.8%	12.2%	24.4	53.7%
6.	Cyber threats	7.4%	32.8%	36.9%	19.7%	3.3%
7.	Scalability	11.4%	19.5%	22.8%	13.8%	32.5%
8.	Information Assurance	6.6%	37.7%	36.1%	17.2%	2.5%
9.	Cost	4.1%	18.7%	35.0%	17.9%	24.4%

When asked about the cloud policy and regulatory framework awareness in Kenyan universities, 56.1% of all respondents indicated that they are aware of cloud policy, while 43.9% indicated they are not aware of any cloud policy and regulatory framework. 88% of all respondents would like cloud application services to be subjected to regulation for governance, while 12% indicated that they don't like it.

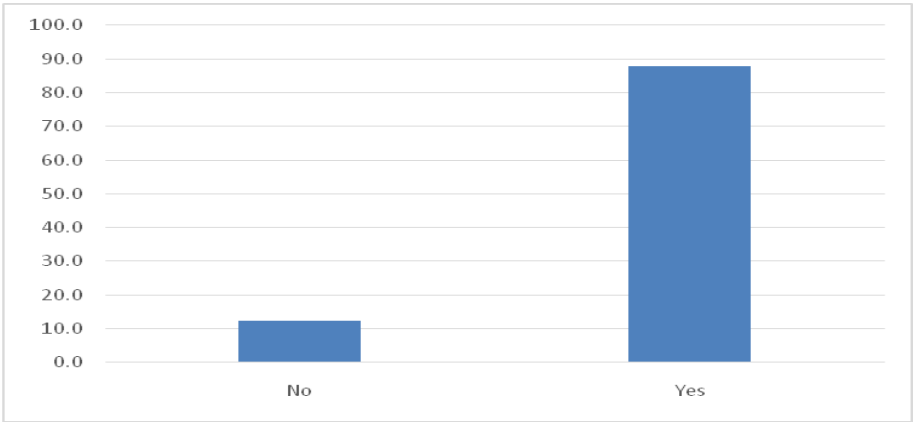


Figure 4: Cloud-based application services to be subjected to regulations

When asked about awareness of cloud computing standards 64.2% of all respondents indicated they are familiar with cloud computing standards, while 35.8% acknowledged they are not aware of cloud computing standards.

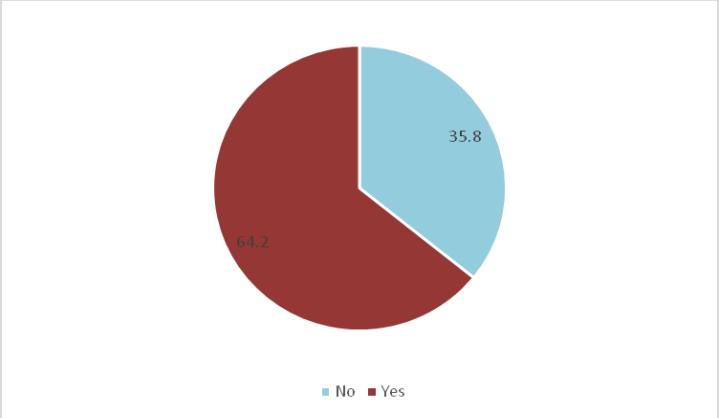


Figure 5: Cloud computing standards and service provision awareness.

Table 8: Recommendation from the Respondents.

Create Awareness
Reduce cost of computing equipment and improve ICT Infrastructures
Enabling environment
Encourage but not regulate
Enforce cyber law
Free internet
Frequent training
Policy framework
Funding
Increase bandwidth
Lower internet cost
Provide Incentives
Support implementation of cloud computing
Tax waiver on hardware and software

4.5: Cross Tabulation

Table 9: How Competitive Pressure Impacts Cloud Implementation Process.

Cross tabulation	**Type of the University**	
	Private	Public
Not sure	12	16
Somehow agree	15	14
Somehow disagree	0	1
Strongly agree	29	35
Strongly disagree	1	0
Total	***57***	***66***

- Competitive pressure is higher in public universities than in private universities.

Table 10: How Social Pressure Impacts Cloud Implementation Process.

Cross tabulation	**Type of the University**	
	Private	Public
Somehow Agree	19	19
Strongly Agree	29	29
Not Sure	3	8
Somehow Disagree	5	7
Strongly disagree	1	3
Total	***57***	***66***

- Social pressure has an equal impact on cloud implementation at both private and public universities.

4.6 Hypothesis Testing

Testing hypotheses from the targeted population makes a practical conclusion on the probability and distribution. The researcher can test assumptions of data using different types of hypothesis testing methodologies. The testing rejects or accepts the null hypothesis. T-test is denoted by t, as shown below:

$$t = (\bar{x}1 – \bar{x}2) / \sqrt{[(s21 / n\ 1) + (s22 / n\ 2)]}$$

Where,

$\bar{x}1$ = Observed Mean of 1st Sample

$\bar{x}2$ = Observed Mean of 2nd Sample

s1 = Standard Deviation of 1st Sample

s2= Standard Deviation of 2nd Sample

n1 = Size of 1st Sample

n2 = Size of 2nd Sample

Table 11: Hypothesis Testing.

	One-Sample Test						
		Test Value = 12					
		T	Df	Sig. (2-tailed)	Mean Difference	*95% Confidence Interval of the Difference*	
						Lower	Upper
H1	Cyber Threats	-87.218	122	.000	-8.138	-8.32	-7.95
H2	Scalability	-68.196	122	.000	-8.634	-8.88	-8.38
H3	Compatibility	-84.307	122	.000	-7.650	-8.03	-7.56
H4	Availability	-88.300	122	.000	-9.092	-9.29	-8.75
H5	Speed & Performance	-106.507	121	.000	-9.213	-9.38	-9.04
H6	Social pressure	-112.298	121	.000	-9.287	-9.45	-9.12
H7	Competitive pressure	-104.667	122	.000	-9.585	-9.77	-9.40
H 8	Management	-83.307	122	.000	-7.870	-8.06	-7.68
H 9	Organizational Culture	-85.913	122	.000	-7.780	-7.96	-7.60
H10	Privacy	-111.843	122	.000	-9.943	-10.12	-9.77

The above table is statistically significant since the p-value is < 0.05. There is strong evidence against the H_0. Therefore, we reject H_0 and accept H_1 because there is evidence in the sample in favor of H_1. The following institutional factors, such as privacy, competitive pressure, social pressure, speed and performance, availability, scalability and cyber threats are influential and have a significant effect on cloud implementation.

H1: Cyber threats impact cloud technologies implementation, e.g. malicious attacks damage data, corrupt data and disrupt the cloud implementation process. The relationship between cyber threats and cloud implementation is statistically significant, since ($p<0.05$). H2: Scalability provides the capability to increase and decrease computing resources such as storage and performance. Institutions are sourcing cloud applications that can scale up to accommodate future developments. There is a significant effect between scalability and cloud implementations since ($p<0.05$). H3: Compatibility is essential in cloud computing. Institutions are looking for responsive cloud applications that are flexible, portable and interoperable with other platforms. Compatibility supports systems integration using the same data formats. The relationship between compatibility and cloud implementation is statistically significant as ($p<0.05$). H4: Availability provides a global overview of cloud resources and is critical in achieving cloud implementation success. It also

enhances accessibility of resources and services that influence cloud usage. The relationship between availability and cloud implementation is significant as $p<0.05$). H5: Speed and performance enable easy access to resources, which enables cloud users and service providers to build and run intensive workloads. The relationship between speed and performance and cloud implementation is statistically significant as ($p<0.05$). H6: Social pressure influences institutional decisions because management makes decisions based on environmental conditions and social conditions or trends. The relationship between social pressure and cloud implementation is statistically significant as ($p<0.05$). H7: Institutions are using the public cloud to implement their core services virtually, which enables them to increase revenue, expand their client base and maintain competitive advantage. The relationship between competitive pressure and cloud implementation is statistically significant as $p<0.05$). H8: Management determines the success of cloud implementation because managers oversee cloud projects; identify and recommend capacity-building programs; deploy and train staff. The relationship between management and the cloud implementation is statistically significant as ($p<0.05$). H9: Organizational culture influences cloud implementation. The finding is consistent that culture dictates the success of cloud implementation, e.g., an innovative culture enables institutions to develop new brands that promote competitiveness. Culture also determines the capability of personnel in an organization, e.g. training, team work, experimentation or scientific progression and the ability to adopt new teaching methodologies. The relationship between organizational culture and cloud technologies implementation is statistically significant as $p<0.05$). H10: Privacy impacts cloud usage and implementations. In an organization, privacy is maintained to protect personal data and other types from unauthorized access or disclosure and fraudulent acts like phishing, email spamming and identity theft. The relationship between privacy and cloud technology implementations is statistically significant as $p<0.05$).

4.7 Correlations

Correlation measures association among the two variables to ascertain if they demonstrate linear relationship between them.

Table 12: Network Connection and Cyber Threats

Correlations			
		Cyber Threats	Network Connection
Cyber Threats	Pearson Correlation	1	.324**
	Sig. (2-tailed)		.000
	N	123	123
Network Connection	Pearson Correlation	.324**	1
	Sig. (2-tailed)	.000	
	N	123	123
**. Correlation is significant at the 0.01 level (2-tailed).			

- Figure of .324 indicates positive correlation.

Significance

- Tables 12 indicate that the Sig of .000 is < than standard alpha value (0.05) this means the correlation between network connection and cyber threats is highly significant.

Table 13: Management and Cost

Correlations			
		Management	Cost
Management	Pearson Correlation	1	.246**
	Sig. (2-tailed)		.006
	N	123	123
Cost	Pearson Correlation	.246**	1
	Sig. (2-tailed)	.006	
	N	123	123
**. Correlation is significant at the 0.01 level (2-tailed).			

- Figure of .246 indicates a positive correlation

Significance

- Table 13 indicate that the Sig of.006 is < than the standard alpha value (0.05), this means the correlation between management and cost is significant.

Table 14: Scalability and Cost

Correlations			
		Scalability	Cost
Scalability	Pearson Correlation	1	.236**
	Sig. (2-tailed)		.009
	N	123	123
Cost	Pearson Correlation	.236**	1
	Sig. (2-tailed)	.009	
	N	123	123
**. Correlation is significant at the 0.01 level (2-tailed).			

- Figure .236 indicates a positive correlation.

Significance

- Table 14 indicate that the Sig of .009 which is < than the standard alpha value (0.05), this means the correlation between cost and scalability is significant.

Table 15: Management and ICT Skills

Correlations			
		Management	ICT Skills
Management	Pearson Correlation	1	.289**
	Sig. (2-tailed)		.001
	N	123	123
ICT Skills	Pearson Correlation	.289**	1
	Sig. (2-tailed)	.001	
	N	123	123
**. Correlation is significant at the 0.01 level (2-tailed).			

- Figure of .289 indicates a positive correlation.

Significance

- Tables 15 indicate that the Sig of .001 is < than the standard alpha value (0.05), this means the correlation between management and ICT skills is significant.

4.8 Discussions

The study sought to identify cloud technologies implementation challenges in Kenyan universities. Technology advancement and competition have led institutions to migrate their services to virtual platforms. Recent studies have focused on cloud adoption issues. This study focuses on cloud technologies implementation challenges. The results indicate that, Kenyan universities are implementing cloud-based applications in their core business that have improved efficiency and effectiveness in service delivery and meet institutional needs. The key implementation challenges identified are technology aspects, reliability of solutions providers, network connections, portability, security issues, ICT skills and lack of computers.

4.8.1 Other Institutional Factors that Influence Cloud Technologies Implementation

The analysis of the results identified significant institutional challenges like privacy, competitive pressure, social pressure, speed and performance, availability, scalability, cyber threats, management, organizational culture and compatibility. The outcome of the research shows that cloud solutions (pay-per-use) usage is low at 21.1%. In this era, the use of customized solutions in universities is anticipated to be higher to enhance efficiency in service delivery and improve business value. One of the key determinants required when sourcing cloud-based solutions is scalability because universities are sourcing cloud applications that can accommodate huge numbers of students and personnel; others are speed and performance, compatibility and security.

4.8.2 How Competitive Pressure and Social Pressure Influence Cloud Technologies Implementation

The findings show that competitive pressure and social pressure influence cloud implementation. Nowadays, managers are making decisions to adopt cloud applications based on social environmental conditions and technology trends. Social trends have revolutionalized day-to-day operations and have triggered businesses to be conducted online or virtually. The issue of cyber-bullying and social media misuse is a serious security concern that causes fear and has an impact on the cloud implementation process. Customers' demands and pressure force institutions to re-evaluate their products and services for improvements. Nowadays, institutions are focusing on competition and are devising new strategies to achieve success and maintain competition in the market. The competitive nature of the market has forced institutions to embrace invention and innovation as a differentiation strategy. (Hojnik, 2017) Competitive pressure is the key motivator

for environmental responsiveness that contributes towards the development and deployment of cloud computing technologies and solutions that are customer-focused.

4.8.3 How Regulatory Frameworks Influence Cloud Technologies Implementation

Cloud computing open standards and regulations protect data in the cloud and addresses portability and interoperability issues that promote smooth operation. Regulatory frameworks impact cloud implementation by setting measures and standards that are based on law; therefore, cloud users, service contacts and providers must comply with before undertaking any activity; other issues are permit, licenses, good will, patent, trademarks, taxes etc. Failure to comply affects business growth; it's costly and can lead to destruction of property, court litigation, fines and reputation damage. The issue of cross-jurisprudence is a challenge. Therefore, it is necessary to observe relevant regulatory frameworks, cyber-laws and other international standards before developing and deploying cloud-based applications.

4.8.4 How Management Influence Cloud Technologies Implementation

Management determines cloud implementation success by overseeing cloud projects, deploying competent and experienced employees, facilitating capacity building programs, formulating and implementing ICT strategies and setting guidelines on how the information will be shared, stored and accessed on the cloud.

5.0 CHAPTER FIVE: CONCLUSION

5.1 Introduction

Section one provides background for the study, introduces the research problem area, objectives, research questions, significance and scope. Chapter two describes the literature review, constructs, empirical evidence, success factors and theoretical foundations. The study used the TOE theory to describe key elements such as technology, organization and environment. Chapter three explores research methodology, design, data collection and analysis. Chapter four presents the results of the analysis. After the analysis, the data is interpreted, discussed and conclusions are made in chapter five.

5.3 Revisiting Research Questions

The questions addressed research problems by understanding and illustrating their impact in the context of the study. To attain the results, five questions were presented and reviewed.

1. *What are the key issues that challenge the implementation of cloud technologies in Kenyan universities?*

   The question was asked to understand general issues that impact cloud implementation. The outcome of the study identified technological aspects, reliability of solution providers, network connections, portability, security, ICT skills and lack of computers as significant cloud implementation challenges.

2. *In reference to cloud computing, please indicate the extent to which the following institutional factors influence the implementation of cloud technologies?*

   Questions were asked to explore and discuss further institutional factors that impact cloud technologies implementation. The analysis identified privacy, competitive pressure, social pressure, speed and performance, availability, scalability and cyber threats as significant and influence cloud implementation process.

3. *Competitive pressure influences the implementation of cloud technologies?*

   The question was modeled from research questions to ascertain if competitive pressure impacts the cloud implementation process. The results identified that competitive pressure is significant and influence cloud implementation.

4. *Social pressure influences the implementation of cloud technologies?*

   The question was derived from research questions to ascertain if social pressure impacts the implementation of cloud technologies in Kenyan universities. The results identified that social pressure is significant and influence cloud implementation.

5. *Regulatory frameworks and ICT strategies challenge the implementation of cloud technologies.*

   Regulatory frameworks and ICT strategies were brought on board to assess how technological and institutional factors impact cloud implementation. The outcome of the results identified that regulatory frameworks and ICT strategies have significant effects on cloud implementation and influence cloud usage and performance.

5.4 Methodological Contribution

The main contribution of the research was to structure and conceptualize the framework from the TOE theory, as in Figure 2. The operationalized framework guides in modeling research problems, research questions, data collection, analysis and interpretation. Other studies can use the framework and theory construct to improve their understanding or implement similar concepts in their research.

5.5 Recommendation

Cloud-based technologies have brought fundamental changes that are improving computing capabilities and business performance. The key implementation challenges identified are technological aspects, network connectivity, reliability of solution providers, ICT skills, security, privacy, portability and lack of computers. In that regard, a framework and strategy for determining appropriate cloud solutions should be formulated and implemented to address technology concerns, institutional challenges and security issues that might hinder cloud implementation. To promote efficient and effective implementation of cloud technologies, the following issues need to be addressed appropriately:

a) Develop and formulate a cloud strategy.
b) Develop human capital by employing competent and experienced personnel.
c) Source for low-cost, cloud-based solutions that offer comprehensive services.

d) Increase bandwidth and reduce the cost of network connectivity.
e) Implement elaborate risk assessment practices and use a prioritization security model to enforce security.
f) Authenticate access and enhance the use of private networks to maintain privacy and confidentiality of information.
g) Train users and implement ease-of-use applications with documentation for guidance.
h) Enforce service level agreement to maintain standard and quality of services.

5.6 Conclusion

Based on the research outcome, Kenyan universities are implementing cloud-based applications in their core businesses. To maintain quality and standards, the government should enforce regulatory frameworks that govern and control cloud applications. Support cloud applications by lowering bandwidth costs and promoting an enabling environment that encourages cloud technology investment, cloud applications development. Privacy, speed and performance, availability, scalability and cyber threats are significant concerns that institutions should consider before sourcing cloud-based applications. Hence forth, universities should focus on competitive pressure, social pressure and technology dynamics when sourcing for cloud solutions.

5.7 Limitations

Due to COVID-19 restrictions, it was hard to conduct a broad survey of numerous universities since the universities' services were conducted virtually and getting approval and a permit to conduct a survey was a challenge. Bureaucracy in some universities was a major challenge, especially when obtaining approval and capturing data on time.

5.8 Further Works

Similar studies can be carried out on private firms, organizations and government agencies. Further research can focus on privacy issues, competitive pressure and social pressure. There might be other factors not covered in this study that impact cloud implementation and are worthy of research.

REFERENCES

Ahorlu, M. (2014). European Cloud Professional IT Services 2014 Vendor Assessment. Source November 2nd, 2004 from IDC Market Scape https://www.idc.com/getdoc.jsp?containerId=QL07W**.**

Alkhater, N., Wills, G., & Walters, R. (2015). Factors influencing an organization's intention to adopt cloud computing in Saudi Arabia. In 2014 IEEE 6th International Conference on Cloud Computing Technology and Science (pp. 1040– 1044). IEEE. https://doi.org/10.1109/CloudCom.2014.95.

Awa, H., & Kalu, S. (2010). Repositioning the non-incremental changes and business strategic windows correlates. International Journal of Business and Management, 5,184–193.

Benlian, A., Koufaris, M. and Hess, T. (2011) Service Quality in Software-as-a-Service: *Developing the SaaS-Qual Measure and Examining Its Role in Usage Continuance*. Journal of Management Information Systems, 28, 85-126. http://dx.doi.org/10.2753/MIS0742-1222280303.

Brown RB, 2006, Doing Your Dissertation in Business and Management: The Reality of Research and Writing, Sage Publications.

Blaisdell, R., 2012, How performance issues impact cloud adoption, *viewed 13 October2019,* from https://rickscloud.com/how-performance-issues-impact-cloud-adoption/.

Borgman, H.P., Bahli, B., Heier, H., Schewski, F. (2013). Cloud rise: Exploring Cloud Computing Adoption and Governance with the TOE Framework. 46th Hawaii International Conference on System Sciences, 4425-4432.

Buyya R, Yeo CS, Venugopal S, Broberg J, Brandic I (2009) Cloud computing and emerging IT platforms: *Vision, hype, and reality for delivering computing as the 5th utility*. Futur Gener Comput Syst 25(6):599–616.

Buyya, R., Goscinski, A., & Broberg, J. (2011). Introduction to Cloud Computing. *In Cloud computing: principles and paradigms*. Hoboken, N.J.: Wiley.

Chang, V., Walters, R. J., & Wills, G. B. (2016). Organisational sustainability modelling—An emerging service and analytics model for evaluating Cloud Computing adoption with two case studies. *International Journal of Information Management*, 36(1), 167-179.

C. Fershtman and N. Gandal, Migration to the Cloud Ecosystem: *Ushering in a New Generation of Platform Competition*, Communications & Strategies 85(1) (2012), 1–22.

CAS's 2010 report titled 'Top Threats to Cloud Computing V1.0' identified the following as 'Top 7 cloud-specific risks'.

Chau, P., & Tam, K. (1997). Factors affecting the adoption of open systems: *An exploratory study*. MIS Quarterly, 21(1),1–21. http://dx.doi.org/10.2307/249740.

Chen, H.M. and Lin, K.J. (2005) The role of human capital cost in accounting, Journal of Intellectual Capital, 5(1), pp. 116-130.

Chen, Y., Paxson, V. & Katz, R. H. (2010). What's New about Cloud Computing Security?, *EECS Department*, University of California, Berkeley.

Chang, V., Kuo, Y.-H., & Ramachandran, M. (2016). Cloud computing adoption framework: A security framework for business clouds. *Future Generation computer systems*, 57, 24-41.

Cisco (2013). The Cloud in Africa: reality checks 2013. Available at: http://www.cisco.com/web/ZA/press/2013/112813.html. Retrieved December 13, 2013

Cloud Security Alliance (CSA). Available: http://www.cloudsecurityalliance.org [Mar.19, 2010]

Dan, A.; Davis, D.; Kearney, R.; Keller, A.; King, R.; Kuebler, D.; Ludwig, H.; Polan, M.; Spreitzer, M.; & Youssef, A. *Web Services on Demand: WSLA-Driven Automated Management*. http://www.research.ibm.com/journal/sj/431/dan.html (2004).

Downing SM. Validity: on the meaningful interpretation of assessment data. Med Educ.2003; 37:830–7.

De Vos, A., De Hauw, S., & Willemse. (2011). Competency development in organizations: Building an integrative model through a qualitative study (Vlerick Leuven Gent Management School Working Paper Series). Vlerick Leuven Gent Management School. Retrieved from http://econpapers.repec.org/paper/vlgvlgwps/2011-01.htm.

Dubey, A. (2016). Cloud Computing and Its Security Issues. International Journal, 4(7).

Dubrova E (2013) Fault-tolerant design. Springer, Berlin. European Network and Information. *empirical study*. Industrial Management & Data Systems, 2005. 105(6): p. 685-702.

Doolin, B., & Troshani, I. (2007). Organizational adoption of XBRL. *Electronic Markets, 17*(3), 199-209.

ERNST & YOUNG. (2011). Cloud Computing Issues and Impacts. EYGM Ltd.

Eze, S., Awa, H., Okoye, J., Emecheta, B., & Anazodo, R. (2013). Determinant factors of information communication technology (ICT) adoption by government-owned universities in Nigeria. Journal of Enterprise Information Management, 26, 427–443.http://dx.doi.org/10.1108/JEIM-05-2013-0024.

Eze, S., Awa, H., Okoye, J., Emecheta, B., & Anazodo, R. (2013).Determinant factors of information communication technology (ICT) adoption by government-owned universities in Nigeria. Journal of Enterprise Information Management, 26, 427–443.http://dx.doi.org/10.1108/JEIM-05-2013-0024.

F. Damanpour and M. Schneider, Characteristics of innovation and innovation adoption in public organizations: *Assessing the role of managers*, Journal of Public Administration Research and Theory 19(3) (2009), 495–522.

Fichman, R. G. (2004). Going Beyond the Dominant Paradigm for Information Technology Innovation Research: Emerging Concepts and Methods. *Journal of the Association for Information Systems, 5(8).*

Ferry, N. Hui Song Rossini, A Chauvel, F. Solberg, A. (2014) Cloud MF: Applying MDE to Tame the Complexity of Managing Multi-cloud Applications, *in Utility and Cloud Computing (UCC),* 2014 IEEE/ACM 7th International Conference on, pp.269–277, doi:10.1109/UCC.2014.36.

Feuerlicht, G. and Govardhan, S. (2010) Impact of Cloud Computing: *Beyond a Technology Trend*. Proceedings of the International Conference on Systems Integration, Oeconomica, Prague, 8-9 June 2010, 1-8.

Feuerlicht, G., Burkon, L., & Sebesta, M. (2011). Cloud computing adoption: What are the issues. *System Integration*, 18(2), 187-192.

Gamage, T. C. (2019). Determinants of cloud computing adoption among SMEs in Sri Lanka*: A meta theoretical framework.* International Journal of Asian Social Science, 9(2), 189–203. https://doi.org/10.18488/journal.1.2019.92.189.203.

Gangwar, H., Date, H., & Ramaswamy, R. (2015). Understanding determinants of cloud computing adoption using an integrated TAM-TOE model. Journal of Enterprise Information Management, 28(1), 107–130.

Gartner Research (2019), Press Release, 2 April, https://www.gartner.com/en/newsroom/press-releases/2019-04-02-gartner-forecasts-worldwide-public-cloud-revenue-to-g.

Gartner Inc. Debra Logan, January 2010. "What is Information Governance and Why is it so Hard?" http://blogs.gartner.com/ debra_logan/2010/01/11/what-is-information-governance-andwhy-is-it-so-hard/.

Government Accountability Office [GAO]. (2011b, October). *Information security: Additional guidance needed to address cloud computing concerns* (Publication No. GAO-12-130T). Retrieved from http://www.gao.gov/assets/590/585638.pdf.

Khan, A. N., Kiah, M. M., Khan, S. U., & Madani, S. A. (2013). Towards secure mobile cloud computing: A survey. Future generation computer systems, 29(5), 1278-1299.

Kim, W. (2009). Cloud Computing: *Today and Tomorrow*. The Journal of Object Technology, 8(1), 65. doi:10.5381/jot.2009.8.1.c4.

K'obonyo. P. et al (1999), Complying with Business Regulation in Kenya: *University of Nairobi: Institute for Development Studies*. Occasional Paper No.64.

Kothari C. R. (2008). Research Methodology. *Methods and Techniques (2nd ed.).* New Delhi: New Age International.

KPMG (2011). The Cloud - Changing the Business Ecosystem. Retrieved January 7, 2013, from http://www.kpmg.com/in/en/issuesandinsights/articlespublications/pages/thecloudchangingthebusinessecosystem.aspx.

Kuan, K., & Chau, P. (2001). A perception based model for EDI adoption in small businesses using technology-organization-environment framework. Information &Management, 38, 507–521.

Kumar, D., & Samalia, H. V. (2017). Investigating factors affecting cloud computing adoption by SMEs in Himachal Pradesh. In Proceedings - 2016 IEEE International Conference on Cloud Computing in Emerging Markets (pp. 9– 16). The Institute of Electrical and Electronics Engineers. https://doi.org/ 10.1109/CCEM.2016.012.

Low, C., Chen, Y., & Wu, M. (2011). Understanding the determinants of cloud computing adoption. *Industrial management & data systems*, 111(7), 1006-1023.

Li, S., Long, S. Lee, Q. Guo, R. Li & Y. Liu.2006. Herbs for medicinal baths among the traditional Yao communities of China. Journal of Ethnopharmacology 108: 59-67.

Lin, A., & Chen, N.-C. (2012). Cloud computing as an innovation: Perception, attitude, and adoption. *International Journal of Information Management*, *32*(6), 533–540. doi:10.1016/j.ijinfomgt.2012.04.001

M.C. Jones, M. Cline and S. Ryan, Exploring knowledge sharing in ERP implementation: *An organizational culture framework*, Decision Support System 41(2) (2006), 411–434.

M.I. Salwani, G. Marthandan, M.D. Norzaidi and S.C. Chong, E-commerce usage and business performance in the Malaysian tourism sector: *Empirical analysis*, Information Management and Computer Security 17(2) (2009), 166–185.

M.-S. Pang, G. Lee and W.H. DeLone, In public sec- tor organisations: *A public-value management perspective*, Journal of Information Technology 29(3) (2014), 187–205.

Marston, S., Li, Z., Bandyopadhyay, S., Zhang, J., & Ghalsasi, A. (2011). *Cloud computing-The business perspective*. Decision Support Systems, 51(1), 176-189.

Mather, T., Kumaraswamy, S., and Latif, S. (2009), Cloud Security and Privacy: *An Enterprise Perspective on Risks and Compliance*, O'Reilly Media, Inc.

Miguel G. Xavier & Marcelo V. Neves & Fabio D. Rossi, (2012), "Performance Evaluation of Container-based Virtualization for High Performance Computing Environments", IEEE PDP.

Mishra, A., Mathur, R., Jain, S., & Rathore, J. S. (2013). Cloud Computing Security. International Journal on Recent and Innovation Trends in Computing and Communication, 1(1), 36-39.

Mugenda, M.O and Mugenda A.G (2003) Research Methods: Quantitative and Qualitative Approaches.

Mullei. A. and Bokea. C. (1999), Micro and Small Enterprises in Kenya: Agenda for Improving the Policy Environmental. Nairobi: I.C.E.G.

Mell, P., & Grance, T. (2011). The NIST definition of cloud computing.

Michie, S., & West, M. A. (2004). Managing people and performance: an evidence based framework applied to health service organizations. International journal of management reviews, 5(2), 91-111.

NIST 2011.The NIST Definition of Cloud Computing. *Recommendations of the National Institute of Standards and Technology*. http://csrc.nist.gov/publications/nistpubs/800-145/SP800-145.pdf.

O. Kerimoglu, N. Basoglu and T. Daim, Organizational adoption of information technologies: *Case of enterprise resource planning systems*, Journal of High Technology Management Research 19(1) (2008), 21–35.

Omwenga, B., Waema, T. M., & Omwansa, T. K. (2014). Cloud Computing in Kenya A 2013 Baseline Survey.

Oates, B. J. (2006). Researching Information Systems and Computing. Oxford, SAGE Publications.

Odero-Merino L, Vaquero LM, Gil V, Galán F, Fontán J, Montero RS, Llorente IM, (2010) From infrastructure delivery to service management in clouds. Futur Gener Comput Syst 26(8):1226–1240.

Oliveira, T. & Martins, M. F. 2011. Literature Review of Information Technology Adoption Models at Firm Level. The Electronic Journal Information Systems Evaluation, 14, 110-121.

Oliveira, T., Thomas, M., & Espadanal, M. (2014). Assessing the determinants of cloud computing adoption: *An analysis of the manufacturing and services sectors*. Information & Management, 51(5), 497-510.

OWASP's 2011 report titled 'Cloud - 10 Project' identified following as 'Top 10 cloud security risks'.

P. Kresimir and H. Zeljko, "Cloud computing security issues and challenges." In PROC *Third International Conference on Advances in Human-oriented and Personalized Mechanisms, Technologies, and Services*, 2010, pp. 344-349.

Pang, M., & Jang, W. (2008). Determinants of the adoption of ERP within the T-O-E framework: *Taiwan's Communications industry. Journal of Computer Information Systems*, 48, 94–102.

Paschke, Adrian. RBSLA: Rule-Based Service Level Agreements. http://ibis.in.tum.de/projects/rbsla/index.phpH (2006).

Pocatilu, P., Alecu, F., & Vetrici, M. (2009, November). Using cloud computing for E-learning systems. *In Proceedings of the 8th WSEAS international conference on Data networks, communications, computers* (Vol. 9, No. 1, pp. 54-59).

Dorey, P. G., & Leite, A. (2011). Commentary: Cloud computing - A security problem or solution?. *Information security technical report*, 16(3-4), 89-96.

Raut, R. D., Gardas, B. B., Jha, M. K., & Priyadarshinee, P. (2017). Examining the critical success factors of cloud computing adoption in the MSMEs by using ISM model. *Journal of High Technology Management Research, 28(2), 125–141*. https://doi.org/10.1016/j.hitech.2017.10.004.

Raza, A., & Murad, H.S. (2014). Learning New Management View points: *Re-contextualizing Strategic Leadership in Global and Regional Context*. Business Review, 9(1), 115-121.

Rogers, E. (2003). Diffusion of Innovations (4th ed.). New York, NY: The Free Press.

Rimal, B. P., Choi, E., & Lumb, I. (2009, August). A taxonomy and survey of cloud computing systems. In *2009 Fifth International Joint Conference on INC, IMS and IDC* (pp. 44-51). Ieee.

S. Chuang, A resource-based perspective on knowledge management capability and competitive advantage: An 246M. Easter by-Smith and I. M. Prieto empirical inves- tigation, *Expert Systems with Applications 27(3) (2004), 459–465.*

Sen, J. (2013). Security and Privacy Issues in Cloud Computing. *In Architectures and Protocols for Secure Information Technology Infrastructures*, pp. 1-45, IGI Global, September 2013.

Shooman ML (2002) Reliability of computer systems and networks. Wiley, Hoboken.

Silverman, D. (2011). A guide to the principles of qualitative research.

Silva, G.C, Louis M. R, and Radu, C. (2013) A Systematic Review of Cloud Lock-in Solutions. Cloud Computing Technology and Science (CloudCom), IEEE 5th International Conference on. Vol. 2. IEEE.

Smith, P., Mahdavi, J., Carvalho, M., & Tippett, N. (2006). An investigation into cyberbullying, its form awareness and impact, and the relationship between age and gender in cyberbullying, A report to the Anti-Bullying Alliance.

Snyder et al (2015) Evaluation and design of highly reliable and highly utilized cloud computing systems. J Cloud Comput 4(1):1

Søren Johansen (1991). Estimation and Hypothesis Testing of Cointegration Vectors in Gaussian Vector Autoregressive Models. Econometrica Vol. 59, No. 6 (Nov., 1991), pp. 1551-1580.

Sriram, I., & Khajeh-Hosseini, A. (2010). Research Agenda in Cloud Technologies (arXiv e-print No. 1001.3259).

Swanson, E. B., & Ramiller, N. C. (2004). Innovating mindfully with information technology.MIS Q., 28(4), 553–583.

Stanoevska-Slabeva, K., & Wozniak, T. (2010). Cloud Basics – An Introduction to Cloud Computing. In K.Stanoevska-Slabeva, T. Wozniak, & S. Ristol (Eds.), *Grid and Cloud Computing* (pp. 47–61). Springer Berlin Heidelberg. Retrieved from http://link.springer.com/chapter/10.1007/978-3-642-05193-7_4.

Tornatzky, L. G., Fleischer, M., & Chakrabarti, A. K. (1990). *Processes of technological innovation*. Lexington books.

Trzec, Krunoslav & Huljenic, Darko. Modeling Agent-Based Framework for the Automation of SLA Management Lifecycle. http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=01214627H (2003).

Thorndike RM. Measurement and evaluation in psychology and education. 7th ed. Upper SaddleRiver: Pearson Prentice Hall; 2007.

Venkatesh, V., & Davis, F. (2000). A theoretical extension of the technology acceptance model: *Four longitudinal field studies.* Management Science, 46, 186 204.http://dx.doi.org/10.1287/mnsc.46.2.186.11926.

Venters, W., & Whitley, E. A. (2012). A critical review of cloud computing: *researching desires and realities*. Journal of Information Technology, 27(3), 179–197. doi:10.1057/jit.2012.17.

Vining, J., & Di Maio, A. (2009). Cloud computing for government is cloudy. Stamford, CT: Gartner.

W. Ke and K. Wei, Organizational Culture and Leader-ship in ERP Implementation, Pacific Asia Conference on Information Systems (PACIS) (2005).

Wei, L., Zhu, H., Cao, Z., Jia, W., and Vasilakos, V.A. (2010), SecCloud: Bridging Secure Storage and Computation in Cloud. *International Conference on Distributed Computing Systems Workshops.*

Weick, K. E., & Sutcliffe, K. M. (2001). *Managing the unexpected: assuring high performance in an age of complexity*. San Francisco: Jossey-Bass.

Yang, S., & Hsu, C, (2011). The Organizing Vision for Cloud Computing in Taiwan. Journal of Electronic Commerce Research, 12(4), 257–271.

Younis, M. Y. A., & Kifayat, K. (2013). Secure cloud computing for critical infrastructure: *A survey. Liverpool John Moores University, Liverpool*: Tech. Rep.

Yuanming, Cao; Wendong, Wang; Xiangyang, Gong; & Xirong, Que. Initiator-Domain-Based SLA Negotiation for Inter-Domain QoS-Service Provisioning. http://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=04476553H (2008).

Z. Shao, Y. Feng and L. Liu, The mediating effect of organizational culture and knowledge sharing on transformational leadership and Enterprise Resource Planning systems success: *An empirical study in China*, Computers in Human Behavior 28(6) (2012), 2400–2413.

Zhang, Q., Cheng, L., & Boutaba, R. (2010). Cloud computing: state-of-the-art and research challenges. Journal of Internet Services and Applications, 1(1), 7–18. doi:10.1007/s13174-010-0007-6.

Zhu, K., & Kraemer, K. (2005). Post-adoption variations in usage and value of e-business by organizations: *Cross-country evidence from the retail industry*. European Journal of Information Systems, 12, 61–84.

Zhang, Q., Cheng, L., & Boutaba, R. (2010). Cloud computing: state-of-the-art and research challenges. *Journal of Internet Services and Applications*, *1*(1), 7–18. doi:10.1007/s13174-010-0007-6

APPENDIX I

MSc Project Schedule 2022

Work Break Down ↓	Oct	Nov	Dec	Jan	Feb	Mar	April	May	July
Identify Research Area									
Formulate Research Questions									
Formulate Research Design									
Write Research Proposal									
Milestone One									
Milestone Two									
Milestone Three									

APPENDIX II

DATA COLLECTION TOOL

Masters Project Thesis SCI-University of Nairobi

The study is about the challenges of implementing cloud technologies in Kenyan Universities. This is a part of the Project Thesis for the Study of MSc in Information Technology Management.

Demographic Information

Date of the Interview…….....

Name of the Respondent……...……....

Position within the University……..……

Type of the University……...

1. In your opinion, is using virtual platforms a challenge to the university community?
    - Strongly agree
    - Somehow agree
    - Not sure
    - Somehow disagree
    - Strongly disagree
2. Are cloud resources reliable and flexible, can students and staff access online services?
    - Strongly agree
    - Somehow agree
    - Not sure
    - Somehow disagree
    - Strongly disagree
3. Using the pay-per-use model, will the universities have the potential to access the computing services they need?
    - Strongly agree
    - Somehow agree
    - Not sure
    - Somehow disagree
    - Strongly disagree

4. Competitive pressure influences the implementation of cloud computing?
    - Strongly agree

- Somehow agree
- Not sure
- Somehow disagree
- Strongly disagree

5. Social pressure influences the implementation of cloud computing?
    - Strongly agree
    - Somehow agree
    - Not sure
    - Somehow disagree
    - Strongly disagree
6. In reference to cloud computing, please indicate the extent to which the following institutional factors influence the implementation of cloud technologies?

Criteria: (1. To a small extent 2. To some extent 3. Moderate 4. To a great extent 5. To a very great extent)					
Criteria	1	2	3	4	5
Privacy					
Cyber Threats					
Speed and Performance					
Scalability					
Management					
Organizational Culture					
Cost					
Compatibility					
Service Lever Agreement (SLA)					

9 List the key issues challenging the implementation of cloud technologies in your University? (select all that apply)
- Technological aspects
- Network connection issues
- Security issues
- Reliability of solution providers

- Portability
- Lack of computers
- ICT Skills

7b. Other, please indicate.

10 The ICT strategies in my University challenge the implementation of cloud technologies?

- Strongly agree
- Somehow agree
- Not sure
- Somehow disagree
- Strongly disagree

11 Are you familiar with any cloud policy and regulatory framework in Kenya?

- Yes
- No

12 The regulatory frameworks in Kenya challenge the implementation of cloud Technologies?

- Strongly agree
- Somehow agree
- Not sure
- Somehow disagree
- Strongly disagree

13 In your opinion, should cloud applications services be subjected to any regulation?

- Yes
- No

14 Are you aware of any Standards of cloud computing and service provision?

- Yes
- No

15 Should cloud computing in Kenyan universities be given a higher priority?

- Strongly agree
- Somehow agree
- Not sure

- Somehow disagree
- Strongly disagree

16 Please point out the support you think the Government should provide in relation to cloud computing implementation?

APPENDIX III

University of Nairobi Approval

UNIVERSITY OF NAIROBI
OFFICE OF ASSOCIATE VICE-CHANCELLOR
(Research, Innovation and Enterprise)

P.O. Box 30197-00100
Nairobi, Kenya
Website: dvcrie@uonbi.ac.ke

Fax: +254-2-2317251
Email: avcrie@uonbi.ac.ke

UON/RIE/3/5/Vol.XX February 17, 2022

Mr. Dennis Safari Waema
School of Computing and Informatics
University of Nairobi
P. O. Box 30197 – 00100
Nairobi

E-mail: dennis.safari@gmail.com

Dear Mr. Waema,

PERMISSION TO COLLECT DATA

I refer to your request to conduct research at the University of Nairobi, for your project entitled: ***"Challenges of implementing cloud technologies in Kenyan Universities."***

I write to inform you that your request has been approved.

You are however required to share the findings of your study with the University of Nairobi by depositing a copy of your findings with the Director Library & Information Services on completion of your study.

Yours sincerely,

PROF. M. JESANG HUTCHINSON
ASSOCIATE VICE-CHANCELLOR (AG.)
(RESEARCH, INNOVATION AND ENTERPRISE)
AND
PROFESSOR OF HORTICULTURE

Copy to: Director, Library and Information Services

AAM/jks

APPENDIX IV

KCA Approval

SCHOOL OF GRADUATE STUDIES

Date: February 14, 2022

APPROVAL FOR DATA COLLECTION

Research Area: Challenges of Implementing Cloud Technologies in Kenyan Universities

Student Name:
Mr. Dennis Safari Waema

Comments:

Approval to collect data.

Dr. Nyaribo Misuko
Dean School of Graduate Studies **SIGNED**

Comments:

Approved

Prof. Joshua Bagaka's
DVC (A, E & SA) **SIGNED**

APPENDIX V

Kenya Methodist Approval

Kenya Methodist University
P. O Box 267 - 60200, Meru, Kenya, Tel: (+254-020) 2118423-7, 064-30301/31229 Email: info@kemu.ac.ke , Website: www.kemu.ac.ke

OFFICE OF THE VICE-CHANCELLOR

REF: KeMU/A/VC/GEN.EXT/107

17th June 2020

Mr. Dennis Safari Wema
P. O. Box 30197 - 00100
NAIROBI

Email:

Dear Sir,

RE: **AUTHORIZATION TO CONDUCT SURVEY AT KENYA METHODIST UNIVERSITY**

Reference is made to the above subject matter.

Your request seeking authorization to conduct survey for your final year study, *"Challenges of Cloud Computing Implementation in Kenyan Universities."* at Kenya Methodist University has been approved.

Please note that only approved data forms are to be used in the enrollment of participants with their individual consent. All consent forms signed by subjects and/or witnesses should be retained on file. Further, any substantial changes in the scope of your research from what is presently provided will require an approval from the University.

Please proceed as you have outlined in your proposal and share your findings with the University by sending a copy to the Director, Postgraduate Studies.

If the terms are acceptable to you please sign a copy of this letter and return it to the office of Postgraduate Studies as soon as possible.

Yours faithfully,

17 JUL 2019

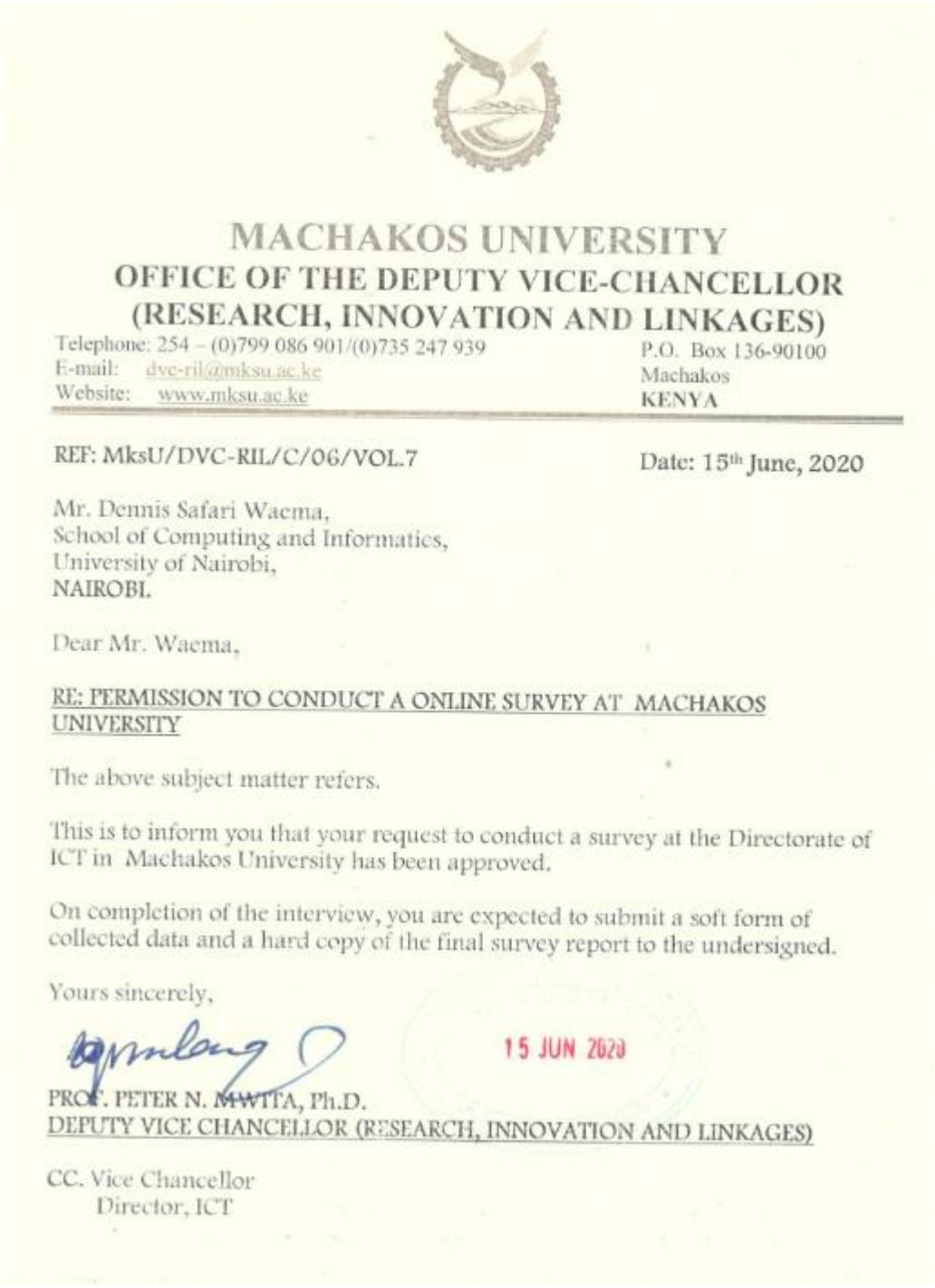
PROF. DAVID GICHOYA, Ph.D.
AG. VICE-CHANCELLOR

I, the undersigned hereby confirm acceptance of this offer and the conditions stated herein.

Signed..... Date.....

APPENDIX VI

Machakos University Approval



MACHAKOS UNIVERSITY
OFFICE OF THE DEPUTY VICE-CHANCELLOR
(RESEARCH, INNOVATION AND LINKAGES)

Telephone: 254 – (0)799 086 901/(0)735 247 939
E-mail: dvc-ril@mksu.ac.ke
Website: www.mksu.ac.ke

P.O. Box 136-90100
Machakos
KENYA

REF: MksU/DVC-RIL/C/06/VOL.7

Date: 15th June, 2020

Mr. Dennis Safari Waema,
School of Computing and Informatics,
University of Nairobi,
NAIROBI.

Dear Mr. Waema,

RE: PERMISSION TO CONDUCT A ONLINE SURVEY AT MACHAKOS UNIVERSITY

The above subject matter refers.

This is to inform you that your request to conduct a survey at the Directorate of ICT in Machakos University has been approved.

On completion of the interview, you are expected to submit a soft form of collected data and a hard copy of the final survey report to the undersigned.

Yours sincerely,

15 JUN 2020

PROF. PETER N. MWITA, Ph.D.
DEPUTY VICE CHANCELLOR (RESEARCH, INNOVATION AND LINKAGES)

CC. Vice Chancellor
Director, ICT