DECISION FRAMEWORK FOR THE USAGE OF CLOUD TECHNOLOGY IN ETHIOPIA HIGHER EDUCATION INSTITUTIONS

M. Sc. THESIS

SELAM DESALGNE

HAWASSA UNIVERSITY

HAWASSA, ETHIOPIA

June, 2019

DECISION FRAMEWORK FOR THE USAGE OF CLOUD TECHNOLOGY IN ETHIOPIA HIGHER EDUCATION INSTITUTIONS

Selam Desalgne

Advisor : Dr. Basant Tiwari

A THESIS SUBMITTED TO THE
HAWASSA UNIVERSITY,
INSTITUTE OF TECHNOLOGY,
FACULTY OF INFORMATICS
DEPARTMENT OF COMPUTER SCIENCE

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF THE MASTER OF SCIENCE IN COMPUTER SCIENCE
HAWASSA, ETHIOPIA

June, 2019

DECLARATION

I, the undersigned, declare that this thesis work is my original work, has not been presented for a degree in this or any other universities, and all sources of materials used for the thesis work have been duly acknowledged.

Name: Selam Desalgne

Signature: _____

I, hereby certify that, this thesis has been submitted for examination with my approval as thesis advisor.

Name: Basant Tiwari (PhD)

Signature: _____

Place and Date of Submission: _____

APPROVAL SHEET

As members of the Examining Board of the Final MSc. Open Defense, we certify that we have read and evaluated the thesis prepared by Selam Desalgne entitled **Decision Framework for the Usage of Cloud Technology in Ethiopia Higher Education Institutions**, and recommend, that it be accepted as fulfilling the thesis requirement for the degree of Masters of Science Degree in Computer Science.

Name of Chairman	Signature	Date
Name of Advisor	Signature	Date
Name of Internal Examiner	Signature	Date
Name of External Examiner	Signature	Date

Final approval and acceptance of the thesis is contingent upon the submission of the final copy of the thesis to the SGS through the Department of Graduate Council (DGC) of the candidate's major department.

Thesis approved by

DGC/SGS	Signature	Date

ACKNOWLEDGEMENT

First and foremost, I would like to thank almighty God for giving me strength, courage and patience in order to accomplish this research.

Secondly, the success of this thesis is credited to the extensive support, assistance and advice starting from the research work and for their constructive comments from my advisor Dr. Basant. I would like to express my grateful gratitude and sincere appreciation for his guidance, valuable advice, constructive comments, encouragement and kindness to me throughout this study.

Thirdly, I would like to thank my family especially to my mom and dad for raising me with love and encouragement to live a purpose-driven life. I can never thank you enough for your love, care and understanding. They are the source of inspiration and the reason of success in my life. I am deeply indebted to my whole family who supported and encouraged me throughout the time of my study, the research work and throughout my whole life.

Finally, I would like to thanks my friend Yared Alibo for his insightful inputs and feedbacks and all of you who support me to complete this thesis work, on their advice and support through my research even if I didn't mention your name here.

ABSTRACT

The rapid technology advancements are always creating new opportunities and a new way of working. Cloud Technology is being popularizing across the world especially in academic institutions. It is not a new technology but rather a new delivery model for information and services using existing technologies. The paradigm has been recognized recently as key enabling efficient and effective technological services that will reshape the delivery and support of the educational services. This study is conducted on public Ethiopian Higher Educational Institutions to explore the critical determinants that influence the adoption of the Cloud Technology. Despite the fact that cloud computing offers great deal of opportunities, its adoption exacerbated with lack of standards and relative lack of general framework created dilemma for the institutions how to approach the cloud adoption.

An exploratory study is carried out. This research work proposes TOETAD conceptual framework according to the Technology Organization Environment (TOE) model, Diffusion of Innovation (DOI) theory and Technology Acceptance Model (TAM) with added Decision Maker Context to the model. Adoption determinants for the technology will be examined through the lens of integrated model.

The framework factors were identified by critically reviewing studies found in the literature together with factors from the industrial standards within the context of Ethiopia Higher Education Institutions. Data is collected by online questionnaire survey with IT managers, lectures, E-learning coordinators and Team Leaders from selected 17 Ethiopia Higher Educational Institutions with a total 103 respondent. On the other hand the proposed frame work is evaluated by an expert to validate the framework.

The result also helps to encourage the Public Higher Educational Institutions in Ethiopia to understand the nature of the problem, increase their awareness about factors to be considered while adopting the cloud computing.

Keywords: Cloud Computing, Cloud Adoption, Ethiopia Higher Education, Technology Adoption

LIST OF FIGURES

LIST OF TABLES

ACRONYMS AND ABBREVIATIONS

ATM: Asynchronous Transfer Mode

CSPs: Cloud Service Providers

CPUs: Central Processing Units

DOI: Diffusion of Innovation

EthERNet: Ethiopian Education and Research Network

EHEIs: Ethiopia Higher Educational Institutions

EC2: Elastic Cloud Computing

HEIs: Higher Educational Institutions

HDI: Human Development Index.

IaaS: Infrastructure as a service

IT: Information Technology

ICTs: Information and Communication Technologies

MOS: Mean Opinion Score

NITS: National Institute for Standard and Technology

PaaS: Platform as a service

REN: Research and Education Networking

RIPPER: Repeated Incremental Pruning to Produce Error Reduction

SaaS: Software as a service

SPSS: Statistical Package for the Social Sciences

TAM: Technology Acceptance Model

TOE: Technological, Organizational and Enviroment

TRA: Theory of Reasoned Action

UTAUT: Unified Theory of Acceptance and Use of Technology

VM: Virtual Machine

VPN: Virtual Private Network

TABLE OF CONTENTS

CHAPTER ONE
INTRODUCTION

In this chapter, the researcher discussed the background of the research, statement of the problem, objective of the study, significance of the study, and scope & limitation of the study. Finally, it provides a quick glance of the structure of this thesis.

1.1. Background

Education is fundamental to sustainable development; it is a powerful driver of development and one of the strongest instruments for reducing poverty [1]. Directly or indirectly the impact of education enable people to be more productive, earn a better living and enjoy a better quality of life and also contributes and ensures economic development of growing countries. Over all, education is critical for reducing the poverty cycle and essential for the economic turnaround.

Higher Education Institutes (HEIs) are public or private organizations that provide programs to individual who has completed high school and their programs may include undergraduate, postgraduate and PhD courses for the advanced level skills development. However, HEIs in developing countries operates under resource constrained enviroment that hinder efficient delivery of services to support the educational, research and development activities [2]. So, the Cloud Computing technology is an excellent alternative for the educational institution which is especially under budget, in order to operate their information systems effectively. Thus, the technology will enable Ethiopian government not investing extra millions of dollars every year to support the sector.

Information and Communication Technologies (ICTs) provides powerful enabling tools for educational change and reform it by introducing new methods of teaching and conducting research as well as provisioning of educational facilities for online learning, teaching and research collaboration [3]. It thus represents a potentially equalizing strategy for developing countries. So, ICTs in education implementation strategy and its corresponding action plan are components of a wider Ethiopian national e-education initiative. The strategy is built on three main streams: Ethiopian National School Net initiative, the National ICTs in Higher Education initiative and the National ICT Education, Training and Awareness initiative. Higher education has always been considered as the major deriver for socio-economic development of Ethiopia [4].

For this reason, Ethiopia gets on higher education expansion; building the constructions is not well enough without integrated with technologies. A relevant Technology-Enabled Higher Education is more important today than ever, because today's networked World demands a personnel that understands how to use technology as a tool to increase productivity and creativity.

The Cloud Computing concept is dated back to 1961 when John McCarthy opinioned that "Computation may someday be organized as a public utility". The term "Cloud" has also been used in commercial field contexts such as describing large ATM (Asynchronous Transfer Mode) networks in the early 1990s. In 2006, the term started to gain popularity after Google's CEO Eric Schmidt used the word to describe the business model of providing services across the Internet. Since then, in a variety of context mainly as a marketing term the term cloud has been used to represent different ideas.

IBM launch the operating system in 1970 known as Virtual Machine (VM), that enabled the companies and organizations to run their operations on the operating systems simultaneously on more than one system with own memory and processing unit. VM became the initial phase towards the evolution of new technology known as virtualization, collective collaboration of different computing platforms like Centralized, Parallel, Cluster, Distributed and Grid computing gave birth of today's most talked computing paradigm known as cloud computing [5]. In the beginning of 21st century, the term Cloud Computing appeared widely to the public where the most focus that time was restricted to software as a service (SaaS). In 2000s, Microsoft extended SaaS through developing web services. In 2007, Google, IBM and number of different universities started large scale Cloud Computing research project [6][7].

Today, the cloud is transforming industry and impacting education and research more than any other technology has ever did. It holds the promise of being the "next big-thing" in IT. Its widespread research has been reported in areas like Banking, Insurance, Library, Healthcare, Education etc. Kale *et al.* [8] mentioned cloud computing usability in education is wide-ranging, as acknowledged by many educational institutions around the world, and it is a hot research area that applies in all sectors where we require fast access and high performance to resources and services. Some highlights from the updated forecast of Cisco system's global cloud index forecast (2016 – 2021) include the following projections: by 2021 the increase for the data center and the cloud resource from both business and consumer service perspective led to the development of large scale public data center which is also called Hyper scale data center. It will grow to 628 from 338 servers in numbers and nearly 53 percent of all installed data center servers [9]. The cloud computing established on the concept of IT resource

virtualization, it represents the next generation in the organizational delivery and accessibility of an extensive IT architecture comprising hardware and software that is delivered over the internet [10].

According to Mtebe, over 30 institutions across Africa have entered into partnerships include grants, technical support, consulting, and training with Google to use Google cloud services. These institutions include University of Pretoria (South Africa), University of Ibadan (Nigeria), University of Mauritius (Mauritius), and University of Ghana (Ghana), National University of Rwanda and the University of Nairobi, United States International University, the Kenyan Methodist University, and the Makerere University Business School (MUBS) [11].

Hence, Cloud technology can play a vital role in improving the quality of education by providing the educational content available to the student, teachers and the research scholar at the remote place and hence provide, "Equal Quality Education for All" [12]. In Addition, if resources including IT services are shared among learning institutions, then there is a better chance that such institutions can have a better concentration on research, as well as core academic activities. Therefore, the education system has witnessed gradual expansion thus transforming a learner centered system rather than teacher centered system [13].

According to Karim, examined in developing countries technology adoption has been explored to a limited degree particularly in relation to Cloud Computing in the tertiary education sector. The knowledge on the adoption factors can provide input to the institutions and governments as well as the providers in formulating a strategy for a better utilization of Cloud technology. Several factors have to be considered when institutions intend to adopt new technology before fully integrated. To make a correct decision, an institution has to consider those factors involved in the adoption of the cloud computing technology [14].

The long way it comes, the dynamic change it has, the specialization and transparent nature of its services and the relative advantage it has over the previous computing technologies has provided, cloud computing has attained the maturity level and position where it is now. However, the rate of adoption varies across various social and cultural boundaries, which are often neglected during the diffusion process. The multidimensional nature of technology adoption and innovation diffusion entails a difference in the rate of technology adoption, which can not only be attributed to economic and technological factors but also to socio cultural factors [15]. To transform the current working

environment to cloud computing environment, it needs to have a sound, comprehensive and agile adoption framework.

Generally during this study, literature review of technology and innovation adoption models and theories were carried out with the aim to understand the theoretical background of technology adoption in organizations & individual perspective. This also subsequently provides basis to design a framework that would serve as chassis for the factors for generic cloud computing adoption model. The resulting framework was heavily based on the Technological Organizational Environmental model (TOE), Technology Acceptance Model (TAM) and the Diffusion of Innovations models (DOI) and with added Decision Maker's Context which are models commonly used to explain technology adoption. Thus, research aims to fill gaps in order to provide a conceptual framework investigating the successful factors for cloud migration designed especially for higher education in Ethiopia.

1.2. Statement of the Problem

Every year, the numbers of students are increasing in universities and higher educational institutes for their regular study as well as for educational development. These students join universities as regular, weekend and evening students and sometime student join the institutes in summer programs, as far as Ethiopian Universities are concerned. But the infrastructures and facilities with the technology aspect (like the class rooms, laboratories and Libraries) are the same and stable from long time [16][17]. Thus, universities are facing some problems in providing necessary information technology (IT) support for educational, research and development activities. While usages of technologies are changing rapidly and even are required by the students for quality education. So, in this regard this sector is now demanding computational resources for which universities are lacked to provide needs of students, lectures and researchers in order to meet quality of education.

Despite the fact that the EHEIs have great contribution to the economic development of the country, their development regarding adoption of modern technologies is still slow. Even though the existence of modern technologies and the opportunities they bring to the economic development of the country is evident, the adoption of these new technologies is still poor. The use of cloud computing in developing countries, such as Ethiopia, is still in its early stages and has not been as widely adopted as in developed countries. In fact, moving a current system to the cloud depends on many factors that may affect the institution's decision to adopt the cloud. In order to encourage the adoption of cloud technology, it is essential to understand why some institutions are more prepared than others to move to the cloud. Hence, the aim of this research is to examine factors that might impact specifically on a

public EHEIs intention to adopt cloud computing. It integrates three influential technology adoption theories with adding construct and enhances understanding of the key factors influencing organizations' cloud computing adoption decisions in this context.

According to Brooks [18] , cloud technology is one of the top 10 strategic technologies in 2019 that will be the focus for higher educational institutions especially for Africa. Since different reports[19][20] shows the cloud technology importance, we have to make sure to study influential factors which should be considered by the organizations while adopting cloud computing because the adoption level of the technology is very low.

1.3. Research Question

Cloud computing has been recognized as the fastest rising area in Information Technology. In this research, we aim to gain comprehensive knowledge in area of cloud computing and its adoption in Ethiopian Higher Education Institutions. Some of the research questions are:

RQ1: Is the current Ethiopian Higher education ICT service delivery strategy efficient?

RQ2: Do we need to change the way we are currently deploying and using ICT in EHEIs?

RQ3: What factors should educational institution consider when adopting Cloud Computing?

1.4. Objectives

1.4.1. General Objective

This study explores key adoption issue regarding the Cloud Technology in Educational Sector in Ethiopia and provide recommendation decision framework.

1.4.2. Specific Objective

- ✓ Conduct literature review of related research works.
- ✓ Analyzing the technological, organizational and environmental and individual factors that affect decision making to adopt Cloud Computing in EHEIs.
- ✓ Identify factors that influence the adoption of cloud computing for EHEIs.
- ✓ Develop a predictive model as practical roadmap for a successful adoption of cloud computing in EHEIs.

1.5. Significance of the study

Cloud computing is considered more interesting and useful at the present time among the technological and educational communities, but its impact on higher education institutions is not explored especially

in Ethiopia that is one of the developing countries. This study will examine various factors that have affected adoption of Cloud Computing, identifies slower growth in EHEIs and also present how Cloud Computing is perceived and beneficial for students, teachers, IT director and other related professional in universities so as to increase the acceptance and promote the implementation of the technology.

This study is significant for the following reasons: Firstly, it helps fulfill EHEIs need for a deeper understanding of the factors that affect the adoption of cloud computing. Secondly, it will allows EHEIs to consider alternative ways of deploying ICT infrastructures for an efficient and effective teaching-learning and service delivery by considering factors in context of Ethiopia. Thirdly, from a theoretical perspective, it will examine cloud technology adoption at the organizational level and individual perspective. Fourthly, it provides a predictive model that enable the EHEIs decide to go for cloud technology. Lastly, this study is significant since it adds to the existing knowledge in this domain. Understanding and identifying the priorities of decision factors and attributes to adopt cloud computing systems is meaningful when organizations ultimately analyze the adoption processes of cloud computing for a firm's successful digital transformation.

1.6. Scope and Limitation of the Study

The main intent of the study is to examine the current ICT service delivery strategies to support EHEIs, to consider Cloud Computing in the field of education. Developing decision making framework for recommendation is baseline of this study for implementation of Cloud Computing in EHEIs. This study's scope is not proposing the implementation of cloud rather it's just providing recommendation system.

1.7. Organizational of Thesis

The study consists of five chapters as listed below.

Chapter one deals with introductory parts of the study which gives highlight about the thesis, which includes: background of the study, statement of the problem, research objectives, general and specific objectives, significance of the study and finally scope and limitation of the study.

Chapter Two deals with literature review related with cloud. It discusses characteristics of cloud computing, Cloud Computing Deployment Models, Cloud computing service/delivery Models, explain the theoretical framework based on existing models of technology adoption, benefit of cloud with respect to education were discussed and finally related works is presented and discussed.

Chapter Three explained a suitable and complete research methodology applied to carry out this research. To discuss the research design, this chapter describes the data collection method, sampling & the population size, evaluation and also the data interpretation & validation.

Chapter Four provides discussions about the finding of the research.

Lastly, chapter Five presents the conclusion and future work.

CHAPTER TWO
LITERATURE REVIEW

This chapter begins with a more in-depth, technical definition of the cloud computing model, explaining the core characteristics, cloud service models, and various deployment models.

2.1. Definition of Cloud Computing

Different researchers and experts in the Cloud computing industry and providers give their own definition for the term Cloud Computing.

The American National Institute of Standards and Technology (NIST), has developed a definition of Cloud Computing which is now accepted by all sectors of information technology. "*A model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g. networks, servers, storage, applications, and services) that can be provided quickly and released with minimal management effort or service provider interaction*" [21].

One of the most common academic definition described by Buyya [10] have characterized cloud computing as "a type of parallel and distributed system consisting of collection of interconnected and virtualized computers that are dynamically provisioned and presented as on or more unified computing resource based on Service-Level Agreements (SLAs) established through negotiation between service provider and customer.

As a working definition, Marston *et al*., 2010 encapsulation of cloud's technical attributes and business benefits, defining cloud computing as: "*It is an information technology service model where computing services (both hardware and software) are delivered on-demand to customers over a network in a self-service fashion, independent of device and location. The resources required to provide the requisite quality-of- service levels are shared, dynamically scalable rapidly provisioned, virtualized and released with minimal service provider interaction. Users pay for the service as an operating expense without incurring any significant initial capital expenditure, with the cloud services employing a metering system that divides the computing resource in appropriate blocks*" [22].

From an educational point of view, the cloud is a balance between control and economy of scale, offering a lower total cost of ownership model. "Cloud computing is attractive to small and medium-sized educational institutions [23].

The market research company's Gartner's defined the cloud computing as "a style of computing where massively scalable IT-enabled capabilities are delivered 'as a service' to external customers using Internet technologies"[24].

After a thorough review of existing Cloud Computing definitions and the computing paradigms, Cloud Computing can be defined in this dissertation as the following " Cloud is the combination of both applications delivered as services over the internet and data centers hardware and software and the users can use those services by on-demand service model and a "pay as you go" payment method where the users use the service when they need it and pay only for what they used of computing resources ,also users can access everything on the cloud by PC's, Laptops, Smart phone…".

2.2. Characteristics of Cloud Computing

The National Institution of standard and technology (NITS) provides key characteristics of cloud services [21].

On-demand self-service: End users can provision computing capabilities, such as server time and network storage, as needed automatically without requiring the involvement of human interaction with the service provider. This enables consumers to manage their resource consumption according to their own needs

Broad network access: Capabilities are available over the network and accessible through standard mechanisms that promote use by heterogeneous client platforms (smart phones, tablets, laptops, mobile devices and desktop computers). Cloud services are ubiquitous and can therefore be accessed using any device connected to the internet; the internet in this case serves as a service delivery mechanism.

Resource pooling: Computing resources are pooled to serve multiple end-users using multi-tenant model with different physical and virtual resources (storage, CPUs, memory, network bandwidth, and virtual machines) that are dynamically assigned based on demand.

Elasticity/ Scalability: Capabilities can be rapidly provisioned, to quickly scale as needed. This is a very vital feature of cloud computing as it enables cloud users to use and release resources based on need. This is enabled by the cloud's ability to automatically shrink and expand based on demand

Measured service: Resource use is automatically controlled and optimized through metering, and resource usage can be monitored, controlled, and reported, providing transparency for both the provider and end-user of the utilized service.

2.3. Cloud Computing Architecture

All Cloud computing is a set of IT services that are provided to a customer over a network on a leased basis and with the ability to scale up or down their service requirements.

2.3.1. Service/ Delivery Model of Cloud Computing

Cloud computing basically offers three types of service model which is called SPI model.

Software as a Service (SaaS): It is the highest level of cloud computing and the most important in education. SaaS provides consumers the capability to use software applications running on the provider's cloud infrastructure and can be accessed through any device through both thin client interface with Internet access and a web browser. The user does not manage or control the underlying cloud infrastructure including network, servers, operating systems, storage, or even individual application capabilities, with the possible exception of limited user specific application configuration settings. Data and applications are stored in the cloud and the users only require a web browser to access them. Examples are salesforce.com, Google Apps for Education, Microsoft One Drive, Microsoft Office 365 and Microsoft Live@edu which provide communication and office applications such as email and spreadsheets [21].

An advantage of a SaaS model is a lower licensing cost since its design principle is one to many i.e. same application is used by many clients in parallel yet maintaining the isolation of each client. Other advantages are such as lower operations and maintenance cost which are also taken care by a SaaS provider as its infrastructure is controlled and managed by the SaaS provider [25]. Hawassa University as an example during this study, it is in progress for going for the migration SaaS moving their email service to the Google cloud.

Platform as a Service (PaaS): Provides a development environment with capability for users to create and run their own custom-built applications using programming language, libraries, services and tools supported by the provider. The consumer does not manage or control the underlying cloud infrastructure including network, servers, operating systems, or storage, but has control over the deployed applications, freedom to build his own application and possibly configure settings for the application hosting environment on provider's infrastructure [21].

PaaS services address the need for a reliable, secure and scalable development environment that can be rapidly configured and deployed without extensive technical expertise. To meet manageability and scalability requirements of the applications, the providers offer a predefined combination of OS and application servers where it enables customers /developers to install and write their own applications using a platform specified by the service provider. An example here is the Windows Azure by Microsoft, Coghead, Pipes by Yahoo, and Dapper.net and Google Apps Engine. This level gives customers virtual servers to run existing applications, in addition new applications can be developed without the need for maintenance [26].

In addition, there is no need to manage infrastructure operations but to set proper rules for automatic load balance. Since PaaS has a design principle of one to many, an application can be configured by different customers from different locations. Security is a shared responsibility in PaaS between a cloud provider and a cloud consumer. Customers can rent scalable virtualized servers, attached services, and can easily scale the demands as per requirement. Costing model for PaaS could depend on multiple factors for example, number of I/O requests, storage usage in GB's, data transfer per GB [25].

Infrastructure as a Service (IaaS): It is known as base layer. Iaas provides consumer the capability to provision processing, storage, deployed application and limited control of select networking components (e.g., host firewalls) and other fundamental computing resources where the consumer is able to deploy and run arbitrary software, which can include operating systems and applications. Elastic Cloud Computing (EC2) from Amazon is an example of IaaS [21].

IaaS is the most wide scale service used amongst the three service models. IaaS provides virtual infrastructure (virtualized servers, networks, storage, and system software) as well as raw hardware for creating, managing and removing storage, virtual machines, and virtual network over the Internet in cloud provider's infrastructure. Most of IaaS providers have capabilities to provide virtual servers with different configurations for example; one or more CPUs for computing with standard RAM as well as can add more RAM later as per demand. Like other service models infrastructure resources scale up or down and are billed as per real usage only. Leading cloud providers have capability to connect a virtual network in a cloud to company's network through Virtual Private Network (VPN) and it appears as a scalable IT infra- structure to existing IT infrastructure [25].

2.3.2. Deployment Model

Cloud deployment models are divided into Private Cloud, Public Cloud, Hybrid Cloud and Community Cloud. Deploying each cloud model differ depending on the requirement and support that needs the service, the user of the cloud, environments availability and the intended access methods. Access permission or limitation is depends on the type of information, business processes and organization characteristics [21][27][28].

Private Cloud: Is provisioned for exclusive use by a single organization comprising multiple consumers (e.g., business units). It may be owned, managed, and operated by the organization, a third party, or some combination of them, and it may exist on or off premises. The main advantage of migrating in private cloud is added security providing full control over the data and quality of service. There by private cloud proves to be less risky.

Public Cloud: Is provisioned for open use by the general public. It may be owned, managed, and operated by a business, academic, or government organization, or some combination of them. It exists on the premises of the cloud provider and providing public cloud services and brings economy of scale in pooling datacenter resources, virtualization and on demand provisioning allows outsourcing enterprise IT infrastructure addresses disaster recovery problem suitable for small and medium-sized enterprises and agile companies. Less cost, scalability and availability are some of the benefits of public cloud.

Community Cloud: Is provisioned for exclusive use by a specific community of consumers from organizations that have shared concerns (e.g., mission, security requirements, policy, and compliance considerations). It may be owned, managed, and operated by one or more of the organizations in the community, a third party, or some combination of them, and the members of the community share access to the data and applications in the cloud and it may exist on or off premises. Community cloud is the most relevant for universities because of its efficiency and cost reduction, security and privacy, and the agility in terms of service delivery [29].

Hybrid Cloud: The cloud infrastructure is a composition of two or more distinct cloud infrastructures (private, community, or public) that remain unique entities, but are bound together by standardized or proprietary technology that enables data and application portability (e.g., cloud bursting for load balancing between clouds). A cloud user may choose to deploy cloud services processing sensitive data to a private cloud and other, less sensitive cloud services to a public cloud. It also combines benefits of

the controlled environment in private clouds and rapid elasticity of public clouds. Hybrid cloud will give us the ability to secure the institution's critical applications and data by hosting them on the private cloud or in house.

2.4. Cloud Computing and Education

Developing countries face so many cultural and infrastructural challenges which impact developmental project delivery and sustainability. Decision makers are often compelled to choose between technological advancements and other more pressing humanitarian requirements. Advances in information and communication technology (ICT) have changed the way businesses, organizations, academic institutions, and governmental agencies in developed and developing countries perform their operations [30].

The Higher educations in each society have big responsibilities for developing the country. The new higher educational models depend mainly on the rapid development in the information and communication technologies (ICTs), the emergence of the internet, and the evolving cloud computing trend for providing better educational services. It is well known that the development of information technology services in HEIs provided unprecedented improvement in the performance of the educational process.

The use of technology does not only help provide education in cost-efficient manner but also address concerns centered on quality of education. Technology plays an integral role in today's educational ecosystem. It has become medium and facilitator of interaction between learners, educators and the school administration. But, HEIs in developing countries operate under resources constrained environments that hinder effective delivery of their services. Without quality education, launching educational institutions by itself cannot give the solution we seek for economic development and poverty reduction. Education should be reinforced through up to date technologies and services which provides user to maintain and improve learning. The Ethiopian government has been investing millions of dollars every year to support higher education institutions with technology. Since Ethiopia is struggling economy, it is difficult for country to provide full ICT infrastructure requirements of all universities.

2.4.1. Higher Education in Ethiopia

Higher education is considered a great asset that positively contributes to the economic and social wellbeing of any society. The cooperation between universities, government and market, specialists and students has demonstrated their commitment to the change of society and the whole world economy. The increase in the number of students, the cost of educational services and the diverge needs of workforce put pressure on EHEIs to develop new educational models that meet the new society's needs. The Ethiopian government has recognized the importance of higher education as a major driver of economic competitiveness in the knowledge driven global economy and has recently tried a series of reforms in education systems in Ethiopia.

The government also recognized the importance of Information and Communication Technologies (ICTs) for the country's economic growth and social development and ICT in education is also expected major driver for the transformation of education so as to contribute for the economic success in the country. Higher Education Institutions (HEIS) are being built in very high speed. Currently in Ethiopia, there are around 42 government owned universities and many private colleges. Making the cloud for EHEIs will give the benefits such as reduces the cost of ICT and resources can share with other universities [1].

The Ministry of Education (MoE) developed a strategic roadmap to address the challenges and opportunities in leveraging the power of ICTs to improve the quality and delivery of general education. The education strategy recognizes ICTs as an enabler for widening access to education for the Ethiopian population, for supporting ICT literacy in education, and for facilitating the delivery of education and training at all levels. Accordingly, Ethiopian higher educations are organizing the ICT manpower, investing on ICT infrastructure and attempting to use ICT for education mainly in the area of course management system (Moodle or other Learning Management Systems), library automation (KOHA, ABCD or other library management systems), digital library (Greenstone, DSPACE etc…) and student management information systems [31]. The establishment of higher education forum by ministry of education (MoE) to exchange information and resources among universities is another important move which is helping universities to use ICT for education. Though the number of universities has increased over years, the use of ICT for education in most universities is still very low

2.4.2. ICT Service Delivery System

Information and Communication Technology (ICT) is an electronic means of capturing, processing, storing, communicating information. The use of ICT in the classroom teaching-learning is very

important for it provides opportunities for teachers and students to operate, store, manipulate, and retrieve information, encourage independent and active learning, and self-responsibility for learning such as distance learning, motivate teachers and students to continue using learning outside school hours plan and prepare lessons and design materials such as course content delivery and facilitate sharing of resources, expertise and advice. ICT has the capability not only of engaging students in instructional activities to increase their learning, but of helping them to solve complex problems to enhance their cognitive skills [32]. One of aim of EthERNet project was also to build capacity for the public universities share educational resources and research among institutions locally and globally in a three phased approach.

The Government of Ethiopia has placed importance on ICT for Education (ICT4E) for national development; both the national ICT4D 2010 Plan and ICT in Education Implementation Strategy recognize ICT as an enabler for widening access to education for the Ethiopian population and for facilitating educational delivery and training at all levels. The strategy is built on three main streams: Ethiopian National SchoolNet Initiative, the National ICTs in Higher Education Initiative and the National ICT Education, Training and Awareness Initiative [31]. In general, the Ethiopian Government has made the development of Information and communications technology one of its strategic plan priorities. The implementation huge ICT infrastructure is also an indication of universities interest in using ICT.

2.4.3. Benefits of Cloud Computing Technology for Higher Education Institutions

If cloud computing is implemented in higher education institution in Ethiopia, the following benefits can be utilized by the research and teaching community to increase the quality and needs of the students [33][34] [35]. Cloud computing is the future and survival tool of every data, business, network and everything access to it.

- ✓ The Cloud technology helps universities to keep pace with ever-growing resource requirements and energy costs.
- ✓ Desirable Costs: Using cloud it allows the cloud clients to avoid investing larger expenditure on the infrastructure like hardware and their up-gradation. It improves the cost efficiency of providing the choice and plan of utilizing the cloud services.
- ✓ Cloud Computing opens doors for the universities to collaborate with other universities and/or with business/industries around the world for research advancement and provides opportunity to use the latest software and hardware technologies without having to own them.

- ✓ Provides a new way of teaching-learning process, the concepts of on-demand learning helps students providing accessibility to learn anything, anytime anywhere and with Cloud technology students can easily manage their project and massive workloads and geographical distances will not be any hindrances in the education system.
- ✓ Personalized Learning: Cloud Services provide diversity in learning to students. A dynamic and effective learning enviroment is provided to students by exposing them to various resources and software tools.

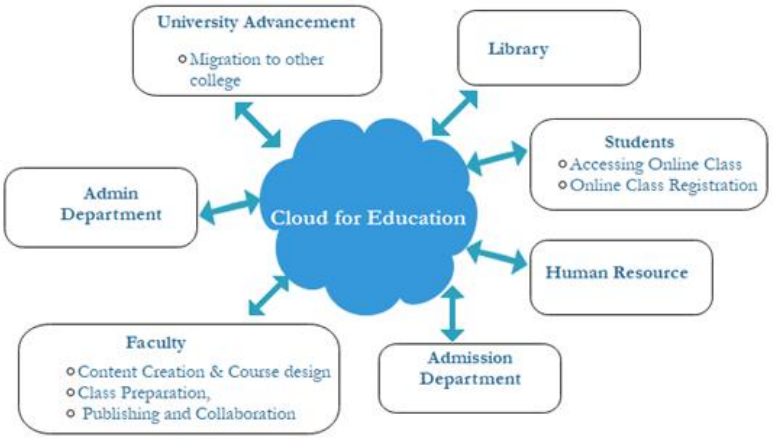


Figure 2-1: Cloud Computing for Higher Educational System [36]

✓ Economics: Need consistent software and hardware updates put a mandatory burden on the financial plan of the HEIs. In these circumstances Cloud Computing acts as the savior. The technology empowers educational institutions to go for the implementations of the new technologies and concentrate on improving the quality of education by providing them hardware, software and other resources on pay-per use basis.

✓ Lower environmental impact: In some countries there are now "green" targets for reductions in power usage by organizations. Cloud computing enables universities to reduce their electricity consumption and optimize power usage over a group of customers.

✓ Flexibility of Cloud computing allows Higher Educational Institutes (HEIs) to begin with small-scale services and grow up the services slowly without any extra expenditures. It also provides the HEIs with rapid development in regard of demand of teaching at peak time such as beginning of the academic year or exam periods.

2.5. Cloud Environment Roles

Overall NIST based reference model architecture represented by five levels where each entity has its own role with respect to the cloud service life cycle. All levels in whole playing a key role in preparation and defining the standards of cloud in terms of service usability, maintainability, operability, security etc. Each entity has its own role and interacting with other entities wherever required and follow standard governance model [37].

Cloud Provider: The provider supplies the cloud service available and owns the assets required producing and offer cloud services to the interested parties/consumer. In the private cloud, internal providers deliver services to internal consumers. In a public cloud, the provider is an external third party, and provides services to multiple consumers. Providers can also be part of a hybrid service delivery model, in which they supply both public and private cloud services, from different service types.

Cloud Consumers or Users: end user who is intended to use the cloud computing services from the cloud Provider.

Cloud Broker is an intermediary consultant or organization between cloud consumer and cloud provider to help cloud consumer to understand complexity, advantages and disadvantages of cloud computing and add value added to the decisions to the cloud consumers.

Cloud Carrier an intermediary that provides connectivity and transport of cloud services from cloud providers to cloud consumers.

Cloud Auditor is a party that can perform an independent assessment and evaluation of cloud service services provided by a cloud provider in terms of security controls, privacy impact, performance, etc.

2.6. Cloud Computing Challenges

Despite various benefits of cloud computing, there are some challenges and drawbacks. Based on the research result and other literature survey, indicated that security, privacy, infrastructure readiness, trusts, no roadmap exists, government support is less and no top management support/ decision makers having less knowledge are identified as challenges for the rapid adoption of technology by educational institutions.

Data Security and Privacy this issue has always been a major concern for users who had data stored in a third-party storage space. The academic institutes will keep worrying about their data confidentiality and privacy in cloud. This issue is also the most important concern of cloud users as they will not know exactly where their data are going to be stored and who would have the privilege to access it inside the cloud infrastructure, and how the safety and integrity of their data can be guaranteed. According to Sahandi et al. [38] suggests a number of security controls which includes identifying user's identities, roles and group access control policies, key certificate and two way authentications for authorize the valid users in the systems. The cloud vendors must support all the security mechanism in order to ensure protection of institutions data, storage that helps to omit the concerns they feel about the security issue. Deploying a hybrid cloud computing model, privacy and other security related issues can be avoided also, since critical and sensitive data could be owned by university members and responsible bodies.

Availability Internet bandwidth institutions to develop better enviroment of cloud computing, they need to develop their ICT infrastructure and have in place adequate internet connections, adequate bandwidth, and stable power supply. Cloud computing services are availed over the network and accessed through standard mechanisms that promote use by heterogeneous thin or thick client. Lack of electric power stability is also other factor.

Trust is very important that a strong reliable relationship is developed between service provider of Cloud and its customers. Many researchers highlight the significance of trustworthy relation between the service provider and consumer when adopting cloud computing. The result of the questionnaire also shows that respondent agree trust has to be exist before adopting the cloud technology.

Lack of regulatory, governance and compliance policies can make institutions feel unwilling to adopt cloud computing due to the lack of regulations governing data ownership.

2.7. Leading Cloud Provider

Cloud providers are companies that serve infrastructure, platforms, and/or software over a network. These services are usually bundled into clouds, which are pools of virtual resources orchestrated by management and automation software. So they can be accessed by user on-demand through self-service portals supported by automatic scaling and dynamic resource allocation. Using a cloud provider is a helpful way to provide computing services.

Cloud computing providers deliver IT resources to their consumers on basis of pay as you go model as a means of communication through internet. With this technology consumers can access resources directly through the internet, from anywhere any time without any technical or physical concerns. It is also a viable solution for institutions that do not have adequate computing resources and this can be facilitated by existence of Cloud Service Providers (CSPs) who provide cloud services for free or at discounted rates to educational institutions such as: Google, IBM, and Microsoft. They have special packages aimed at providing institutions with access to ICT infrastructure, can easily store and share their data, software, platforms, and other educational services hosted in their clouds [39].

The potential and efficiency of using cloud computing in higher education has been recognized by many institution from UK, US and also in developing countries. As a result, several institutions have started adopting various cloud services to reduce ICT investment costs as well as making teaching and learning more efficient. The Cloud computing offers a subscription based services in a pay-as-you-go model which are popularly referred as Infrastructure as a Service (IaaS), platform as a Service (PaaS), and Software as Services (SaaS) and provides other essential features to customers. It is the benefit of using cloud that, we don't have to pay dedicated software license fee as well as no need to arrange compatible hardware for that, So, adopting cloud services will allow EHEIs to shift costs from capital expenses to operational expenses or from fixed to variable [40].

The global penetration of the Internet, along with the affordability of Internet devices (laptops, tablets, smart phones, sensors, gaming consoles), formed the need for IT mobility that led to the emergence of Cloud. In this context at an incredible rate cloud environments transform and revolutionize the way individuals, business and government are managing their services and their data accelerating innovation, improving time-to-market and offering added flexibility. A large number of applications from various domains including file hosting, social networking, office applications, business applications, games and numerous others have been ported from desktops or servers to cloud infrastructures. This provides clear benefits to users, who are released from the burden to install, configure and maintain applications, as well as hosting hardware, while the services itself, can be interconnected using heterogeneous interfaces and platforms [41].

Cloud computing attracts considerable coverage and attention from certification providers and companies that offer cloud related products. According to Forbes article on cloud computing forecasts 2019 [42], summarizes key statistics regarding the current cloud computing landscape and also includes a look to the future. Amazon Web Services (AWS) is the dominant cloud computing player and

achieved an incredible 43 percent year-over-year growth. AWS is followed closely by Microsoft Azure and the Google Cloud Platform. By utilizing Saas, huge vendors like Microsoft, IBM, Oracle and amazon offers different instructive programming and applications in less cost.

2.8. Theoretical Foundation

Adoption of innovation has been the subject of many research studies in areas of medicine, computing, and management science. Many different models and theories try to explain the factors that influence the adoption of new technologies. There are two main types of theories that explain technology adoption: one type that works at the individual level and another that works at the firm level. Theories at the individual level describe the ways in which individuals approach technology, why they adopt it or reject it, and when or in what circumstances. This model of technology adoption shows that adoption is influenced by personal beliefs, attitudes, and intentions and a variety of well-known theories exist to explain the ways in which individuals interact with technology. The theories that work at the individual level comprise the technology acceptance model (TAM), the theory of planned behavior (TPB), and unified theory of acceptance and use of technology (UTAUT). The theories that work at the firm level include the DOI and the TOE framework [43].

Technology adoption helps to drive economic growth and sustainable development within communities. However, the rate of adoption varies across various social and cultural boundaries, which are often neglected during the diffusion process. The multidimensional nature of technology adoption and innovation diffusion entails a difference in the rate of technology adoption, which cannot only be attributed to economic and technological factors but also to socio-cultural factors. Innovation diffusion and adoption must take into consideration with existing social and cultural conditions of the adopters, which can impact the eventual success or failure of the technology adoption process [15].

The purpose of this study is to understand the determinants of cloud adoption in EHEIs. Though worldwide research applicable to EHEIs to at least some extend, research regarding adoption of cloud computing technology is not fully generalizable to the corporate enviroment since there exist cultural values are different all over the world. Therefore, the study investigates whether the determinants of cloud adoption vary across countries. For this purpose, we develop a research model that synthesizes the theoretical perspectives of the diffusion of innovation (DOI) theory (Rogers, 2003), the technology organization environment (TOE) framework (Tornatzky & Fleischer, 1990), TAM(Fred D Davis, 1989) and Decision Maker's Context (Thong, 1999)[44] .

The TOE framework was proposed in 1900 by Tornatzky and Fleischer, to analyze the adoption of new IT technologies at an organizational level. This framework investigated the impact of three factors (Technology, Organization and Environment) on the organization's decision to adopt a new technology. The technology aspect describes the effect of internal and external technologies of the firm which includes the availability and characteristics of the technology and how adopting new technology can influence the firm. Internal technologies are those that are already in use at the firm, while external are those available in the market place and not using by the organization. The organizational context refers to different measures of the organization. For example, Firm size, scope and complexity of managerial structure. These measures have a significant impact on the adoption decision. Lastly, the environmental context is the field where an organization runs its business; the industry, competitors and government regulation define the environmental context (Tornatzky and Fleischer 1990) [45]. Figure 2-2 shows graphical representation of the TOE model.

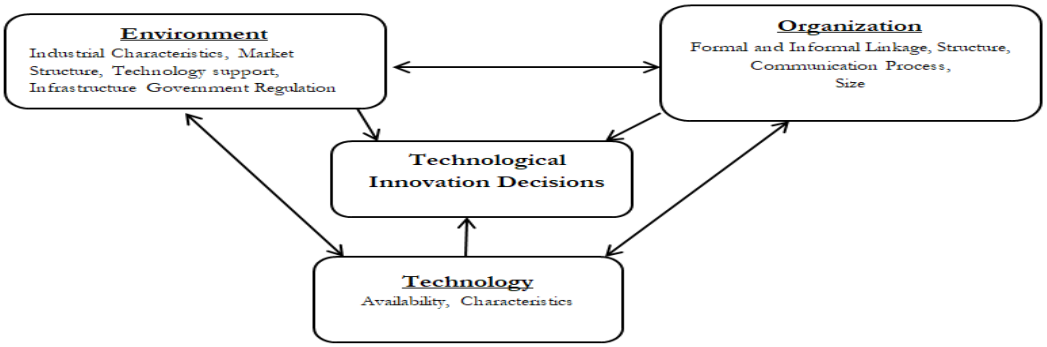


Figure 2-2: TOE Framework (Tornatzky and Fleischer, 1990)

In this model the factors that affect the adoption of the new technologies have been grouped into three categories. The first one is characteristic of the organization itself like the size and structure, the second one is environment which is the factors outside the organization like the industrial characteristics, market structure, the last group the factors related to the technology that will be adopted like the availability and characteristics.

According to Baker, technologies that are currently in use by the firm and technologies which are in the market but not in use by the firm influence the adoption decision. Technologies that are currently in use by the firm influence the adoption decision, because they define the scope and limit of the technological change that the firm can accept. On the other hand the technologies that are in the market but not in use by the firm influence the adoption decision, because they indicate how firms can evolve by adopting new technologies [45].

The DOI was proposed by Rogers in 1995. It is one of the most commonly used theories that try to explain and predict the adoption of innovations. Majority of these theories explain and predict the adoption decision, predominantly based on the characteristics of the technology and the users' perceptions of the innovation. Rogers proposed five attributes that explain the adoption of innovation These are Relative Advantage (RA), Compatibility (COMP), Complexity, Trial-ability (TB) and Observe-ability [46]. DOI theory has valuable insights in adoption of innovations as it categorizes organizations' adoptions styles (innovators, early adopters, early majority, late majority, laggards and leap froggers) and organizations' type of decision (optional innovation decision, collective innovation decision and authority innovation decision). Those factors make it an exceptionally good model for predicting technology adoption. Rogers identified five stages of innovation adoption: knowledge, persuasion, decision, implementation and confirmation. In this process a decision-making unit goes from obtaining the necessary knowledge of an innovation, building the attitude toward the new idea, adopting or rejecting the decision toward the innovation, implementing it, implement decision and go through the final stage of confirmation in which to seek information and affirm decision. This process is also influenced by cultural differences [46].

The external and internal organizational features of DOI theory are same as identified organization context in TOE framework. Since DOI concern is more on technology related constructs, it lacks some crucial feature pointed as a drawback like the enviroment aspect. However in order to overcome the issue with DOI, TOE framework is able to provide an extensive perspective to fully comprehend IT adoption through considering three different contexts, technology; organization; and environment. Therefore, these two theories complement each other implicitly to help better understanding the adoption process of firm towards IT [46].

While the TOE framework and DOI theory complement each other, the theories which explain individual technology adoption should not be discarded. TAM is a widely accepted model for understanding IT adoption and usage processes. It predicts a user's acceptance of IT and its usage on the job performance [44]. Two main variables are used for this study to be the main determinants of the attitude towards the acceptance of the new technology perceived usefulness (PU) and perceived ease of use (PEOU). PU is defined as 'the degree to which a person believes that his/her job performance would be enhanced by using a particular technology" and PEOU refers to 'the degree to which the prospective user expects the target system to be free of effort'. The model also suggests that perceived ease of use influences perceived usefulness, because technologies that are easy to use can be

more useful. The perceived usefulness can be a function of the learning value in terms of up gradation of technological knowledge of the user owing to the adoption of the new technology.

Claims were pointing out that there is a lack of integration and a lack of understanding of the linkages between individual and organizational adoption of IT. Thong recognized this by adding the characteristics of the decision makers to his proposed adoption model in addition to the technological, organizational and environmental characteristics [47]. Thong's model distinguished decision-maker characteristics from the organizational characteristics. This context has been classified as decision-maker context. Thong believes that the IT adoption depends largely on both of the decision makers' feelings and functions that reflect the attitudes, motivations, and perceptions towards innovation adoption. Decision-makers are responsible for making the most critical decisions. Therefore, in agreement with the significant role played by the decision maker, this study adds the Decision-maker context as a fifth dimension besides. In Addition to Thong, Jha & Bose explained also individual factors are the very important in determining if adopting an innovation would be successful. Furthermore, excluding individual factors leads to unbalanced and atomistic theories; therefore, research from an organizational perspective should be complemented with research from the individual perspective [48] .

Combining concepts from different models provides increased ability to improve the understanding of the adoption of new technologies and innovations. Integrating models with one another offers a large number of constructs and provides a richer theoretical base for understanding the adoption behavior. Thus, this study will integrate the Technology Acceptance Model (TAM), Technology Organizational and Enviroment model (TOE) and Diffusion of Innovation (DOI) taken as models and forms into new model for analyzing the need of cloud in the EHEIs. This is because those models complement each other in terms of that including the knowledge of innovation characteristics [49]. Specifically, they explain the inter-organizational level. A set of factors that influence the adoption of technology both at the organization and individual level will be identified with respect to the Public EHEIs.

2.8.1. Reason for choosing DOI, TAM, TOE and Decision Maker's Theory

- ✓ DOI is one of the most commonly used theories that try to explain the adoption decision, based on factors that are related to the technology itself (such the characteristics of the technology, or users' perception about the technology).

- ✓ It is helpful in analyzing the different factors which can ease or impede the adoption of technology. These attributes are helpful in understanding the prospects of an organization adopting or rejecting innovation.
- ✓ Cultural issues are also considered on DOI. The rate at which new technologies and ideas are transferred from one culture to another and how and why they are used individually and cumulatively can be understood in terms of the theory of DOI.
- ✓ As discussed on the previous section, technology related constructs are not the only factors that influence the adoption of technologies. There are non-technological aspects such as environmental factors, which are not taken into account in DOI. Technology Organization Environment (TOE) is another theoretical framework that overcomes this drawback.
- ✓ TAM is a widely accepted model for understanding IT adoption and usage processes.

According to Olivirea and Martins in [43], combining different theories help us achieve a better understanding of technology adoption. Therefore, the conceptual adoption framework (TOETAD) that is being proposed in this study adapts selected elements from TAM, DOI, TOE and Decision Maker Context. Accordingly, the affecting factors about this adoption should be clearly discovered, discussed and understood before taking the adoption decision. A strategic mechanism should be held and a migration strategy into the new cloud computing adoption technology must be completely investigated in order to welcome a good decision making when steeping towards cloud computing adoption in EHEIs.

2.8.2. Conceptual Development

Based on the findings of the literature accessed, the selection of variables will be made and examined for cloud computing adoption within the context of EHEIs. Review of factors affecting the adoption of technology in the previous studies independent and dependent variables were examined as factors in light of IS theories to enrich the understanding of how new technologies will be adopted.

The proposed conceptual model will subsequently be used as the basis for a general understanding of the adoption of cloud computing in EHEIs context.

In order to develop this integrated Conceptual framework, factors of cloud computing adoption are categorized into six groups: Individual, Technology, Organization, Environment, Innovative and Decision Maker's Context. Figure 2.3 shows each of the context represented the theoretical foundation shown below.

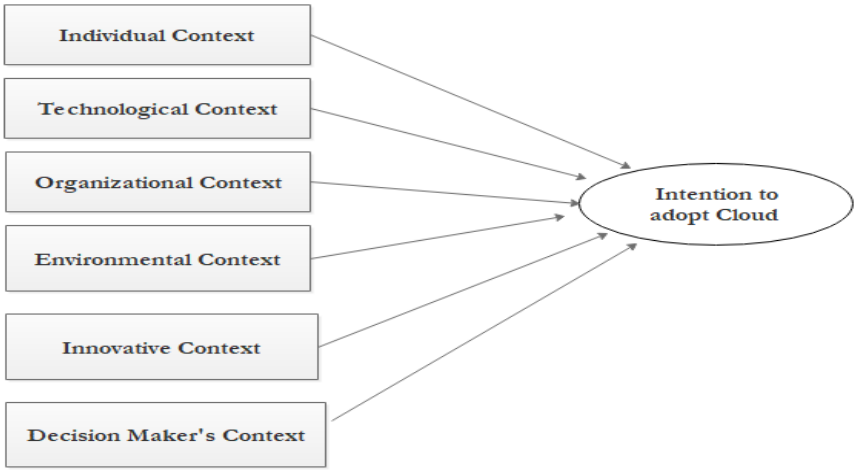


Figure 2-3: Integrated Conceptual Framework (TOETAD) [44][45][46][47]

2.9. Related Work

Related research work done in area of cloud computing in foreign countries is discussed below:

The study done by Makoza [2] aims to investigate how context of Higher Education Institutions (HEIs) would be affected in the dimensions of Technology, Organization and Enviroment. This research use Technology, Organization and Enviroment (TOE) model used as theoretical lens. The study was carried out in Malawi and used a case study approach supported by both the qualitative and quantitative method to collect data on factors that would influence on the adoption of the cloud technology. Purposeful sampling was used to select the respondents for the study. The finding of the study suggest that factors such as top management support awareness level, potential security risks and inadequate legal framework concern determined as challenge for the HEIs when adopting the cloud computing. The study is not able to address the individual perspective.

Chormale *et al.* [50] conducted an empirical study based on technology organization environment (TOE) framework, within a Maharashtra state of India targeting higher education institutions. Their objective of the study was to explore the factors affecting the cloud computing adoption in higher education institutions. A questionnaire-based survey was used to collect data from 41 Universities operating in Maharashtra. Relevant hypotheses were derived and tested by structural equation

modeling. The findings revealed that Relative advantage, complexity and data concern were the most significant factors. The research offered education institutions and cloud computing service providers with better understanding of factors affecting the adoption of cloud computing. The researcher used less construct to develop the framework so that, the study will not able us to figure/explore the factors affecting the cloud adoption.

Harfoushi *et al.* [51] aimed to evaluate how Technological, Organizational and Environmental factors influence the cloud computing adoption decision to the hospitals in Jordan. A questionnaire-based survey were distributed to the IT departments of 47 hospitals belonging to the Jordanian health sector to evaluate their ability and willingness to adopt and deploy cloud computing. Relevant hypotheses were derived and tested using multiple regression analysis in order to determine whether Technology, Organizational, and Environmental factors (TOE) played a role in hospitals' decision to consider cloud computing as a beneficial investment. The findings revealed that that all the three factors had a significant positive impact on the intention of hospitals to adopt cloud computing, with the Technological factor having the most impact on the decision made. The research contributes to the ICT managers as well as providers to develop plans for cloud computing adoption.

The researches mentioned above uses only one model which loses to measure the influential factor and less to provide theoretical bases for the understanding of adoption of cloud for the respective context.

The authors Adrees *et al.* [52] conducted a research to determine the impact of the cloud computing implementation in Sudan Higher Education Institution. The SWOT analysis metrics (Strengths, Weaknesses, Opportunities and Threats) put forward in understanding and evaluating the cloud computing adoption in higher education context, Republic of Sudan as model from the perspective of directors, teachers and student. The outcome of the research indicated flexibility, efficiency, and the ability to acquiring knowledge as an advantage to adopt the cloud technology and also finds drawbacks in the implementation of cloud computing such as privacy and security issues. The conclusion of the study showed that Cloud Computing as an exciting development which is significant alternative in today's educational perspective to compute with each other and with global institution and give a solution to benefit from the opportunities, and to overcome the threats. The study only focus on the benefit and drawback on the cloud computing.

In case of Ethiopia there are a few researches on the area of cloud computing but most of the current research focused on implementation of cloud in different areas; they are not directly related to the Cloud computing adoption in the Higher Education Institutions.

The study conducted by Alemayehu [53] proposed hybrid cloud computing model for Ethiopian Banking sector. The study states advantages of cloud computing for banking sectors and their limitation of ICT usage and find an alternative solution for the usage of IT to deliver a scalable, efficient and flexible IT services, to reduce IT investment cost and management complexity for the sector.

The study done by Selamawit [54] explore the internal and external factors that have influenced IT executives and expert's decision on the adoption of cloud computing focusing on the Ethiopian banking sector.

The research work done by Sangheethaa *et al.* [17] proposed an academic cloud framework for adapting e-learning using cloud computing and states the advantage of e-learning. The framework addressed to manage effectively the technological needs of university to better utilize of their infrastructure such as providing development platform for student, storage of data and delivery of software & computing. The proposed framework has six layers, and each layer specifies essential components needed to construct an academic cloud in a university.

The research work of Alkindi [55] stated the advantages of cloud computing for academic institutions for teaching and learning enviroment and service delivery, shows the limitations of current IT utilization in Sultanate of Oman Higher Education institutions. Also proposes alternative solutions Higher Education Hybrid Cloud (HEHC) as a framework to solve the current IT utilizations limitations and to enable the service delivery to be more of efficient and effective in Sultanate of Oman Higher Education institutions. The proposed framework consists of four layers (user Interface, SaaS, PaaS and Iaas). The proposed HEHC framework facilitates innovative teaching pedagogies, enable more effective knowledge transfer and encourage lifelong learning. It also facilitates e-learning, knowledge transfer from academics and affords more teaching learning methodologies like improvement in course contents and providing lecture notes, presentations and assignments in digital form via the Web.

The study done by Fasil [56] proposed Cloud Readiness Assessment Framework and expert system that assesses cloud readiness and recommend which cloud deployment and service model to, use TAM, DOI and TOE as a conceptual framework to build the model.

El-Alfi *et al.* [57] proposed a cloud based Learning Management System (LCMS) architecture. The aim of the paper was to promote adopting cloud-based, multi-platform E-learning solution to help educational institutes especially, which were under budget to manage their E-learning content in an efficient, cost effective way. The main components of the proposed cloud-based LCMS were: automated authoring applications, learning object repository, administrative application, and dynamic delivery. To evaluate the proposed system, the researchers' used heuristic evaluation checklist was developed. Depending on a heuristic evaluation checklist, the proposed system was evaluated by a group of computer and information technology teachers. Based on evaluators' responses, the system achieved 92.4% of usability and efficacy, so it has been highly recommended, since it showed a high level of availability, accessibility, and cost effectiveness.

Almubarak in his study [58] combined the TOE (Technological, Organizational, and Environmental), Diffusion of Innovation (DOI) theory, and Decision maker context model to evaluate the adoption of Cloud and investigate the factors that impact the adoption with in the Saudi hospitals. The objective of the study were to identify factors that affect the adoption of cloud computing and to develop a new framework for Saudi university hospitals. A questionnaire based survey and semi structured interview was used to collect data from 4 university hospitals located in Saudi, Riyadh city. Among the ten factors examined, the study determined the five most significant factors that influenced the adoption of cloud computing. The finding revealed in sequence that Relative advantage, Decision-maker's innovativeness, Decision-maker's knowledge in IT, Compatibility, and Top management support have significant effect on the adoption of cloud technology. Moreover, among the four different contexts, the most important context is the Decision-maker context, followed by the Technological context, then the Organizational context, and finally the Environmental context. The results obtained are beneficial for hospitals to guide them to make better decisions regarding cloud computing adoption.

Similarly, Singh and his co-worker's in their paper [59] proposed COTED framework (Cost, Organizational, Technological, Environment and Decision maker) to investigate the integrated factor that impact in the adoption of cloud technology in the banking sector. The paper provides an overview of the cloud computing technology and detailed explanations of the benefit and challenges for the industry. Relevant hypotheses were derived and tested using SPSS tool. The finding revealed that

technological factors were the most influential factor during the cloud adoption for the banking industry. The proposed model lacks the individual perspective.

The study conducted by Noor [60] provides some basic knowledge about Cloud Computing, intends to gain and see what is happening in Saudi Arabia universities towards the technology acceptance and adoption of cloud computing. The researcher proposed a two-dimensional research model namely motivators and inhibitors to examine the usage and the adoption of Cloud computing technology in Saudi Arabia. A wide-ranging statistical analysis was conducted on data collected from more than 300 participants from 5 different universities in Saudi Arabia. The finding revealed those two highest motivators and five inhibitors for using Cloud computing from the perspective of Saudi Cloud consumers. Those are ubiquitous network access and on demand (self-service) and availability, reliability, security, compliance & privacy respectively.

The researcher Awosan [61] evaluate factors affecting the adoption of cloud computing in Nigeria mainly aimed to investigate the perception of employees in IT and Telecommunication companies and user of device that support the cloud technology, current state of the cloud and identifying the motivating factors. The research methodology consisted of both the qualitative and quantitative approach targeted 15 different IT and Telecommunication companies located in Nigeria. The result pointed out 3 significant factors; poor awareness of cloud technology, unstable power supply and high cost of internet bandwidth & unreliability internet service. The study also pointed out Software as a Service (SaaS) is the most used cloud service, increased focus on primary services, collaboration, easy access of data and provision of basic infrastructures were identified as the motivating factors for cloud computing adoption in Nigeria.

Author	Title	Adoption Model/	Methods/ Methodology	Finding
Makoza 2016 [2]	Cloud computing adoption in Higher Education Institutions of Malawi: An exploratory study	TOE	Explanatory Approach Thematic analysis used for qualitative data	Top management awareness level, Inadequate legal framework and Security issue determined as a challenge for HEIs in Malawi.
El-Alfi *et al. (*2016) [62]	Adopting Cloud Computing Technology to Enhance the Architecture of a Proposed Learning Content Management System.	-	Proposed a cloud based Learning Management System (LCMS)	A cloud-based LCMS was developed, help educational institutes and teachers to manage E-learning content effectively and costless.
Changchita et al.	Cloud Computing: An Examination of Factors Impacting Users' Adoption	Integrate TAM and Proposed construct	Statistical Analysis (Multiple regression)	Examined four factors that played important role in user's decision making process for the adoption of the cloud computing technology.
Noor [60]	Usage and Technology Acceptance of Cloud Computing in Saudi Arabian Universities	Propose two dimensional model namely called Motivator and inhibitor	Statistical Analysis	Two highest motivators factors are ubiquitous network access and on demand (self-service) while the highest 5 inhibitors are availability, reliability, security, compliance, and privacy respectively.

Almubarak [63]	Factors Influencing the Adoption of Cloud Computing by Saudi University Hospitals	Integrates TOE,DOI and Decision maker context	Use both qualitative and quantitative methods.	Determines the five most significant factors influencing the adoption of cloud computing in Saudi university hospitals, which are in sequence: Relative advantage, Decision-maker's innovativeness Decision maker's knowledge in IT, Compatibility, and Top management support.
Alkindi et al. [55]	A Conceptual Architectural Framework of Cloud Computing for Higher Educational Institutions in the Sultanate of Oman		Use Design Science	Propose higher Education Hybrid Cloud Framework
Adrees et al. [52]	Cloud Computing Adoption in the Higher Education (Sudan as a model): A SWOT Analysis	SWOT analysis	Deductive approach	Suggests measures values in order to increase the acceptance and to overcome threats & to take advantage of opportunities.

Table 2-1: Summary of Related Work

So as we can see from above researches on cloud computing adoption is minimal especially in context of Ethiopian Higher Education Institutions. This needs urgent attention because essential factors that to be first considered in determining the success of adoption. Therefore, in this study a new conceptual framework is developed to get enhanced understanding of cloud adoption in EHEIs. The framework is grounded by 4 theories which make it unique from related work. i.e. Individual, Technological, Organizational, Environmental and Decision Maker context. The framework is integrated and developed with its own variables that are identified as suitable for the cloud adoption in EHEIs.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1. Overview

Methodology is defined as the steps and procedures that one follows to achieve the objectives and research questions of a certain study. This chapter intends to explain the choice of method used to answer the proposed research questions, determining design strategy for the study including a conceptual framework and designing the sample population as well as data analysis methods employed in this study. In terms of regional boundary scope, this study focuses on the Public EHEIs.

3.2. Research Design

A research design is a plan, structure and strategy of investigation conceived as to obtain answers to research questions or problems. It is the conceptual structure within which research is conducted and constitute the blueprint for the collection, measurement and analysis of data [64]. Research design articulates what type of data is required, what techniques of data collection will be used and how the data will be analyzed [65]. Both data and methods, and the way in which these will be configured in the research, need to be the most effective in producing the answers to the research. As stated by Babbie, exploratory research is useful in situations where the researcher is aiming to obtain a better understanding of the situation and achieve new insights into it [66].

Therefore, due to its characteristics this study used is Exploratory Research. Explorative research is aligned with our research since the intention of our research is to investigate the factors of cloud computing in EHEIs and then gain enough information to propose conceptual framework for adopting cloud computing.

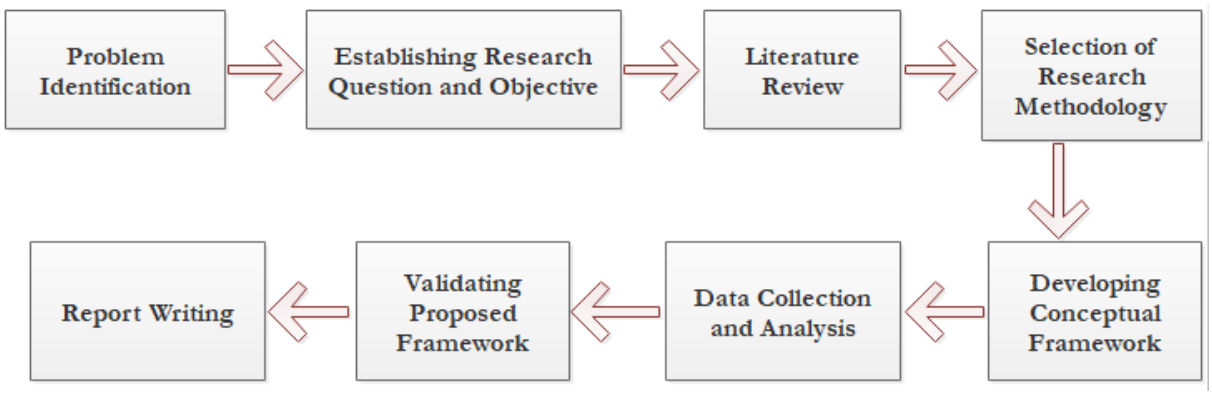


Figure 3-1: Research Design Steps

3.3. Research Method

Qualitative approach is more concerned with data that cannot be measured, such as people's opinions, descriptions or observations. The method regularly uses close-ended questions, where the participant has to choose from specific selections and the participants are not allowed to describe their answers.

Since the nature of our research is explorative, the qualitative data collection method is the best option for us to collect the required data and information in order to draw the best results. The required data for our research gathered via studying the literature review, observing the facts and the current on-going events or by questionnaire & interviews.

Therefore, the requirements this study is, developing the knowledge base about the state of the problem and current solutions to identify the requirements by reviewing extensive related literature; the knowledge of theory that brought to accept in a solution by designing a conceptual decision making framework for the usage of cloud computing using three innovation technology adoption theories and adds decision maker's knowledge construct to propose and has been centered on the identifying existing core variables. Thus, it has been used to create the research model to understand which of them is the most dominant for the context of EHEIs. Hence, integrated conceptual adoption framework (TOETAD) is developed with direct relationships of those core variables. To further quantify, a detailed online questionnaires were set up using Google survey, used to gather the formal data (primary data) and sent via their e-mails for the selected populations (IT managers, lecturers and E-Learning coordinators, students, researchers and decision makers).

3.4. Data Source and Sampling Method

3.4.1. Method of Data Collection

Primary Data Source

The primary data defined as the data collected firsthand for subsequent analysis to find solutions to the research problem. Different persons including students, researchers, developers and ICT directors from different higher education institutions are interviewed for better understanding of the current ICT utilization strategy, effectiveness and efficiency of service delivery and their recommendations for better service delivery are covered by the interview. The online questionnaires were designed and sent out to the potential responders using Google form of survey as a link through their emails which is used as primary source data. The questionnaires will enable to determine the awareness level of about cloud computing and the understanding of cloud computing, cloud computing adoption, issues about cloud computing and factors to be considered in the EHEIs context.

Secondary Data Source

The secondary data refers to the information gathered by someone other than the researcher conducting the current study. secondary data are collected from subject related previous reports, published articles related to the subject, books, academic journals, periodicals websites and electronic versions that have relevance with research topics. This helps the researcher in order to have detailed understanding regarding research area and what has already been done.

3.4.2. Sampling Participants

In this study purposive sampling is taken, which means that the best suitable respondents are chosen from different EHEIs in order to get a deeper insight and better understanding into the factors that influence the decision to adopt cloud. Since in purposive sampling participant are selected based on their special perspective, experience and characteristics; questionnaires are distributed for the selected populations and the criteria to select the universities establishment year/Generation by categorizing them in to first, second and third generation. Among 42 universities exists, a sample of 41% in numbers expressed 17 universities were selected. The data is collected from the purposive sampling by providing questionnaire for 123 participant attached in annex 2.

Table 3-1: Sample Population

Year of Establishment	Name of Institutions	Total Number of selected Institution
1st generation	AAU, Hawassa ,Harmaya, Bahirdar, Gondor, Mekelle	6
2nd generation	Dilla, Wollo, Debremarkos, Debrebirhan, Wolaiyeta	5
3rd generation	ASTU, Madawalabu, Samara, Wolkite, Raya, Wachamo	6
	Total Number	**17**

3.5. Method of Data Analysis Techniques

In this study the analysis is made based on two components. First, data collected from literature review conducted in related works and second one is questionnaire survey. Consequently, by analyzing this two this study presents a requirement to construct the proposed framework. Lastly the proposed conceptual framework validated and evaluated by expertise.

3.5.1. Expert Evaluation Design and Analysis

This study uses a semi-structured interview to design the interview, which included both open and closed questions. The interviews were conducted between April 20 and April 28, 2019 and responses were obtained from IT specialists working within the educational sector. The objectives and concepts of the study briefly explain for interviewees and each respondent is interviewed individually by the researcher. Interview questions are prepared by adapting others work from various literatures and modifying for the specified case. In order to review the proposed framework of this research within EHEIs context, 12 IT experts working in Hawassa and Addis Ababa Universities recruited to provide their feedback. The expert team comprised of five senior software engineers, four senior security and network IT expert, three computer science researchers. A pilot session to test the interview questions was carried out with five people; three were IT security experts from security group and two were computer science researchers. The expert evaluation questionnaire is available in annex 1.

3.5.2. Questionnaire Design and Analysis

The online questionnaires were designed and sent out to the 123 potential responders using Google form of survey as a link through their emails. 108 responses were received during the period of March 13 to March 23, 2019. Although 108 were returned completed, only 103 respondents accepted for this study because of contradicting responses. Therefore, the questionnaire response rate was 83.7%. A pilot survey conducted with three IT security practitioners drawn from the network & security department and two from computer science researchers. All the online collected data was converted to Statistical Package for the Social Sciences (SPSS) format for analysis. The questionnaire was coded within SPSS version 25. In SPSS, each question in the questionnaire was typed as a variable with coding options where applicable.

The survey has three main parts. The first part is about respondent's demographics data which includes: name of institutions, educational level, stream and major of their study, years of experience. The second parts related to understanding of the current ICT utilization strategy, effectiveness and efficiency of service delivery, respondent knowledge and perception about cloud technology, current usage of the cloud, knowledge and idea about cloud computing technology and its services, current level of cloud computing deployment and type of delivery within the organization, challenges & issues and benefit towards cloud. The third parts of questionnaire designed based on Likert response scale. Responses to factors need to be considered towards adoption of cloud computing technologies in context EHEIs statements are based on a five-point Likert scale coded from 1 to 5, with 1 representing 'Most Irrelevant, and 5 representing 'Most Relevant'.

3.6. Validity and Reliability of the Research

Reliability refers to the degree to which a research instrument produces consistent results. While validity refers to how accurate an instrument is at measuring what it is trying to measure. So, in this study in order to ensure reliability, internal consistency approach was used to check for consistency in the data using different questions to measure the same characteristic, such as using rating scale statement, correcting inconsistent wording and spelling errors, adjust technical vocabulary were checked and adjusted, designing the question sequence and overall questionnaire layout. To ensure validity, the questionnaires were designed based on the integrated model to examine the casual relationship between the surveyed variable and their respective construct indicated by the conceptual framework through the selected population.

Summary of the Methodology

This study conducts exploratory research design to collect critical information. With the exploratory design, various sources of information examined relating to the research problem and to meet the research objectives. In order to answer the research questions and to meet the research objectives, this study primarily use qualitative in nature because of its nature to provide an in-depth understanding of the research problem. Benefits and risks have subsequently created a dilemma for organization on how to approach cloud adoption. Through it qualitative nature, it creates to identify factors to be consider EHEIs while adopting cloud technology. This study aims to fill this research gap by proposing a conceptual framework for institutions and identify factors which to be considered when adopting cloud computing.

Furthermore, the researcher adopted the Mean Opinion Score (MOS) method for the data analysis, which is uses to validate the proposed framework.

CHAPTER FOUR
DATA ANALYSIS AND DISCUSSION

4.1. Overview

This chapter provides an analysis of survey response data, findings and discussion of the result. As discussed in the previous chapter, data is collected by using different techniques. So in this chapter those collected data analyzed with the help of statistical package for social scientists (SPSS) and presented using tables, charts, frequencies, percentages and some statistical summaries.

Survey Findings

The following figures and explanation show a sample of the result of the questionnaire. In this study 103 respondents participated.

The first part of the survey consists of four items. This part identifies the respondents' demographics and characteristics of the research population. Aims to collect background information about the online survey participants such as about stream of the study, educational level job position discussed as first, second and third item respectively. The fourth item is about the number of total years' experience of the participants with in the institution. This item is measured by categorized into six scales (below 2 years; 2-5 years; more than 5 years). The main items of this part are discussed in the below Table 4.6.

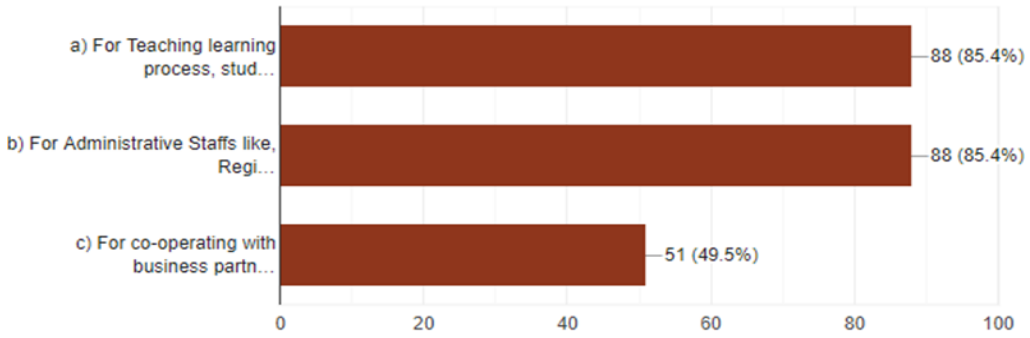
Table 4-1: Demography Information

Section	Characteristics	Frequency	Ration (%)
Stream of Study	Computer Science	36	35
	Electrical and Computer Engineering	15	14.6
	Information System	33	32
	Software Engineering	13	12.6
	Other	6	5.8
Education Level	Undergraduate/ Bachelor Degree	49	47.6
	Postgraduate/ Master Degree	38	36.9
	PhD	16	15.5
Year of Experience	Below 2 years	26	25.2
	2-5 years	32	31.1
	5+ years	45	43.7
Job Title	Lecturer	27	26.2
	IT Manger/ ICT Director	9	8.7
	Head of Department	9	8.7
	College Dean	12	11.7
	IT Expert	28	27.2
	Team Leader/ Academy with administrative position	18	17.5

The second part survey consists of seven items. The first item collects information about understanding of the current ICT utilization strategy, effectiveness and efficiency of service delivery. The Second item is about respondent level of knowledge in a relation to CC. This item is measured by categorized into five different levels (excellent knowledge, good knowledge, some knowledge, little knowledge, and no knowledge), current usage of the cloud, knowledge and idea about cloud computing technology and its services. The third item is about current level of cloud computing deployment. This item is measured by categorized into six scales (already used cloud based system; planning to adopt in 1-2 years; evaluating cloud for specific needs; still pilot test/learning to the cloud; not adopted; not discussed.) Type of cloud service/delivery model and type of cloud computing deployment models within the organization are the fourth and fifth items discussed respectively. The participants can choose more than one answer from the range of service/delivery models and range of deployment model respectively presented in the survey. The final item is about challenges and benefit towards cloud issues are discussed sixth and seven items respectively.

What are the Information Communication Technology (ICT) services and supports that are provided to the university community by your institution? The analysis of the responses obtained from this study as illustrated in Figure 4.2 indicated that EHEIs most delivered services for Teaching learning process, students, lecturers & researchers and for Administrative Staffs like, Registrar offices, finance offices, human resource offices and related offices in the university.

Figure 4-1: Current Service Delivery of EHEIs



Do you think that the higher educational institutions are currently utilizing technology effectively to deliver better service? The analysis of the finding presented in figure 4.3 respondents representing 53.4% of the total respondents are not satisfied by the current technology delivery system while 32 respondents were satisfied by the current delivery system and the remaining are not sure about the effectiveness of the current delivery service that is conducted by EHEIs. Therefore, most of the respondents are not happy in the present stage of EHEIs ICT service delivery system.

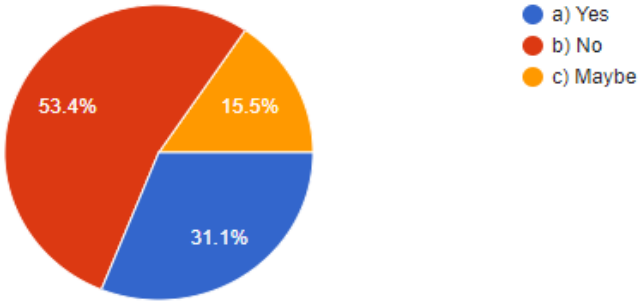


Figure 4-2: Technology Effectiveness

Knowledge related to cloud computing figure 4.4 represents the participant's knowledge related to cloud computing in the study. The figure 4.4 indicates that 35 of the respondents with 34 percent report excellent knowledge related to cloud computing, 27 of the respondents with 26.2 percent report good knowledge about cloud. Twenty six respondents with 25.2 percent report some knowledge about the cloud. Just 10 of the respondents with 9.7 percent report little knowledge. There were only 5 respondents with 4.9 percent reporting no knowledge about cloud. These results indicate that most of the respondents have considerable knowledge related to cloud computing.

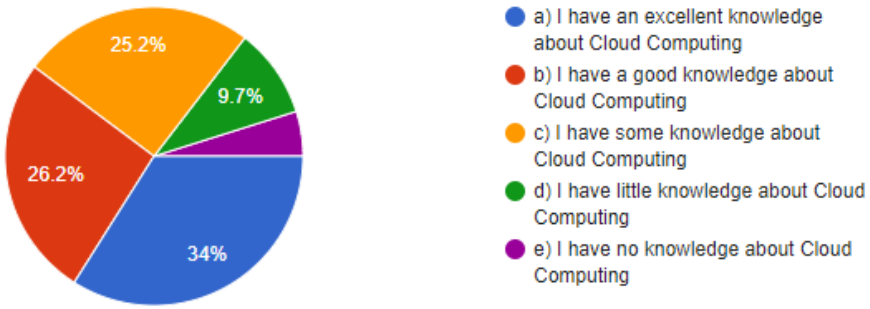


Figure 4-3: Knowledge Related to cloud computing

In your opinion, is cloud computing significant to your institution? Almost all respondents were agreeing. The analysis of the responses obtained from this study as illustrated in Figure 4.5 indicated that the responses obtained from 95 respondents agree upon on the usefulness of the cloud technology.

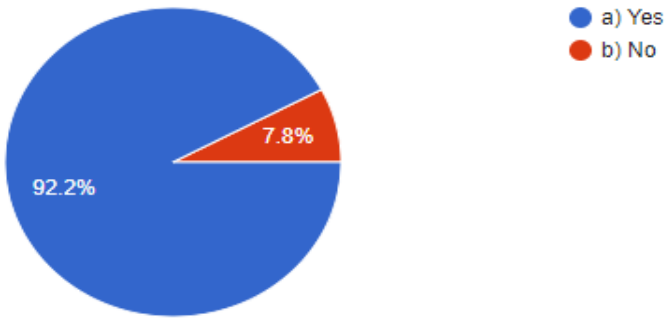


Figure 4-4: Perceived Usefulness

What is the bandwidth connection of your internet?

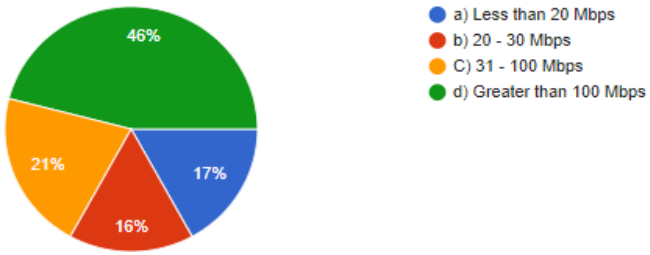


Figure 4-5: Bandwidth of internet connection

Is there any plan to move to the Cloud Computing? The respondents were asked whether they have plan moving to cloud or not?

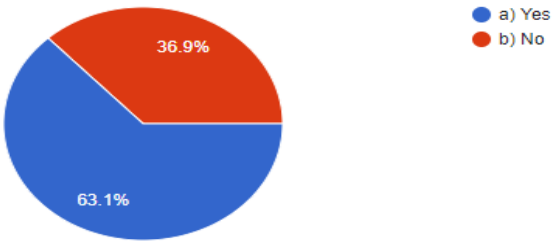


Figure 4-6: Plan to move to Cloud

What stage is your institution in with regard to cloud services adoption? Institutions were asked their current status towards adoption of cloud services. To understand the current state of cloud adoption in EHEIs, the respondents were asked to specify the current state of cloud computing adoption in their organizations, the results show that only 16.5 % of respondents report that their organizations have adopted some cloud computing services, with 29.1 % planning to adopt cloud computing in the next two years, with 18.4% evaluating cloud for their specific needs.

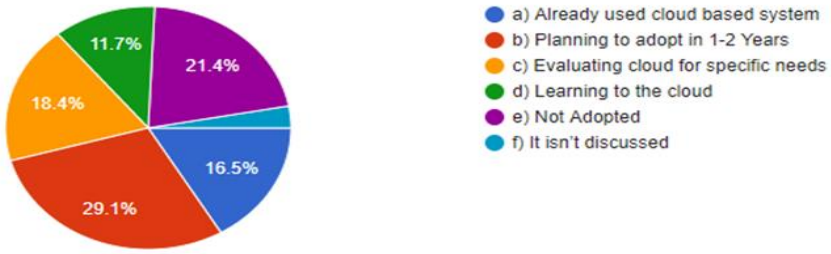


Figure 4-7: Current Status towards Cloud

What kind of cloud model would you choose if your institution intends to migrate to Cloud Computing? Most respondents agree upon on deploying the Hybrid cloud model.

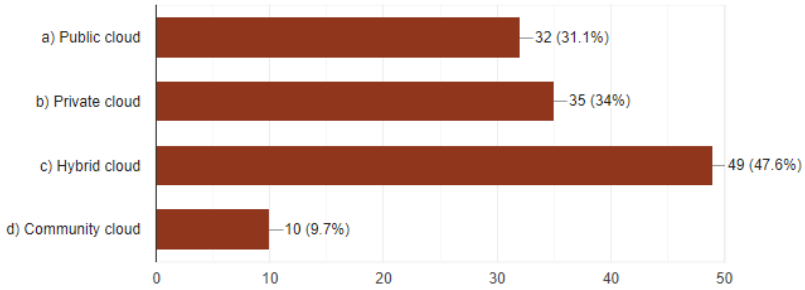


Figure 4-8: Cloud Delivery Model

In your opinion, what do you think that hinders the adoption to the cloud service adoption? The security issue or fearing to lose their data was the most challenge for the institutions for moving to cloud.

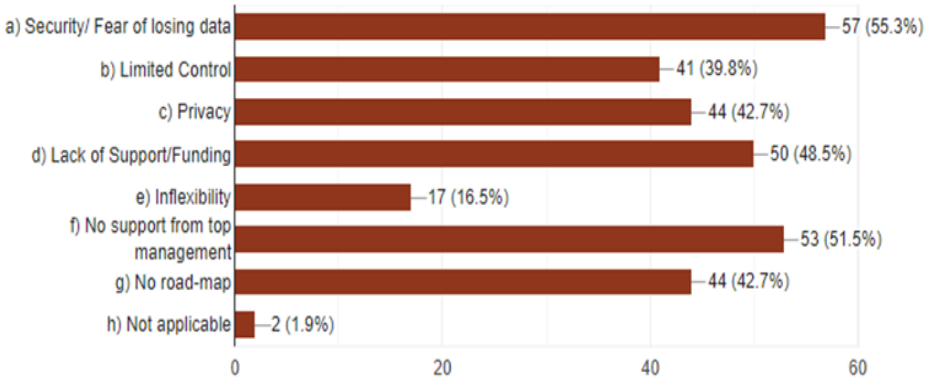


Figure 4-9: Challenge Factors

The concerns ranking have been considered in the study based on participant responses. Security concerns top the list with 55.3% followed by no support from top management with 51.5%, third ranking luck of support and governance issues 42.9%, availability and performance 28.6% and other 4.8%. These survey results show that security is still the main concern for organization when considering cloud adoption.

As mentioned before, we have also had face to face interviews. The objectives behind conducting these interviews were twofold: firstly, they allow us to gain a deeper understanding about the current status of the institutions, identify factors that effect on the adoption cloud and attitude towards innovation. Secondly, they provide us with the opportunity of understanding context in which the answers to the survey were and also to explain the responder what was intended with the questions.

The following bulleted sections further elaborate on the results of various questions asked during the interviews. The questions are grouped as exploratory questions about the current status of cloud migration within the context of EHEIs. Descriptive statistics is used in order to present the qualitative data collected from the survey

Security & Privacy

Privacy and security are the top concerns for higher educational institutions planning to adopt cloud computing, due to the migration of sensitive data such as students' records, researchers' patents and intellectual properties outside campus walls. Hence the importance of security and information privacy within University IT environment is crucial.

The interview confirmed that security is considered to be the highest priority amongst all the adoption issues. The interviewees believed that *having one's own data stored somewhere else, would render it vulnerable to the exposed environment, "depending on what kind of information is hosted there, and the level of sensitiveness of the information*", said Interviewee A

Top Management Support

From a strategic perspective, the successful implementation of cloud solutions EHEIs depends on the capabilities of top leadership or management to drive the change from traditional deployment to cloud adoption. In terms of their understanding of cloud computing all the participants have good knowledge of cloud computing and were able to describe cloud computing from different views. Interviewer B said that "*The decision makers' awareness and consensus is vital. Their support will ensure what cloud services are needed and what type of cloud deployment is best for higher education settings. In order to do that the decision makers have to understand the benefits of cloud-based services, the value they can add to the educational services and how to migrate to cloud computing environment".* The questionnaire result also agrees with the interviews. All participant were asked their

awareness level towards to the cloud computing. More than half of the percent respondent having knowledge and understand the technology.

Compliance with regulations was another factor stated by the 3 respondents. *The country is based on strong supervision of the government sector on all the educational and other public service sectors. There exists a declaration which inhibits the outsourcing of cloud and other IT infrastructure bearing critical data to external service providers. This factor was already proposed as Ministry of Education Policies however it was advised to be supported on national level via the government.*

4.2. General Overview of Proposed Framework

This study uses different theories of information system researches that have been used to explain technology adoption, both at the individual level and organizational level, which are already discussed in chapter two. Benefits and risks have subsequently created a dilemma for organization on how to approach cloud adoption. The factors that should be considered in educational institutions while adopting cloud computing should be answered. Therefore, this study aims to fill the gap by proposing a conceptual framework for the institution and to identify factors that should be considered when adopting Cloud Computing. The figure 4.1 below shows our proposed conceptual adoption framework.

The seventeen variables within this proposed research model are divided into five main categories. Figure 4.1 illustrates the variables categorized into five groups: innovation characteristics; technology context; organizational context; environmental context; individual context and decision maker's context. These groups are expected to impact the intention to adopt cloud computing in EHEIs. The TOETAD framework is developed based on the outcomes of the literature review and interview. These concepts are derived from the TAM, TOE framework and DOI theory [44][45][46][47]. These factors are modified in order to suit the context of EHEIs.

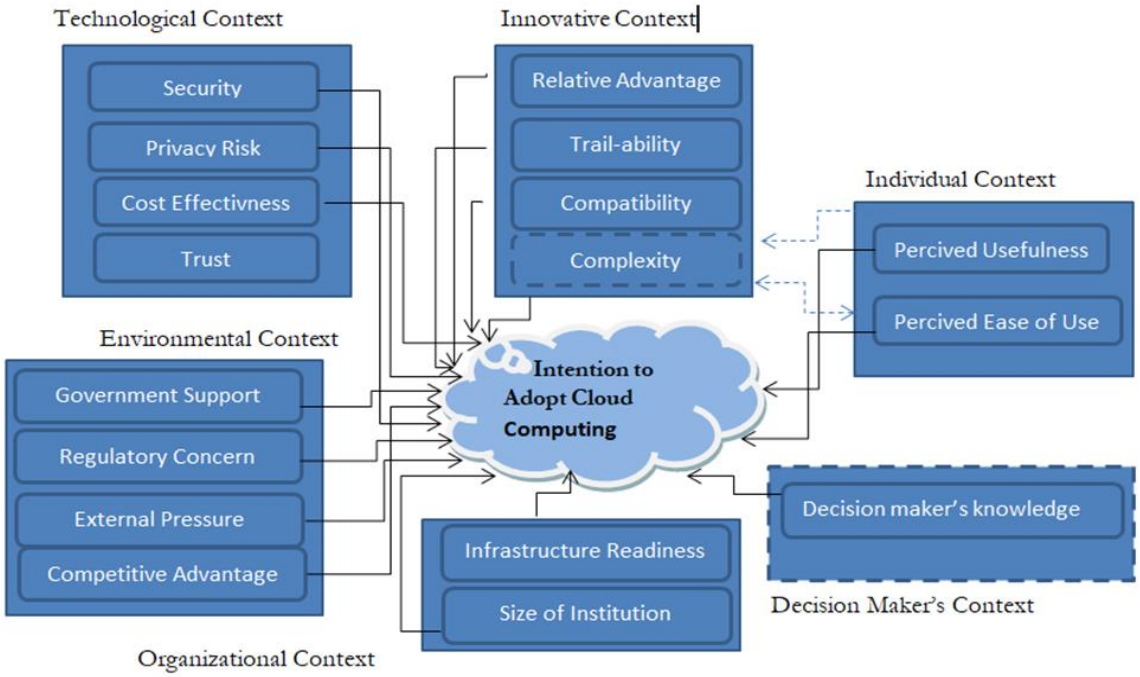


Figure 4-10: Research Proposed Conceptual Framework for Adoption of Cloud in EHEIs [44][45][46][47]

4.2.1. Definition of the Proposed Model Variables

This section provides the definition of the research proposed model variables. In this study, the research model incorporates technological, organizational, and environmental contexts as important determinants of cloud computing adoption. The decision-making framework to adopt cloud computing system will be developed based on integration of five models. The feature of this framework was designed as a three-tier architecture including decision areas (Construct), decision factors (Variables), and decision attributes to facilitate intuitive and rapid decision making for decision-makers. The table 4.1 below shows summary of important factors to be considered on the conceptual framework.

Universities in developing countries are faced with challenging socio-economic and political constraints that limit their ability to invest in expensive information systems to compete on the global stage. Using constructs from the TAM, DOI, TOE and Decision Maker's Context, this paper proposes a model that takes account of contextual, economic, and technological influences in the perception and adoption of cloud computing at universities in EHEIs. The factors under each context usually were selected from previous studies and interviews taken which were found suitable with the context of EHEIs.

Using constructs from the TAM, TOE, DOI and Decision Maker Context, [67] [68] [69] [70], this Study proposes a model that takes account of contextual, economic, and technological influences in the perception and adoption. The proposed model will attempt to address the direct impact of variables from

innovation diffusion characteristics, Individual characteristics, technological factors, and contextual factors on the diffusion of cloud computing in EHEIs.

Technological Context

The technological factor describes the characteristics of the cloud technology and identifies the factors that affect an organization's decision to adopt the technology.

- Availability: Availability is an influential factor in relation to an organization's decision to adopt cloud computing. Cloud computing offers resources online, meaning that the consumer can access the cloud from anywhere and at any time. This means the system needs to function properly and must be available to use whenever it is requested.
- Reliability: The reliability of the cloud is another major factor in the decision. It refers to the ability of a system to fulfill its intended function in a proper manner as expected.
- Security: Refers to the level of security procedures in place to protect information or the system from unauthorized access or any other security events.
- Privacy: Defined as confidentiality of data, where only authorized users can access it.
- Trust: Refers to the reliance on another entity and the belief that this entity will function as expected. Trust in the cloud environment heavily depends on trusting the service itself and the provider to provide a trusted level of authenticity, integrity and confidentiality in regard to the service and the stored data.

Organizational Context

The organization context is defined in terms of the resources available to support the adoption of an innovation; it refers to the characteristics of the firm that facilitate or constrain the adoption and implementation of the innovation. Multiple factors influence the relationship between organizational structure and the adoption of innovation, including size, scope, and managerial structure.

- Organization size: The size of the organization is another influential factor. The organization size is defined by the number of employees, the amount of investments, the target market and annual revenue.
- Organization readiness/ Infrastructure readiness: Aims to measure if the organization has the capability to adopt the innovation and is defined as the availability of human, technology and financial resources to adopt cloud computing.

Cloud computing services can become part of value chain activities only if firms have the required infrastructure or technical competence. Broadly, it has been described with two dimensions, that is, financial readiness (financial resources for cloud computing implementation and for ongoing expenses during usage) and technological readiness. Technological readiness is sometimes called as technological competence. It is defined as the availability of technological capability (IT infrastructure and human resources) within the firm. Therefore, firms that have technological readiness are more prepared for the adoption of cloud computing. Technology readiness will be positively correlated with the adoption of cloud computing.

Environmental Context:

Environmental context refers to the external factors that influence the adoption of technology includes government regulation and initiative, service providers and competitors and might have a significant impact on their decision.

- External support in this research is defined as support from the cloud service provider to influence clients to adopt cloud technology. CSPs can provide knowledge and expertise to their clients.
- Government support: Government support in this context is understood as the regulation, policies and initiatives that support enterprises in the adoption of cloud computing. Regulation can encourage or discourage cloud computing adoption.
- Competitive pressure: The external environment can have a direct effect on the firm's decision. The competitive pressure faced by a firm is a strong incentive to adopt relevant new technologies.

Innovative Context

- Relative advantage: "degree to which an innovation is perceived as being better than the idea it supersedes". This factor refers to the level of benefit to an organization if they decide to go for the cloud computing. Relative advantage was seen in terms of savings on software and hardware costs which offers technical as well as economic advantages over traditional IT environments. The fact that users can pay-as-they-go, for what they need, rather than paying on an ongoing basis for excess capacity was something that was viewed as extremely beneficial by the majority of study participants; the move away from perpetual capital expenditure to operational expenditure was also cited as a cost benefit; company saved on license costs, maintenance costs, back-up costs of tapes, electricity bills and air conditioning bills. Relative advantage was also seen in terms of time-savings. Relative advantage will be positively associated with the adoption of cloud computing.
- Firms may not have confidence in a cloud computing system because it is relatively new to them. It may take users a long time to understand and implement the new system. Complexity refers to difficulty of

understanding and use of new technology in the existing system. It also refers to the knowledge level and expertise of the members in an organization. Thus, complexity of an innovation can act as a barrier to implementation of new technology; complexity factor is usually negatively affected. Complexity is inversely proportional to ease of use, usefulness and adoption intentions.

- Compatibility has been considered an essential factor for innovation adoption. When technology is recognized as being compatible with an organization's existing IT infrastructures, the organization is more likely to consider adoption of the technology. Compatibility is an issue in cloud computing because there may be technology limitations on the ability to introduce cloud computing services in conjunction with an organization existing IT. When technology is viewed as significantly incompatible, major adjustments in processes that involve considerable learning are required. Compatibility will be positively correlated with the adoption of cloud computing.
- Trial-ability "The degree to which cloud computing may be experimented on a limited basis". Majority of the current cloud providers, such as Microsoft, IBM, Amazon etc. offer a trial version of their service. Opportunity to try and experiment cloud computing on a trial basis positively influences the adoption of cloud computing.

Decision Maker Context

Knowledge about cloud computing and the attitudes towards using the technologies are important factors in the adoption of cloud computing.

- Employees'/Higher management IT Knowledge: A key aspect of the learning perspective is that improvements in assimilation are realized when organizations have prior experience in a given area that has allowed the organization to build knowledge, this knowledge relates to the ability to assimilate external information and apply it internally. So, Decision maker's Cloud Knowledge having enough knowledge about an innovation is the first step in adoption process. Institutions whose decision makers are knowledgeable about cloud computing are more likely to adopt cloud computing. As the complexity and sophistication of technologies increase, top management can provide a vision and commitment to create a positive environment for innovation. Top management plays an important role because cloud computing implementation may involve integration of resources and reengineering of processes. Support from top management is essential because they have the ability to make the change and execute acceptance of the cloud. Top management support will be positively correlated with the adoption of cloud computing.

Table 4-2: Summary of important factors to consider on the research model

Constructs	Variables	Attributes	Definition
Technological context	Security	Privacy and Trust	level of data and the system security within the organization
Technological context	Reliability	Availability, Internet Connection and Bandwidth	ability of a system to fulfill its intended function in a proper manner as expected
Innovations context	Complexity and Compatibility	Ease of use, Usefulness, Integration with cloud infrastructure	Complexity is the perceived difficulty by a firm to understand and use an innovation.
			Compatibility refers to the degree to which innovation fits with the potential adopter's existing values, previous practices and current needs.
Innovations context	Relative Advantage	Cost Advantage, Efficiency, Flexibility, Manageability	The "degree to which an innovation is perceived as being better than the idea it supersedes'.
Organization Context	Organizational size		defined by the number of employees, the amount of investments, the target market and annual revenue
Organization Context	Technology readiness	Infrastructure Readiness Financial readiness	Technological infrastructure and IT human resources, influences the adoption of new technology.
Enviroment Context	Government Regulation	Law and Policy, Government incentive, Regulatory Concern	It refers to the policies, initiatives, agencies and everything that is provided or organized by the government to accelerate the rate of adopting a techno-innovation.
Enviroment Context	Competitive pressure		The level of pressure felt by the firm from competitors within the

			industry
Decision-Maker	Decision-maker's innovativeness	Top/ Executive higher management support	Levels of decision maker's preference to try solution that have not been tried out and therefore are risky.
Individual Context	Perceived Usefulness	-	Degree to which an individual believes a certain technology will make them perform their jobs better.
Individual Context	Perceived Ease of Use	-	Degree to which a person believes that using a particular system would be free from effort.

4.3. Evaluation of the Proposed Framework

The main purpose of this interviews interpretation is to present the views and ideas of the respondent related to adoption of cloud computing technology in EHEIs. The result of the interview finding helps for identifying the benefit, challenges and to identify improvements aspects of the proposed conceptual framework for EHEIs practices. Interview questions are prepared by adopting from literatures and modified according to this study and analysis of the collected data from interview done by the researcher.

A total of 12 experts interviewed were taken from Hawassa and Addis Ababa Universities. The expert team comprised of five senior software engineers, four senior security and network IT expert, three computer science researchers. The data collection method utilized was semi structured interview which helped the researcher to acquire in-depth insight for the study. As per the past qualitative studies, the appropriate number of experts for qualitative analysis suggest the range from 10-30 [65].

In [71], Mean Opinion Score (MOS) defined as a measure used in the domain of Quality of Experience representing overall quality of a stimulus or system. It is calculated as an arithmetic mean over all individual "values on a predefined scale that a subject assigns to his opinion of the performance of a system quality". Such ratings are usually gathered in a subjective quality evaluation test, but they can also be algorithmically estimated.

$\mathbf{MOS} = \sum_{n-1}^{N} \boldsymbol{Rn} / \boldsymbol{N}$ Where: R are the individual ratings for a given stimulus by N subjects.

The online questionnaires were designed and sent out to the 123 potential responders using Google form of survey as a link through their emails. 108 responses were received during the period of March 13-23, 2019. Only 103 respondents were accepted for this study because of contradicting responses. Therefore, the questionnaire response rate is 83.7%. A pilot survey was conducted with three IT security experts and two computer science researchers. All the online collected data was converted to Statistical Package for the Social Sciences (SPSS) version 25 format for analysis. In SPSS, each question in the questionnaire was typed as a variable with coding options where applicable. The Likert scale was coded from 1 – 5, with 1 representing 'Most Irrelevant', and 5 representing 'Most Relevant'.

4.4. Discussion of the Results with Domain Experts Evaluation

The experts were asked to rate their attitude to the proposed framework. The raw responses to these questions are presented in Appendix 1, and were based on a five point Likert scale, with 5 denoting 'Strong Agree', 4 denoting 'Agree', 3 denoting 'Neutral', 2 denoting 'Disagree', and 1 denoting 'Strongly Disagree'. The aim of the questions was to evaluate the importance of the proposed framework to adopt cloud services in EHEIs, from the experts' point of view. The experts' responses is collected and entered by SPSS software. The data was analyzed by using Mean Opinion Score (MOS).

It is important to verify the reliability of an instrument and ensure the quality of the measures before conducting any other statistical analysis. At measurement level, the relationships between factors in the proposed model and items used to measure these factors were assessed at this stage. The composite reliability (CR) and construct validity were utilized to verify the measurements used in this research. The reliability of the instrument was measured by the Cronbach's alpha coefficient. A value of composite reliability above 0.7 is considered to be highly reliable and between 0.6 and 0.7 acceptable [72].

Results shown in figure 4.2 suggest that the model is considered reliable as all composite reliabilities are above the recommended threshold values.

Table 4-3: Reliability Statistics

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.887	.881	13

Accordingly, all the invited 12 participants completed the survey. Hence, the response rate of the framework evaluation survey is 100%. Table 4.3 shows case processing summary.

Table 4-4: Case Processing Summary

Case Processing Summary

		N	%
Cases	Valid	12	100.0
	Excluded[a]	0	.0
	Total	12	100.0

a. Listwise deletion based on all variables in the procedure.

Descriptive analysis (mean and standard deviation) of the survey result is computed as shown in table 4.4. Mean result of the evaluation variables is found to be greater than 4 which indicated that the respondents agreed on the applicability, realistic, clarity, completeness, provides knowledge sharing enviroment and helping to analyze influential factor and relevance of the proposed framework. As shown in table 4.5 as summary overall rating of the proposed framework is 4.462 which represent the category of strongly agree. This indicates that the IT experts participated on the evaluation survey confirmed applicability, realistic, clarity, completeness, provides knowledge sharing enviroment and helping to analyze influential factor and relevance of the proposed framework.

Table 4-5: Descriptive Statistics

Descriptive Statistics					
	N	**Min**	**Max**	**Mean**	**Std.deviation**
The proposed conceptual framework provides a knowledge sharing environment to support cloud adoption decision making.	12	4	5	4.7500	.45227
The proposed framework would reduce the cost.	12	3	5	4.0833	.51493
The proposed framework would reduce the time.	12	4	5	4.5833	.51493
The implementation of the proposed framework fits with EHEIs problems.	12	4	5	4.6667	.49237
The content of proposed framework is relevant.	12	4	5	4.5000	.52223
The content of the proposed framework is clear.	12	4	5	4.3333	.49237
The proposed framework helps EHEIs to analyze the influential factors.	12	4	5	4.7500	.45227
The proposed framework is comprehensive in terms of coverage.	12	4	5	4.4167	.51493
The content of the proposed framework is complete.	12	3	5	4.1667	.57735

Descriptive Statistics					
	N	Min	Max	Mean	Std.deviation
The organization and presentation of the framework is suitable for EHEI's.	12	4	5	4.6667	.49237
The proposed framework is applicable in Ethiopia context.	12	3	5	4.1667	.57735
The proposed framework is acceptable.	12	3	5	4.2500	.62158
The proposed framework is realistic.	12	3	5	4.6667	.65134

Table 4-6: Summary Item Statistics

Summary Item Statistics

	Mean	Minimum	Maximum	Range	Maximum / Minimum	Variance	N of Items
Item Means	4.462	4.083	4.750	.667	1.163	.057	13
Item Variances	.283	.205	.424	.220	2.074	.005	13

The evaluation result as we can see from table 4.4 the comprehensiveness in terms of coverage of the proposed framework and reducing the cost are scored the lowest mean value (4.0833) and (4.1667) respectively among all quality attributes used to measure the Framework. This indicates the need for further improvement of the framework coverage is required to ensure the completeness of its content.

The evaluation result indicated that, the proposed framework can help EHEIs to analyze the influential factors in different aspect considering technology, organizational, environmental, individual, innovation and decision makers and providing a knowledge sharing environment to support cloud adoption decision making have the highest mean value (4.750) which revealed that majority of the experts Strongly agreed on it.

The proposed framework is clear, and reduces time strongly agreed by majority of the experts with mean value of 4.667. Thus, results suitability of presentation and organization of the framework for EHEIs with a mean value 4.583 lies under the category of strongly agreed by the majority of the experts.

Similarly, the proposed framework is realistic strongly agreed by majority of the expert with a mean value 4.667. The implantation of the proposed framework fits with EHEIs problems shows with a mean result 4.50 lies under the category of strongly agreed by majority of the experts. Thus, results the proposed framework is acceptable.

Based on the above analysis evaluation result proves how the proposed framework is realistic/relevant. Moreover, the completeness of the contents of the proposed framework and cost effectiveness to be considered as an improvement area to further develop the framework so that it can serve its intended goal.

Based on this response summary and themes, it can be seen that all the experts have agreed that the proposed factors are important.

CHAPTER FIVE
CONCLUSION AND FUTURE RECOMMENDATION

5.1. Conclusion

This chapter presents a summary of the study and highlights the main findings and conclusions drawn from the study.

The conclusions and recommendations drawn focused on addressing the objectives of this study which is to find alternative to use of IT through cloud, while leading higher institutions of learning to increase operational efficiency and cut cost, identify key barriers affecting adoption of cloud computing in EHEIs, and develop decision framework for adoption of cloud computing. Cloud computing is an emerging trend as a combination of many already existing and computer technologies like the internet, networking, operating systems, hardware, software, middleware, virtualization, multi-tenancy.

In order to answer research question 1 & 2 respectively; "Is the current Ethiopian Higher Education ICT service delivery strategy efficient?"2: "Do we need to change the way we are currently deploying and using ICT in EHEIs?" The current status of ICT usage in Ethiopian Higher Education Institutions, limitations of the current ICT service delivery in the institutions, and identification of better ICT service delivery technologies is studied. Through interview potential users (IT managers, lecturers and E-Learning coordinators told the researcher the present stage of EHEIs ICT service delivery system is not satisfactory. The respondents also responded that there is scarcity of resources for their course and research works.

To make it focus on Ethiopian Higher Education Institutions, this thesis propose a last research question to be: "What factors should educational institutions consider when adopting cloud computing?" The purpose of this thesis is to find the factors and indicate their importance in relation to the adoption decision of Cloud Computing in EHEIs. A total of 17 factors with varying levels of significance is identified and discussed that cloud influence the adoption decision. Security, Top management support and compliance with regulation as all found the most prominent to be considered. In other words, EHEIs should thoroughly and seriously consider those factors for the adoption of Cloud.

The objective of this research was to investigate key factors that influence cloud technology adoption and to propose conceptual cloud adoption framework for EHEIs. The research utilized a combination of TAM, TOE framework, DOI theory and Decision maker's context for the theoretical validation of the proposed model. The model was then used to investigate the significance of ten important constructs on cloud computing adoption in EHEIs. The intention of the research was to analyses factors that hinder intentions or decision-making on the use or adoption of new technologies by constructs including

individual, innovation characteristics, technological, organizational, and environmental contexts, and decision maker's characteristics. The results of this investigation offer guidelines to EHEIs on cloud adoption.

Adoption of new technology is considered a driving force for economic growth and sustainable development. Taking into consideration the growth of ICT in Ethiopia, this research tried to study one of the fastest growing IT technology i.e. cloud computing. Despite the fact that cloud computing offers great deal of opportunities, its adoption is not as expected. Uncertainty can lead to a wrong decision making, unnecessary cost, and to major project failure. So, several factors have to be considered when institutions intend to adopt new technology before fully integrated.

Semi-structured interviews and questionnaire are used to examine the factors identified previously in literature review and to explore others factors, to measure ICT level of the EHEIs, to capture opinion of about the cloud computing technology, to specify the most influential factors to adopt the technology so as to make right decision. Online survey questionnaire were distributed to the potential user (IT managers, lecturers and E-Learning coordinators, students, researchers and decision makers). Capturing such knowledge allows assessing non adopters for their readiness of adopting such a technology. Qualitative method is used to ensure the validity of the results. Expert evaluation is also conducted to validate the framework. The results from the full study will also contribute to the literature on cloud computing through empirical evidence from the study results and provide a potential of success rate of cloud computing adoption project which can help the decision makers organization to efficiently monitor the current situation of their organization and make a conscious decision in migrating to the cloud computing process. The study also has significant implications and considerable value for scholars, top managers, to devise better strategies for adoption of cloud computing in EHEIs.

Understanding the priorities of decision factors and attributes to adopt cloud computing systems is meaningful when organizations ultimately analyze the adoption processes of cloud computing for a firm's successful digital transformation.

5.2. Future Work

This research will contribute to the ICT growth of the country by providing valuable tool. It will open doors for further research considering other institutions other than EHEIs.

Future studies could extend the developed framework by adding other technological adoption theories such as SWOT(study Strength, Weakness Opportunity and Threat of cloud), Task Technology Fit (TTF) and adding more factors/Construct, adding and so as to enhance the predictive model system looking

ability to cross check certain aspect in details while institution decide to go for to cloud. The work can be expanded by additionally considering the cloud deployment and service models.

REFERENCE

[1] Alemu, B.M. "Transforming Educational Practices of Ethiopia into Development and the Knowledge Society through Information and Communication Technology," *Afr.Edu.Res.J.,* vol. 5, no.1, pp. 1–14, January, 2017.

[2] F. Makoza, "Cloud Computing Adoption in Higher Education Institutions of Malawi : An Exploratory study," *International Journal of Computing and ICT Research (IJCIR).,* vol. 9, no. 2, pp. 37–54, December 2016. http://ijcir.mak.ac.ug/volume9- issue2/article4.pdf

[3] "Cloud Computing in Education – A Study of Trends , Challenges and an Archetype for Effective Adoption in Nigerian Universities," *Information Communication Technology (ICT) Integration to Educational Curricula*:, A New Direction for Africa, University Press of America., August 2015, ISBN: 9780761865360

[4] Zelalem A, "Role of EthERNet in Making GIS Resources More accessible in Ethiopian Academic and Research Institutions ," 2016.

[5] A. R. Dar, "A Comprehensive Study On Cloud Computing Paradigm," *Int.J.Adv.Res.Sci.Eng.*, vol.7, no.4., March, 2018.

[6] Jadeja, Yashpalsinh, and Kirit Modi , "Cloud Computing Concepts , Architecture and Challenges," *International Conference on Computing, Electronics and Electrical Technologies (ICCEET)*, pp. 877-880., March, 2014.

[7] R. Meganathan, "Effective use of Cloud Computing in Educational Organizations," *International Journal of Recent and Innovation Trends in Computing and Communication.,* vol 4., no.10, pp. 176–179, October 2016.

[8] P. A. V. D. Dr. Mukund kale1, "Role Of Cloud Computing In Education System : A Study In Special Reference For Technical Education," *International Journal of Advanced Research in Engineering and Management* (IJAREM), vol. 03, no. 04, pp. 31–38, 2017

[9] Networking, Cisco Visual. "Cisco global cloud index: Forecast and methodology, 2016–2021." *White paper Cisco Public, San Jose* (2016)

[10] Buyya, Rajkumar, James Broberg, and Andrzej M. Goscinski, eds. *Cloud computing: Principles and paradigms*. vol., 87. John Wiley & Sons., 2010.

[11] Mtebe, Joel S. "Exploring the Potential of Clouds to Facilitate the Adoption of Blended Learning in Tanzania." *International Journal of Education and Research* , vol.1, no. 8, pp. 1-16 August 2013

[12] Sultana, Jakia, Md Fahami Ahsan Mazmum, and Nymatul Jannat Nipa. "Factors Affecting Cloud Computing Adoption in Higher Education in Bangladesh: A Case of University of Dhaka." *Applied and Computational Mathematics.,* vol. 6, no. 3, pp. 129-136. (2017)

[13] R. M. Almajalid, "A Survey on the Adoption of Cloud Computing in Education Sector," *CoRR*, pp. 1–12, 2017.

[14] Karim, Faten, and Giselle Rampersad. "Cloud Computing in Education in Developing Countries," *Computer and Information Science* .,vol. 10, no. 2., pp. 87-96 , April 2017.

[15] C. I. Eseonu and Egbue, "Socio-Cultural Influences on Technology Adoption and Sustainable Development," *Proceedings of the 2014 Industrial and Systems Engineering Research Conferenc*e, 2014.

[16] Shiferaw, T., & Cerna, P. D.. Cloud Library Framework for Ethiopian Public Higher Learning Institutions. *International Journal of Modern Education and Computer Science*, vol 8 no.5.,pp 1-9., May 2016.

[17] Madhumathi, Cl, and Gopinath Ganapathy. "An Academic Cloud Framework for Adapting E-Learning in Universities." *International Journal of Advanced Research in Computer and Communication Engineering* vol.2, no. 11.,pp 4480-4484., 2013.

[18] "Higher Education's 2019 Trend Watch & Top 10 Strategic Technologies _ EDUCAUSE." .

[19] P. K. Senyo, E. Addae, and R. Boateng, "Cloud computing research: A Review Of Research Themes, Frameworks, Methods and Future Research Directions," *Int. J. Inf. Manage.*, vol. 38, no. 1, pp. 128 139, 2018.

[20] Tashkandi, AlAlaa N.,and Ibrahim M. Al-Jabri. "Cloud Computing Adoption By Higher Education Institutions In Saudi Arabia: An Exploratory Study," *Cluster Computing.,* vol. 18, no. 4.,pp 1527-1537, 2015.

[21] P. Mell and T. Grance, "The NIST Definition of Cloud Computing Recommendations of the National Institute of Standards and Technology," *Natl. Inst. Stand. Technol. Inf. Technol. Lab.*, vol. 145, p. 7, 2011.

[22] S. Marston, Z. Li, S. Bandyopadhyay, J. Zhang, and A. Ghalsasi, "Cloud computing the business perspective ☆," *Decis. Support Syst.*, vol. 51, no. 1, pp. 176–189, 2010.

[23] W. Klug and B. Columbia, "Factors Affecting Cloud Computing Adoption Among Universities," *Issues in Information Systems*, vol. 16, no. III, pp. 1–10, 2015

[24] Plummer, D. C., Bittman, T. J., Austin, T., Cearley, D. W., & Smith, D. M, "Cloud Computing: Defining and Describing an Emerging Phenomenon. *Gartner, June*, *17*. 2008

[25] George, F., & Shyam, G," Impact of Cloud Computing: Beyond a Technology Trend" *Systems Integration*, pp. 262-269, 2010

[26] Feuerlicht, George, and Shyam Govardhan. "Impact Of Cloud Computing: Beyond A Technology Trend." *Systems integration*., pp. 262-269, May 2010.

[27] D. Wu *et al.*, "Cloud Computing – An Overview," *White Pap.*, vol. 462, no. 7276, pp. 1–5, 2009.

[28] Sun Microsystem, "Introduction to Cloud Computing Architecture", *White Paper,* 1st Edition, June 2009.

[29] V. Chang, R. John, and G. Wills, "The development that leads to the Cloud Computing Business Framework," *Int. J. Inf. Manage.*, pp. 1–15, 2013.

[30] G. Kite, "The Impact of Information Technology Outsourcing on Productivity and Output: New Evidence from India," *International Conference on Applied Economics*, vol.1, no.12, pp.239–248, 2012.

[31] H. Hare, "ICT in Education in Ethiopia," *Survey Of Ict And Education In Africa*: Ethiopia Country Report, pp. 1–9, 2007.

[32] G. Ali, F. A. Haolader, and K. Muhammad, "The Role of ICT to Make Teaching-Learning Effective in Higher Institutions of Learning in Uganda," *International Journal of Innovative Research in Science, Engineering and Technology* (IJIRSET), vol. 2, Issue 8, pp. 4061–4073, August 2013

[33] A. Rai, "Cloud Technology in Higher Education : A Review," *9th International Conference on Software, Knowledge, Information Management and Applications* (SKIMA), March, 2016.

[34] R. Alsufyani, F. Safdari, and V. Chang, "Migration of Cloud Services and Deliveries To Higher Education," *Proc. ESaaSA 2015-2nd Int. Work. Emerg. Softw. as a Serv. Anal. conjuction with 5th Int. Conf. Cloud Comput. Serv. Sci. 2015*, pp. 86–94, 2015.

[35] C. Bulla, B. Hunshal, and S. Mehta, "Adoption of Cloud Computing in Education System : A Survey Adoption of Cloud Computing in Education System : A Survey," ***IJESC,*** vol. 6 no. 6, July, 2016.

[36] M. I. Ghareb, Z. A. Ahmed, and A. Abubakr, "The Ability of implementing Cloud Computing in Higher Education-KRG," *Kurdistan Journal for Applied Research*., vol. 2, Issue 1, June 2017.

[37] G. Ramachandra, M. Iftikhar, and F. A. Khan, "A Comprehensive Survey on Security in Cloud Computing," *Procedia Comput. Sci.*, vol. 110, no. 2012, pp. 465–472, 2017.

[38] R. Sahandi, A. Alkhalil, and J. Opara martins, "SME's Perception of Cloud Computing : Potential and Security," *International Federation for Information Processing (*IFIP), October, 2012.

[39] Muli, E.,& Kimuai, J.,"Adoption of cloud computing for education in kenyan universities: challenges and opportunities. *Int J Adv Res Comput Eng Technol (IJARCET)*, vol. *4, no.* 6., pp. 2854–2860, 2015.

[40] Blessing F. Adeoye., "Utilization Of Cloud Computing In Education," *Journal of Global Research in Computer Science*., ISSN-2229-371X .,vol. 6, no. 4, pp. 10–11, 2015. http://rroij.com/global-research-in-computer-science.php

[41] A. Introduction, W. Machines, and S. Edition, "The Datacenter as a Computer."

[42] "5 Best Cloud Certifications."[Online].Available https://www.prepaway.com/certification/5-bestcloud-certifications-2019 [Accessed: March 7, 2019].

[43] Oliveira, T., & Martins, M. F., "Literature Review of Information Technology Adoption Models at Firm Level.," *Electronic Journal of Information Systems Evaluation*, *14*(1), 110., 2011.

[44] R. Sharma and R. Mishra, "A Review of Evolution of Theories and Models of Technology Adoption," *Indore Management Journal.,* vol. 6, no. 2, pp. 17–29, 2014.

[45] Baker, J., "The Technology–Organization–Environment Framework.," *Information systems theory*., pp. 231-245., Springer, New York, NY, 2012.

[46] Rogers, Everett M. "*Diffusion of Innovations*," Simon and Schuster, 2010.

[47] Thong, J. Y, "An Integrated Model of Information Systems Adoption in Small Businesses," *Journal of management information systems.,* vol. 15, no. 4, 1999.

[48] A. K. Jha and I. Bose, "Innovation research in information systems : A commentary on contemporary trends and issues," *Inf. Manag.*, 2015.

[49] R. Sharma and R. Mishra, "A Review of Evolution of Theories and Models of Technology Adoption," vol. 6, no. 2, pp. 17–29, 2014.

[50] S. A. M. Avinash Appasha Chormale1, "Adoption of Cloud Computing By Higher Education Institutions in Maharashtra India: An Investigative Study," *Res. J. Pharm. Biol. Chem. Sci.*, vol. 7, no. 3, pp. 365–373, 2016.

[51] O. Harfoushi, A. H. Akhorshaideh, N. Aqqad, M. Al Janini, and R. Obiedat, "Factors Affecting the Intention of Adopting Cloud Computing in Jordanian Hospitals," *Commun. Netw.*, vol. 08, no. 02, pp. 88–101, 2016. Published Online May 2016 in SciRes. http://www.scirp.org/journal/cn http://dx.doi.org/10.4236/cn.2016.82010

[52] Adrees, M. S., Omer, M. K., & Sheta, O. E.,"Cloud Computing Adoption in the Higher Education (Sudan as a model): A SWOT Analysis," *American Journal of Information Systems*, vol. 4, no.1, pp.7–10, 2016

[53] A. Ababa, "A Cloud Computing Framework for Ethiopian Banking Industry" A Thesis Submitted in Partial Fulfillment of the Requirement for the Degree of Master of Science in Information Science," 2014.

[54] Selamawit. B., "Exploring Factors That Affect the Decision to Adopt CC Technology in Ethiopian Banking Sector.", A Thesis Submitted in Partial Fulfillment of the Requirement for the Degree of Master of Science in Information Science, October, 2014.

[55] Z. S. Alkindi, J. Haynes, and S. Arockiasamy, "A Conceptual Architectural Framework of Cloud Computing for Higher Educational Institutions in the Sultanate of Oman," *Journal of Emerging Trends in Computing and Information Sciences*, vol. 6, no. 9, pp. 482–487, ISSN 2079-8407, September 2015.

[56] Alemeye, F., & Getahun, F. "Cloud Readiness Assessment Framework and Recommendation System," *In AFRICON, IEEE,* pp. 1-5, September, 2015

57] El-Alfi, A. I., Amin, A. E., & El-Hosary, O. M. "Adopting Cloud Computing Technology to Enhance the Architecture of a Proposed Learning Content Management System," *International Journal of Computer Applications*, vol. 153, no.6, 2016.

[58] Almubarak, S. S. "Factors influencing the adoption of cloud computing by Saudi university hospitals," *International Journal of Advanced Computer Science and Applications* (IJACSA), vol. *8, no.*1, 2017.

[59] Singh, M., Tanwar, K. S., & Srivastava, V. M., "Cloud Computing Adoption Challenges in the

Banking Industry.," *International Conference on Advances in Big Data, Computing and Data Communication Systems (icABCD),* pp. 1-5, IEEE. August 2018.

[60] Noor, T. H. "Usage and Technology Acceptance of Cloud Computing in Saudi Arabian Universities.," *International Journal of Software Engineering and Its Applications*, vol. *10, no.* 9, pp. 65-76. 2016. Available: http://dx.doi.org/10.14257/ijseia.2016.10.9.07

[61] Awosan, R. K. "Factor Analysis of The Adoption of Cloud Computing in Nigeria.," *African Journal of Computing & ICT*, vol. *7, no.*1, pp. 33-42, 2014.

[62] El-Alfi, A. I., Amin, A. E., & El-Hosary, O. M. "Adopting Cloud Computing Technology to Enhance the Architecture of a Proposed Learning Content Management System.," *International Journal of Computer Applications, vol.153, no.6,* pp. *975*, 8887 2016.

[63] S. S. Almubarak, "Factors Influencing the Adoption of Cloud Computing by Saudi University Hospitals," *Int. J. Adv. Comput. Sci. Appl.*, vol. 8, no. 1, pp. 41–48, 2017

[64] Kumar, Ranjit.," Research Methodology: A Step-By-Step Guide For Beginners. S*age Publications Limited,* 2019.

[65] Kothari, Chakravanti Rajagopalachari.," Research Methodology: Methods and Techniques," *New Age International*, 2004

[66] Babbie, Earl R.," The practice of social research," *Nelson Education*, 2015

[67] T. Oliveira, M. Thomas, and M. Espadanal, "Assessing the determinants of cloud computing adoption: An analysis of the manufacturing and services sectors," *Inf. Manag.*, vol. 51, no. 5, 2014.

[68] B. S. Shukur, M. Khanapi, A. Ghani, and M. A. Burhanuddin, "An Analysis of Cloud Computing Adoption Framework for Iraqi e-Government," *International Journal of Advanced Computer Science and Applications* (IJACSA), vol. 9, no. 8, pp. 104–112, 2018.

[69] Gangwar, H., Date, H., & Ramaswamy, R., "Developing a Cloud-Computing Adoption Framework.," *Global Business Review, 16*(4), 632-651, 2015.

[70] Erind Hoti.,"The Technological, Organizational and Environmental Framework Of IS Innovation Adaption In Small And Medium Enterprises Evidence from Research over the Last 10 Years. *International Journal of Business and Management,* Vol. III(4), pp. 1-14., 2015 10.20472/BM.2015.3.4.001.

[71] Wikipedia. "Mean opinion score" Internet: https://en.wikipedia.org/wiki/Mean_opinion_score, 6 April 2019 [01 June 2019].

[72] B. J. Babin and R. E. Anderson, *on Multivariate Data Analysis Joseph F . Hair Jr . William C . Black Seventh Edition*. .

ANNEXURES

Annex 1 (*Shows the request latter and selected number of asked questions for domain experts*)

Dear Participant,

I am currently undertaking a Master Degree in Department of Computer Science at Hawassa University. In fulfillment of my dissertation, I am required to research a topic area. The topic i have chosen is "Developing a Decision Framework for Cloud Computing Adoption in Ethiopia Higher Education Institutions." More specifically, the research aims to investigate the proposed frame work.

The questionnaire is for the research purpose only. There is no right or wrong answers. All responses will be kept strictly confidential. The questionnaire only will take few minutes of your time. The information obtained from the questionnaire will construct the basis of the scientific work and will not be used for any other purpose.

Thank you for considering your participation. If you would like to receive feedback on my study or have any concerns or questions about the research, please contact me selam.deslagne123@gmail.com. Thank you for giving the time completes the questionnaire. Your views are critical for the success of the research study.

Question No.	Please rate the extent to which you agree or disagree with the following statements.	1 = Strongly Disagree 5 = Strongly Agree				
q1	The proposed conceptual framework provides a knowledge sharing environment to support cloud adoption decision making.	1	2	3	4	5
q2	The proposed framework would reduce the cost.					
q3	The proposed framework would reduce the time.					
q4	The implementation of the proposed framework fits with EHEIs problems.					
q5	The content of proposed framework is relevant.					
q6	The content of the proposed framework is clear.					
q7	The proposed framework helps EHEIs to analyze the influential factors.					
q8	The proposed framework is comprehensive in terms of coverage.					
q9	The content of the proposed framework is complete.					
q10	The organization and presentation of the framework is suitable for EHEI's.					
q11	The proposed framework is applicable in Ethiopia context.					
q12	The proposed framework is acceptable.					
q13	The proposed framework is realistic.					

Annex 2: (*Shows the request latter and selected number of asked questions for initial survey*)

Dear Participant,

I am currently undertaking a Master Degree in Department of Computer Science at Hawassa University. In fulfillment of my dissertation, I am required to research a topic area. The topic I have chosen is "***Decision Framework for The Usage of Cloud Technology in Ethiopia Higher Education Institutions***" the questionnaire is structured to research the student perceptions, ICT Mangers and related professional of Cloud technology in Ethiopia. More specifically, the research aims to investigate cloud computing readiness of EHEIs in Ethiopia.

The questionnaire is for the research purpose only. There is no right or wrong answers. All responses will be kept strictly confidential. The questionnaire only will take few minutes of your time. The information obtained from the questionnaire will construct the basis of the scientific work and will not be used for any other purpose. Result of the study will promote our understanding of CC adoption by EHEIs and the factors influencing the institutions adoption decision.

Thank you for considering your participation. If you would like to receive feedback on my study or have any concerns or questions about the research, please contact me selam.deslagne123@gmail.com. Thank you for giving the time completes the questionnaire. Your views are critical for the success of the research study.

Definition:

Cloud is the combination of both applications delivered as services over the internet, and data centers hardware and software that provide those services, and the users can use those services by on-demand service model and a "pay as you go" payment method where the users use the service when they need it and pay only for what they used of computing resources, also users can access everything on the cloud by PC's, Laptops, Smart phone…"

It is a technology that uses the internet and central remote servers to maintain data and applications. Cloud computing allows consumers and businesses to use applications without installation and access their personal files at any computer with internet access. This technology allows for much more efficient computing by centralizing storage, memory, processing and bandwidth.

Part A:

General Information

1) Institutions _____
2) Department _____
3) Education Level:
    a. Under Graduate/ Bachelor degree b) Post Graduate/Master degree c) PhD
4) What is your job title? Please select for the appropriate option
    a. Lecturer
    b. IT Manger/ICT Director
    c. Head of Department
    d. College Dean
    e. Team Leader/ Academy with administrative position
    f. IT Expert
    g. other
5) How long have you worked in a University system?
    a. Below 2 years b) 2- 5 years c) 5+ years
6) What is your Stream/Specification of your study? Please Specfiy_____
7) If you are lecturer, what is the average number of students that you have in each class? Please Specify _____

Part B

Respondent Perception

1) What are the ICT services and supports that are provided to the university community by your institution?

    a) For Teaching learning process, students, lecturers and researchers

    b) For Administrative Staffs like, Registrar offices, finance offices, human resource offices and related offices in the university

    c) For co-operating with business partners, graduated student, on student on job training, giving support for developers and researchers from outside the university
2) Do you think that the higher educational institutions are currently utilizing technology effectively to deliver better service?
    a. Yes b) NO

3) If your answer is Yes, How would you rank your infrastructure?

a) Highly inefficient b) Inefficient

c) Efficient d) Highly Efficient e) I don't know

4) How would you rate your knowledge of CC?

a. I have an excellent knowledge about CC
b. I have a good knowledge about CC
c. I have some knowledge about CC
d. I have little knowledge about CC
e. I have no knowledge about CC

5) In your opinion, is cloud computing significant to your institution?

a) Yes b) No

6) Do you think adopting Cloud Computing would save money for your company?

a) Yes b) No

7) How many servers does u have on your institution? (TR)

a) Less than 10 b) 10-100

c) 500-1000 d) 1000 and more

8) What is an average age of the server? (TR)

a) Less than 1 year b) 2-5 year c) 5 year and more

9) How many of your servers are virtualized? _____

10) What is the bandwidth of the internet connection? (in Mb) _____

11) Do you have enough resources and skills to manage your systems in-house?

a) Yes b) No

12) Is there any plan to move to CC?

a) Yes b) No

13) If your answer is Yes, What stage is your institution in with regard to cloud services adoption?

a) Already used cloud based system b) Planning to adopt in 1-2 Years

c) Evaluating cloud for specific needs d) Learning to the cloud

e) It isn't discussed f) I don't know

14) If your answer is Yes, what kind of cloud model would you choose if your institution decide to adopt CC?

a) Public cloud b) Private cloud

c) Hybrid cloud d) Community cloud

15) In your view, would you consider Cloud Service Provider as having the capability and skills to handle any of your institution data?

a. Strongly Agree b) Agree

c) Not Sure d) Disagree E) Strongly disagree

16) If your answer is No, What technology decisions do you make? (Choose all that apply)

a. Purchase of software b) Purchase of hardware

c) Design of Network d) Design of server e) Other (Please specify)

17) What are the reasons for using cloud services?

a) Accessibility b) Enough storage capacity
c) Make backup of my files d) Editable
e) share data with my classmate and friends f) Enhanced collaboration and share ability
g) Increasing computing capacity h) Scalability of IT resources
i) Provide high Flexibility j) Not Applicable
k) Other please specify

18) In your opinion, what do you think that hinders the adoption to the cloud service adoption? (choose all that apply)

a) Security/ Fear of losing data b) Privacy

c) Limited Control d) Lack of Support

e) Inflexibility f) Change management issues

g) No support from top management h) Lack of funding

i) No skills j) No roadmap

k) Not applicable l) other (please specify)

16) Suppose you decide to move to the cloud, would you be willing to subscribe to more than one provider, say to back up your data to the other provider?.....single point failure

a) Yes b) No

17) How the technology adoption and use is governed in Ethiopia?

a) Government regulations

b) Technology Act

c) Agreements (between the government of Ethiopia and other technology regulatory bodies in an international level)

18) What are the main reasons for adopting Cloud Computing? Rank from 1 (Low) to 5 (High). ?

a) Flexibility and scalability of IT resources

b) Greater IT efficiency and agility

c) Avoiding capital expenditure in hardware, software etc

d) Increasing computing capacity

e) Cost reduction

f) Much greener way of managing IT

g) Mobility

19) What are the challenges that you are facing in adopting Cloud Computing? (Choose all that apply)

a) Change management issues

b) No support from top management

c) lack of funding

d) No design and architecture

e) No roadmap

f) Security

g) No skills

h) Other (please specify)

Part C

Research Model Constructs

When new IT investment is made or being considered, institutions/institutions will look at various innovation characteristics; technological factor; institutional factor and benefit characteristics.

Most Relevant	Relevant	Neutral	Irrelevant	Most Irrelevant
1	2	3	4	5

Innovation characteristics

Item	1	2	3	4	5

1. CC is easily connected with existing IT infrastructure on my institutions.
2. I believe that the relative advantage of cloud computing solutions is not significant enough to motivate adoption of the technology in my institution.
3. The skill needed to adopt CC is not seen as complex for employee in the institutions.
4. Using CC system is not seen as complex for the business operation on my institutions
5. I believe that Cloud Computing technology is an important component in enabling our IT service delivery.
6. CC compatibility is not an issue for my institution.
7. CC complexity is not an issue for my institution.

Technological Factors

Item	1	2	3	4	5

8. CC technology helps my institution to minimize the cost and manage the required services.
9. Security concern is very essential in order to adopt CC technology within my institution.

Institutional Factor

Item	1	2	3	4	5
10. Top management provides resources to support the adoption of CC.					
11. Top management is seriously considering the adoption of an appropriate cloud system in my institution.					
12. Top management supports the new technologies which serve the learning process and the university students.					
13. The size of an institution impacts its adoption of CC.					

Environmental Factor

Item	1	2	3	4	5
14. Government regulation can provide a better process for the adoption CC.					
15. There is no specific government policy, proclamation, signed agreement or any kind of binding document which is restricting or influencing the adoption and use of CC solutions in Ethiopia on adoption of CC.					
16. The external pressure is not strong enough to cause my organization use or adopt cloud solutions.					
17. The adoption of CC technology is included in strategic plan for IT center.					