ANALYSIS OF TECHNOLOGICAL FACTORS INFLUENCING ADOPTION OF ICT IN TEACHING AND LEARNING: A CASE OF GITHUNGURI SUB-COUNTY KENYA

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DECLARATION AND APPROVAL

Declaration by the Student

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

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We conform that the candidate under our supervision carried out the work reported in this thesis.

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DEDICATION

I dedicate this work to my Wife Wangeci, sons; Gakenga and Mathu, Mum; Elizabeth Wambui and the entire Gakenga's Family.

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ABSTRACT

Living in the digital age, it is hard for any aspect of human endeavor to be carried on effectively without information communication technologies. Empirical literature revealed that, the level of input on ICT resources for adoption of ICT fails to commensurate. The study established lack of conclusive research hence a research gap on technological factors influencing adoption of ICT. Literature revealed that ICT rapid change poses technological challenges to adoption of ICT, hence the need to review the adoption models. Critical review of identified models and theories indicates that, there are serious inconsistencies; knowledge gaps, which these theories and models have not explained; various models reviewed could not be self-sufficient and serve in all circumstances. Thus, leaving this study with a gap to establish technological factors in adoption of ICT and develop a technological adoption model. The study investigated how well Innovation Diffusion Theory DIO can be used to facilitate ICT adoption. The researcher adopted an exploratory research design, discussing the finding of the study on adoption of ICT, taking the case of Githunguri sub-county in the central part of Kenya. The researcher employed Descriptive Survey Design. Thirty-two schools gave a sample size of 637 respondents for the research. Quantitative data collected using questionnaires were analyzed using descriptive and inferential statistical techniques. To enhance understanding, the meaning of quantitative data the researcher used Qualitative data collected using interview and observation procedures. A wide range of literature was reviewed; among the developed countries where ICT is widely adopted are: Albania, Bosnia, Herzegovina, Bulgaria, Croatia, FYRO Macedonia, Republic of Moldova, Romania, Serbia and Turkey. In developing countries, some of which classified as economies in transition; Azerbaijan, Armenia, Georgia and Kyrgyzstan in Central Asia, Hong Kong Special Administrative Region of China, New Zealand, Malaysia, Singapore East Asia, Republic of Korea, Maldives in South and West. In Arab countries include; Egypt, Jordan, Oman, Palestine and Qatar. In Africa some of the countries considered are; Botswana, Gambia, Zambia, Niger, Guinea and Kenya. The scope of this study was technological factors emerging from the technology characteristics, limited to technological factors affecting current ICT, with no regard to any advancement of ICT while the study was in progress. This study assumed that: The state of ICT technological factors remained constant over the study period. This study investigated and established technological factors with strong significance on influencing adoption of ICT as; ICT infrastructure, ICT Trialability, ICT technical support, ICT complexity, ICT relative advantage, ICT hardware architectural rapid change, software portability, ICT adaptability. The researcher guided by the theoretical model developed and tested a technological adoption model. The researcher also developed an automated tool for assessing status of technological factors in adoption of ICT. The researcher recommends that, the government to establish policies and strategies for technical support. The ministry of communication and technology to adopt the model developed in this study to quicken the rate of adopting ICT. This study calls for more review on the theoretical model and the automated assessment tool.

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LIST OF ABBREVIATIONS AND ACRONYMS

CBI: - Computer-Based Instruction

ESP: - Economic Stimulus Program

G.O.K: - Government of Kenya

IT: - Information Technology

KICD: - Kenya Institute of Curriculum Development

SITES: - Second Technology in Education Research

CMC: - Computer-Mediated Communication

ICT: - Information and Communication Technology

NEPAD: - New Partnership for African Development

MHEST: -Ministry of Higher Education, Science and Technology

UNESCO: - United Nations Education, Scientific and Culture Organization

CCK: - Communications Commission of Kenya

OECD: -Organization for Economic Cooperation and Development

CHAPTER ONE

INTRODUCTION

This section presents the focus for this study and knowledge gap that the research aimed to address. The chapter entails the following sections: background of the research, statement of the problem, statement of the purpose, research objective, research quotations, justification, significance, scope, limitations, assumptions and theoretical framework of the research.

1.1 Background of the Study

The affordances of ICT have coincided with increasing demand for education at all levels. In line with this, ICTs have become foundational building blocks of modern society, within a very short time (Daniels, 2002). Many states terms understanding of ICT foundational skills and concepts of ICT as part of the core of education, alongside reading and writing numeracy. This is because ICT has the ability to support education and provide opportunities for effective communication to the adopters (Teeroovengadum, Heeraman and Jugurnath, 2017).

ICT is an all-inclusive word encompasses various devices used for exchange of information among communicators. These devices include, TV set, mobiles, radio, computers and networking hardware (H/W) and software (S/W), satellite systems, as well as the various services and applications (Elisha, 2006).

IT on the other hand is defined as technology that combines computing with high speed links transmitting sound, data and video (Spencer, 1992). On the same vein, ICT is defined as the technology that provides access to information through telecommunications (Christensson, 2010). Christensson argues that ICT is similar to IT, but ICT focuses predominantly on communication technologies (Christensson, 2010). This comprises of internet, wireless networks, cell phones and other communication mediums (Christensson, 2010).

In this context, ICT comprises not only H/W devices (i.e. equipment) but also to set of knowledge and skills those adopters require in order achieving a given level of competences as it relates to (Zuppo, 2012, p.19). On the other hand, Zhang, Shelly and Sun (2008) defines ICTs "technologies used in organisations for the purpose of processing information". Information Technology Infrastructure Library (ITIL), is referred to by Xiaojun and Yuki (2013) as; "the

most highly acknowledged method of IT service management in the world" (p.1). Xiaojun and Yuki (2013) define ICT as, the scientific method of manipulating data following programmed instructions to give out information useful in decision-making. In general, ICT includes all communication devices, information itself and related technologies. IT on the other hand is used in a narrower sense, typically excluding telecommunications (voice) technologies while including data networks as a reference to the system that support processing of information.

Over a number of years, there has been misunderstanding those ICTs that generally refer to computers and computing related activities. This debatable though computers and their application play a substantial role in modern information management. Other technologies and systems include phenomenon referred to as ICTs.

In the late 1980s, the word 'IT' (information technology) was substituted the term computer (Pelgrum and Law, 2003). This indicates a change on focus from computing technology to the capacity to store and retrieve data (Pelgrum, 2001). This was followed by the introduction of the term 'ICT' (Information and Communication Technology) in the early 1992 when electronic email reached the community (Pelgrum and Law, 2003).

The term ICT include provision of internet services telecommunication services and equipment, commercial information providers, media and broadcasting, Internet service provision, telecommunications equipment and services, libraries and documentation centers, network base information services and other related information and communication activities (United Nations Report, 1999). ICT can be regarded as a blend of Informatics technology and communication technology (UNESCO, 2002). ICTs include teleconferencing, audio conferencing, email, radio broadcasts, interactive voice response system, interactive radio, audio cassettes and CD ROMs (Sanyal, 2001: Sharma, 2003; Bhattacharrya and Sharma, 2007).

To form a well-founded background for this study the following tools were highly reviewed: Technological Advancement, Internet Technologies, Presentation Tools, Collaboration Tools, Social Network Tools, Virtual Tools, RSS Feed and Learning Management Tools as follows.

ICT has been undergoing technological advancements over the centuries, highly improving on computer hardware, software and networks. The technological innovation in ICT is more rapid today (Kramer, Jenkins and Katz, 2007). In the same manner ICTs is becoming wider in terms of magnitude than it was twenty years ago; it incorporates wider universe of players than ever

before (Kramer et al., 2007). In that light use of ICTs and support services are provided by entities ranging from corporate giants to garage entrepreneurs, individual developers and open source network Kramer et al., (2007). They further state that ICT now comprises H/W, S/W, internet (WWW), telephony and content application and support services. This broad and fast improvement resulting from extensive application of ICT including communication devices and applications. Additionally, internet technologies are among rapidly emerging ICT technologies.

Internet Technologies encompass numerous varieties of tools and technologies (Walsh, 2009). Walsh emphasizes on ten internet technologies, which educators should seek to utilize. These technologies comprise Podcast and Video. The most commonly used internet technologies for instructional settings being the video streaming (Walsh, 2009). Following is an overview of some of these tools as are of interest to this study. Identified internet tools and technologies were useful in explaining technological factors influencing adoption of ICT in work place procedures. They present adoption of ICT in teaching and learning (T&L), thus useful in explaining technological factors discussed in this study. Various technological factors discussed in this study, including SPA, TBL, OBS, CPL and need for T.S.

Presentation tools are massive and rich, useful in creating and sharing presentations. They range from simple PowerPoint slide players like SlideShare to multimedia timeline tools like Vuvox and OneTrueMedia (Walsh, 2009). Collaboration and Brainstorming Tools is another wide-ranging category including thought organizing tools like Mindmap and Bubblus. Web based Collaborative tools includes whiteboard and Google documents, wikis and virtual worlds (Walsh, 2009).

Most of internet users know of bloggers and blogging, but there are many more other internets professional users who are not frequenters of "blogosphere". ICT adopters should be aware of sites like WordPress and Blogger useful in creation of own blogs free, easily and faster (Walsh, 2009). In the same manner, adopters should be informed about sites like Wetpaint among other ICT / internet technology tools, enabling adopters to create free wiki web sites as a great way of getting started with using wikis for educational applications (Walsh, 2009).

Social networking S/W; Facebook, Myspace and LinkedIn Walsh (2009), are essential to adopters, as they enable networking of a wide range of professionals with specialties in a given area of ICT applications. ICT professionals' network can offer a great deal of technical support

to less skilled adopters. Therefore, adopters should be familiar with professional social networking sites like LinkedIn (Walsh, 2009). Moreover, Walsh recommends use of Meebo to permit adopters to combine messaging from Aim, Yahoo, Myspace, Facebook and other sites / Tools (Walsh, 2009).

Virtual Worlds – This technology is popular with Second Life existing as one of the best in ICT application. On the other hand, Active Worlds is one of a number of competitive technologies and provides a "universe" dedicated to education that has been popular with educators (Walsh, 2009). Active Worlds is one of a number of competitive technologies, and provides a "universe" dedicated to education that has been popular with educators (Walsh, 2009).

RSS Feeds, it allows adopters to generate their own "push" data stream (that is, define data flows user want to be receiving automatically instead of using "pull" for information with a google search or other browsing effort). RSS feed allow users to take advantage of streams of published content that will be sitting in them in boxes, or in RSS reader, when they are needed. RSS exist in a wide variety of topics and web sites.

Others include "LMS" (Learning Management Systems) including "Moodle" (Modular Object-Oriented Dynamic Learning Environment) used for the creation of the virtual classroom. Moodle created in the 1990s by Martin Dugiamas, specializing in Computer Assisted Education (CAE) (Blas and Fernandez, 2009). As divers' scholars may have perceptions and interpretation of which technologies are essential for adopters in this context, this study identifies with this list as a great one to start with. Of course, this list requires regular updating as technologies change and as adopters becomes better skilled with time (Walsh, 2009).

Nevertheless, lack of an ICT adoption model catering for technological factors and technical support, remains a big challenge to adopters. Therefore, investigating technological factors and developing a suitable model for adopters at hand is a worth effort for this study. On the same vein, it is not clear whether the list of technological factors in Roger's model, are exhaustive or not leaving more to be investigated (Lyytinen and Damsgard 2001). Considering the theory of Reasoned Action by Davis (1989) who developed the Technology Acceptance Model to examine the factors influencing individuals to accept or reject IT. As a result, considered

perceived usefulness and ease of use as very fundamental factors in adoption of IT (Davis, 1989).

Reviewed studies reveal that various models reviewed could not be autonomous and serve in all manner of situations. As technologies are not discrete packages, with distinct and measurable features (Lyytinen, and Damsgaard, 2001). This is strongly in line with Lee, Hsieh and Hsu (2011) who questioned the possibility that one model can be applicable in examining every instance of ICT adoption and implementation.

Review of scholarly work revealed that varying technological factors relate to adoption of ICT in varying areas of applications. Various technology adopters identify the factors dragging adoption of ICT in their area of applications. This has prompted researchers to analyze technological factors affecting their area of interest, hence developing several models. In support to this study, it was noted by various researchers that, little research has been done on technological factors influencing adoption of ICT in Kenya (Gikandi and Bloor, 2010; Macharia and Nyakwende, 2010; and Magutu et al., 2011).

Research has established the significance in relationship between technological factors and adoption of the technology. For instance, a significant relationship exists between Inter-Organizational Information System (IOIS) adoption and IOIS technological factors (Waithaka, Kimani, Korir and Muathe, 2013). Arguably, there is no specific length of the list of technological factors hence different studies have established different technological factors as it concerns their area of applications.

Technological factors as identified by various researchers including Tornatzky and Klein (1982), who identified ten attributes namely, i) Compatibility; ii) Relative advantage; iii) Complexity; iv) Cost; v) Communicability; vi) Divisibility; vii) Profitability; viii) Social approval; ix) Trialability and x) Observability. On the other hand, Premkumar, Ramamurthy and Nilakanta (1994) used this list to explore Electronic Data Interchange (EDI) diffusion: i) Compatibility; ii) Relative advantage and iii) Cost. Hai (1998) used a different set of six attributes: i) Relative advantage; ii) Compatibility; iii) Complexity iv) Trialability; v) Observability and vi) Risk.

Technical support and technological characteristics are key factors in their research (Peansupap and Walke, 2005). This is in line with those attributes identified by Waithaka et al., (2013)

technical support, infrastructure necessary for IOIS adoption, security of information sent over the IOIS link and complexity of the IOIS technology. On the same vein, technological infrastructure was identified as a technological factor in the study done by (Afaneh, AlHadid and AlMalahmeh, 2015) as well as in the research by (Makau, Omwenga and Muranga, 2015).

Theories, models and frameworks where developed in association with technological factors in adoption of innovation. Adoption of ICT like any other innovation is faced with various technological factors. Some of the important models considered in this study includes Diffusion of Innovation model (Rogers, 1995) and Technology Acceptance Model (Davis, 1989).

ICT application spans beyond communication, business automation, industrial automation and education (Elisha, 2006). This study is interested in application of ICT in teaching and learning (T&L). Diverse ICT products relevant in application of ICT in T&L include teleconferencing, interactive radio counseling, television lessons, radio broadcasts, interactive voice response system, YouTube, Internet, websites, animations audiocassettes and CD ROMs among others (Bhattacharya and Sharma, 2007).

1.2 Statement of the Problem

The level of input on ICT resources for adoption of ICT fails to commensurate. The rate of ICT adoption is the relative speed with which ICT is adopted my members of a community (Rogers, 1995). The same way, ICT exhibit a gap in its integration, where adopters' rate of use lags behind the rate at which institution is adopting the technology (Fichman and Kemerer, 1999). Despite that various researchers have attempted to explore this factor the rate of adoption is still low. This study re-examines the contributing factors from a broader methodological and conceptual perspective.

ICT adopters anticipate that low rate of ICT adoption to be resulting from technological factors, which hinder adoption of ICT. In the same manner, a study done on adoption of e-government adoption in Kenya by Makau, Omwenga and Muranga (2015) indicates that there are numerous technological challenges influencing implementation and adoption of ICT.

ICT rapid change poses technological challenges to adoption of ICT. For instance in the last five years computer architectures have gone from 1000 processors (CPU) to 100,000 CPU. These rapid architectural changes of hardware demand for redesigning of software to cope up

with new requirements (Al Geist, ORNL and Lucas, 2009). In the same line of understanding Maina and Nzuki (2015) called for further research at the lower levels of learning institutions, aiming at easing penetration of the technology adoption. Much of research work done in this area took place in UK, Australia, USA and some Northern European states including Finland and Norway. This indicates the need for similar research in other areas, which is one of distinct contribution this study makes.

Critical review of identified models and theories indicates that, there are serious inconsistencies which these theories and models have not explained (Long 2003). A study done by Lyytinen and Damsgaard (1991) to examine usefulness of DIO identified a theoretical gaps in DIO as it is inline with this study.

Previous research performed a qualitative meta-analysis on TAM and established that TAM fails to predict influencing variables in a number of studies (Legris et al., 2003). Additionally, there is lack of research on the effect of the perceived characteristics of innovation thus leaving a knowledge gap (Rogers, 2003). On the same vein Lyytinen and Damsgaard (2001) indicate that, it is not clear whether the list of technological factors in Roger's model are exhaustive or not, therefore leaving a knowledge gap which calls for further investigation.

Importantly, research has established that; Technologies are not discrete packages as DOI research associates an innovation with distinct and measurable features (Hai 1998; Premkumar et al., 1994; Rogers 1995; Tornatzky and Klein 1982). As noted in the context of this study, stakeholders put a lot of effort and resources, but the rate of adoption is not proportionate. In support of this observation, various researchers (Afe, 2002; Olakulehin, 2007 and Olatokum, 2008) indicate that integration of ICT in African schools faces diverse challenges hence the rate at which ICT is diffusing in T&L is too sluggish.

Research on e-learnig readiness in public secondary T&L in Kenya, revealed that presence of computer hardware in schools is not a complete indicator of ICT adoption (Gordon and Kyambo, 2014). In the same line, the success of the implementation of ICT do not depend a single factor, but is influenced through active process including a set of interrelated factors.

1.3 Purpose of the Study

The purpose of this study is to develop a model for adoption of ICT in T&L.

1.4 Objectives of the Study

This study aimed at exploring technological factors influencing adoption of ICT in teaching and learning, guided by the following objectives:

i. To identify technological factors influencing adoption pf ICT in T&L,
ii. To examine the influence of technological factors in adoption of ICT in T&L,
iii. To use identified technological factors in developing a model for adoption of ICT in T&L,
iv. To validate the model developed for adoption of ICT in T&L.

1.5 Research Questions

i. Are there technological factors influencing adoption of ICT in T&L in Kenya?
ii. What is the extent to which ICT technological factors influence adoption of ICT in T&L in Kenya?
iii. Do theories and models in place cater for ICT technological factors influencing adoption of ICT?
iv. Are there validations for the model developed?

1.6 Justification of the Study

Having invested in ICT resources, research and knowledge, this study responds to the need for investigating technological factors influencing adoption of ICT in T & L in Kenya. Even after conducting a number of studies on adoption of ICT in various developed countries, there is no common agreement on factors influencing adoption of ICT (Alimazighi and Bouchbou, 2009). Cosequentially, little research has been done in the effort to establish technological factors that are determinant in adoption of ICT in Kenya (Gikandi and Bloor, 2010; Macharia and Nyakwende, 2010; Magutu et al., 2011). Records show that; availability of ICTs is not an assurance that ICT adoption is taking place (Gordon et al., 2014). Hence, the need for a reliable model to useful on adoption of ICT (Cuban et al., 2001).

It is not clear whether the list of technological factors identified is covering all features that affect adopters' behavior. It is questionable why technical styles do not appear in the list while past studies on technologies demonstrate the contrary (Hughes, 1987). Again, what is the

justification for characterizing all technological innovations with the same set of attributes (Hughes, 1987).

In the interest of adding to this body of knowledge, this study fills the gap identified by Rogers (2003), on the need to research on the effect of perceived characteristics of innovation. The research reviewed the technological factors in adoption of ICT and investigated the impact of ICT technological factors on adoption of ICT in T&L. On the same vein, it is therefore important to investigate for more technological factors, as the list of technological factors in Roger's model could not be complete (Lyytinen and Damsgaard, 2001).

To equate technological advancement with its rate of adoption there is need to investigate further and develop on site models for adoption, as technologies are not discrete packages, with distinct and measurable features (Lyytinen, and Damsgaard, 2001). As Rogers (1995) defined DOI, research associates an innovation with distinct and measurable features (Hai 1998; Premkumar et al., 1994; Rogers 1995; Tornatzky and Klein 1982). With this sort of definition, several difficulties arise calling for research on technological factors influencing adoption of ICT in T&L.

In the advent of incorporation of ICT to learning process, institutions need to embrace profound models that relate to effective integration of the ICT into their programs. Therefore, this study shall significantly help institutions to realize their ability to benefit from the technology and embrace ICT. More so, the ministry of communication and technology will benefit from application of the new models in facilitation of adoption of ICT in the country's programs like; "The Jubilee Government Laptop Project, 2013", which may enjoy a lion's share from the findings of this study.

Significantly, having noted that there is limited research on technological factors affecting adoption of innovation and technology in Kenya. It is important to establish the technological factors that are determinants of ICT adoption in Kenya (Gikandi and Boor, 2010; Macharia and Nyakwende, 2010; Magutu et al., 2011). This study further investigated, analyzed and presents its findings on technological factors influencing adoption of ICT in T&L.

On the same vein, this study responds to the call by Maina and Nzuki (2015), who called for further research at lower institutions of T&L to enhance adoption of ICT. In responding to this call, this study investigated technological factors in technology adoption theories and models.

This helps to narrow integration gap stated in section 1.2, paragraph one of this study (Fichman and Kemerer, 1999).

Considerably, this study developed a model responding to Oliveira and Martins (2011) call, for research that fills this gap; "combine more than one theoretical model to achieve a better understanding of the IT adoption phenomenon" (p.120).

Consequently, findings of this study are essential in developing a technological model for adopting ICT in T & L. Regulators will benefit from findings of this study, while formulating policies relating adoption of technology. This is in line with views of and opinion of Kamau and Sanders (2013), who explains that it is important to formulate policies to facilitate adoption of ICT. This study provides important details for further research to scholars, interested on technological factors on adoption of ICT. The reason is that; it is in line with the realization that the GOK is conscious of the benefits of adopting ICT in areas like education (Waithaka et al., 2013). GOK takes ICT as a basic need in building future careers Waithaka et al., (2013). Finally, there is richness on technological factors analyzed and a range of models and theories considered in the development of a conceptual framework.

1.7 Scope of the Study

This study payed attention to technological factors emerging from the technology characteristics, including; compatibility, complexity and technical support in the context of adoption of ICT in T&L.

1.8 Research Limitations

This study refers to technological factors affecting current technology, with no regard to any advancement of technology while the study was in progress. Interpersonal issues: some respondents required time to be convinced on the positive purpose of the study and thus informed consent was so useful.

1.9 Assumptions of the Study

This study assumed that: The state of ICT technological factors remained constant over the study period. Respondents were truthful & honest and state of ICT with the sampled respondents was representative of the target population.

1.10 Structure of this Thesis

This thesis is subdivided into five chapters. The first chapter is the introduction of the research. It describes the problem background and statement, study objectives, scope of the study and contribution of the study, justification and significance of the study.

The second chapter follows with the literature review. Literature review entails detailed findings of from accessible literature relating to technological factors influencing adoption of ICT in T&L. The conceptual framework is also presented in this chapter and finally a recap of literature clearly defining the existing gaps in this area.

The third chapter focuses on the research methodology. It describes the research methods and materials used to achieve the objectives of this study. Following is Chapter four which presents the data analysis results. Chapter four also presents the development and validation of proposed model with focus on each of the indicators considered to be critical technological factor influencing adoption of ICT in T&L. This chapter answer the research questions in relation to objectives of this study, draws conclusions based on the statistical analysis and discuss the research analysis results. Lastly, Chapter five presents the summary, conclusions and recommendations based by the findings of the study.

1.11 Summary of Chapter One

In summary, the purpose of the study was to develop a technological model for adoption of ICT in T&L. The model developed in this study shall be useful in helping ICT adopters to understand technological factors in adoption of ICT. In justification, in the effort to establish technological factors influencing adoption of ICT, this study established there is very little research. Reviewed studies supported the need for this study; Alimazighi and Bouchbou (2009) discusses that, there is no common agreement on factors influencing ICT adoption. In support of this study (Gikandi and Bloor, 2010; Macharia and Nyakwende, 2010 and Magutu et al., 2011) state that, little research has been done to establish the technological factors that are determinants in adoption of ICT in Kenya.

This study agrees with Hughes (1987), that the list could not be complete, hence the need for further research on technological factors influencing adoption of ICT in T & L. Significantly there is need to demonstrate ICT adoption model for secondary T & L, outlining technological

factors of interest, for technologist to improve on them, for ease of adoption of ICT. The scope of this study was restricted to current technological factors emerging from the technology characteristics.

In conclusion, this chapter explained the purpose of this study, described the context discussed in the statement of the problem, outlined research question, stated research objectives, outlined research assumptions, discussed scope and limitations of the research. This chapter therefore created the need for further review of the research on technological factors affecting adoption of ICT in T&L as in chapter two below.

1.12 Operational Definition of Key Terms

Innovation: -refers to a practice, an idea or object that is perceived as new by individuals for adoption.

Adoption: - Full use of an innovation as the best course of action available

Diffusion: - is the process of communicating innovation through certain channels over time among the members of a social system.

Technical support (T. S): - Provision of assistance on technology complex skills and professional specialties.

Technology (IT): -IT refers to anything related to computing technology, such as networking, hardware, software, the Internet, or the people that work with these technologies.

Information Communication Technology (ICT): -The application of science to the processing of data, according to programed instructions in order to derive results.

Technological factors in adoption of ICT: - are factors emerging from the technology characteristics, which are influential in adoption of the same technology.

Relative advantage (RA): -refers to the degree of perceiving an innovation as better than the idea it supersedes.

Compatibility (CPA): -Compatibility is the unit to which an innovation perceived as unfailing with the prevailing standards, historical familiarities, and requirements of possible adopters.

Complexity (CPL): **–** ICT complexity is the degree to which ICT perceived as relatively difficult to understand and use.

Trialability (TBL): - is the degree to which an innovation may be experimented with a limited basis.

Observability (OBS): - is the degree to which the results of an innovation are visible to others.

Social approval: -The status gained in one's reference group, "a non-financial aspect of reward".

Communicability: -The degree to which aspects of an innovation may be conveyed to others Tornatzky and Klein.

Divisibility: -The extent to which an innovation can be tried on a small scale, prior to adoption.

Profitability: -The level of profit gained from adoption of the innovation.

Technological infrastructure (TI): -Technological infrastructures include computer hardware, internet connectivity, Electricity supply, and the potential of portable and alternative energy technologies.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction of the Literature Review

The review focused on synthesis of the literature on adoption of ICT, with emphasis on the technological factors emerging from technology characteristics. Ideally, these technological factors require a review in relation to a given area of application; to gather relevant information for the study, it is important to review related literature with considerable bias towards technology literature. Therefore, this study did a review in the context of ICT technological factors affecting adoption and integration of ICT in T&L.

In more details, the study was set to investigate and assess ICT technological factors. The study explored the technological and technical issues, emerging as the study moved on to distinguish local needs, the supporting factors and bottlenecks on technology use in this developing context. Identical factors include T.S, ICT infrastructure like access to internet, bandwidth, hardware and software provision.

2.2 Adoption of ICT in Teaching and Learning

Levels of adoption of ICT in T&L were considered at this section grouping them as adoption of ICT in developed countries, adoption of ICT in non-African countries developing countries and African countries. Kenya was considered on its own in level of ICT infrastructure in general.

2.2.1 Adoption of ICT in T & L in Developed Countries

ICT has been widely adopted in T & L in developed countries. Among the developed countries where ICT is widely adopted are: Albania, Bosnia, and Herzegovina, Bulgaria, Croatia, FYRO Macedonia, Republic of Moldova, Romania, Serbia and Turkey (Petia Assenova, 2005).

Common indicators of adoption of ICT in T&L in these countries include: Presence of computers in school, computer networks, increased Learner-to-Computer Ratios, Computer Assisted Learning (CAL), use of School Website and learning ICT as a subject or using it as tool (Petia Assenova, 2005). In United States of America, the LCR ratio ranges from about 9:1;

in Florida to about 63:1; in Louisiana, students attending poor and high-minority schools have less access than student attending other schools (Petia Assenova, 2005). Figure 1 below shows number of students per computer as indicated by (Coley, Cradler and Engel, 1997).

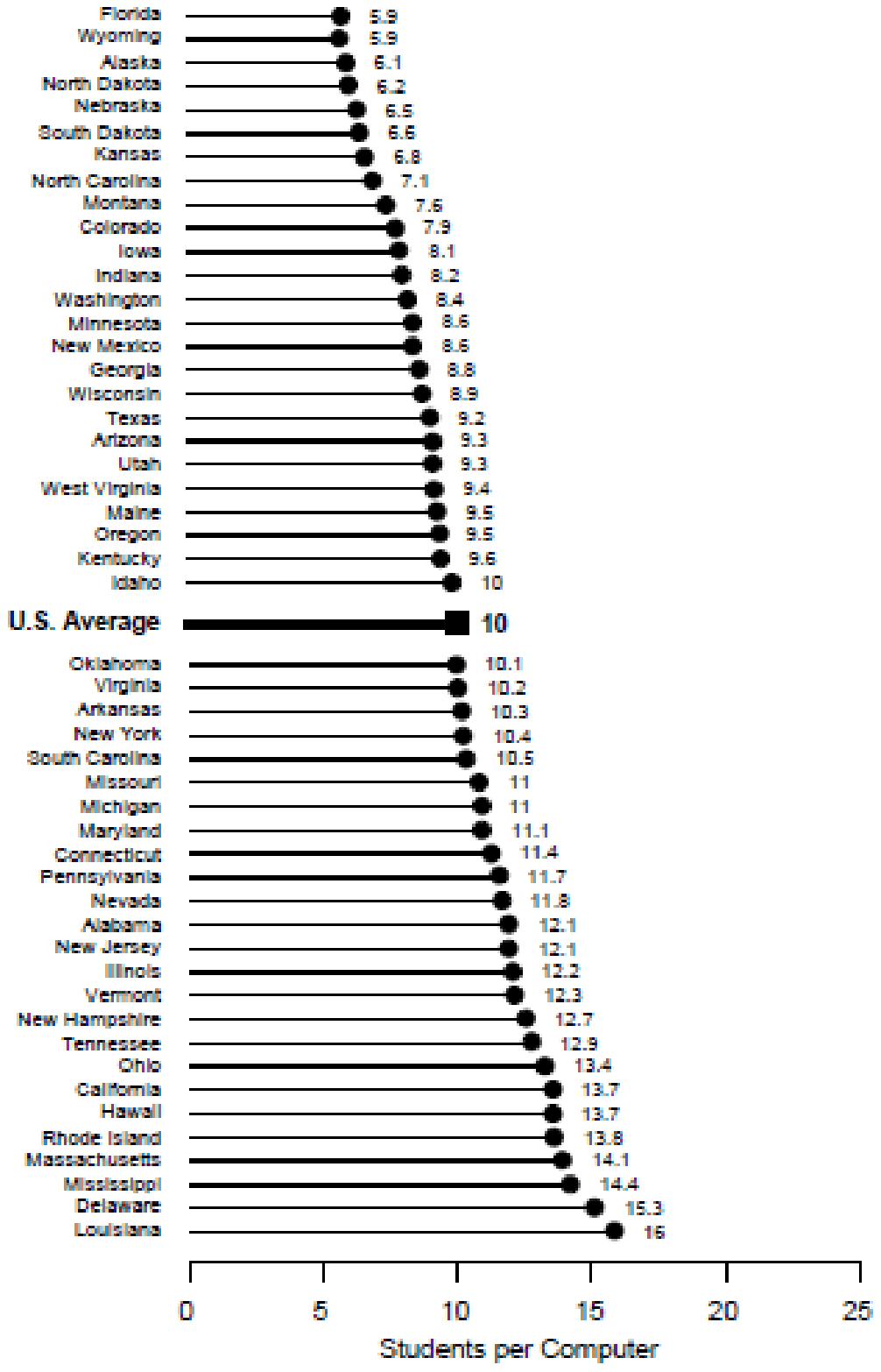

Figure 1. Students per Computer in USA (Source QED, 1997).

In Albania, 30% of schools have a computer laboratory and in school, the learner-computer-ratio (LCR) is 60:1. A few schools in Albania have local network for T&L rated as 1% (Petia

Assenova, 2005). In Croatia and FYRO Macedonia, 100% of school shaves a computer laboratory and learning resource center LCR of 17:1, 150:1 respectively. 90% of computers in Croatia are modern, bought after 1995. 100% of computers in FYRO Macedonia are modern bought after 1995 with a 100% LAN similar with Croatia (Petia Assenova, 2005).

In Romania, 40% of schools have a computer laboratory, an LCR of 25:1, modern computer not bought before 1995, 70% of schools having a LAN (Petia Assenova, 2005). In Serbia and Bosnia, over 90% of schools have got computer laboratories, an LCR of less than 50:1, Bosnia and Montenegro have 55% of computers being modern that bought after 1995. Bosnia has about 5% of its schools connected to a LAN. Montenegro has about 55% of computers connected into a LAN. 35% of schools in Bulgaria have computer laboratory and an LCR of 40:1 in school. About 65% of schools have a LAN and modern computers bought later than 1995 (Petia Assenova, 2005).

Adoption of modern technologies in ICT are becoming popular in T&L. Developed countries have been able to adopt use of web 2.0, smart board and cloud computing among other innovations in T&L (Ministry of Education Spain, 2015). For instance, in Spain an ICT platform, web 2.0 is widely used with a community of more than 10,000 teachers sharing knowledge, experiences, digital material and resources. They are created, organized and managed by the very user of web 2.0 platform (Ministry of Education Spain, 2015). This is because of strong support given by MOE in Spain through actions of: EducaLab, Procomún and CeDeC (Ministry of Education Spain, 2015).

2.2.2 Adoption of ICT in Non-African Developing Countries

In developing countries, ICT is a priority in education. Past studies show that various developing countries adopt ICT in T&L. Some of these countries are also classified as Economies in transition; Azerbaijan, Armenia, Georgia and Kyrgyzstan in Central Asia, Hong Kong Special Administrative Region of China, New Zealand, Malaysia. Others include; Singapore East Asia, Republic of Korea, Maldives in South and West Africa (UNESCO, 2014). In Arab countries; Egypt, Jordan, Oman, Palestine and Qatar, are listed among Economies in transition (UNESCO, 2013).

In the effort to facilitate adoption of ICT in T&L in developing countries, computer equipment's are available to the learners. To determine adoption of ICT in T&L, we consider reviewing

learner computer ratio. In this approach, study revealed that: Nepal has LCR of 378:1 in lower secondary. In Cambodia has LCR of 44:1 in lower secondary. Singapore emerges the best with a ratio of 4:1 for both primary and secondary education and in Korea Republic we have LCR of 5:1 for both primary and secondary education combined (UNESCO, 2014).

Korea is termed as an "educational powerhouse", with the top ranking at Program for International Student Assessment (PISA) (Hwang, Yang and Kim, 2014, p.134). The program run by Organization for Economic Co-operation and Development (OECD) (Hwang, Yang and Kim, 2014, p.134). Korea is an ICT powerhouse with the world's second-best ICT infrastructure, ranked number one in technological excellence and penetration (Hwang, Yang and Kim, 2014, p.134).

This study reviewed adoption of ICT in T&L of Arab countries including Egypt, Jordan, Oman, Palestine and Qatar. In Egypt, 42% of schools have a computer laboratory; LCR is at 25:1 supporting CAI up to 96% with 94% connection to internet. In Palestine, 71% of schools have a computer laboratory, with 100% support services and LCR is at 13:1 supporting CAI up to 76% with 87% connection to internet. In Jordan, 96% of schools have a computer laboratory; with LCR supporting CAI up to 97% in lower secondary is at 15:1 with 20% connection to internet, 92% able to access technical support and 81% with a LAN. In Oman 100% of schools have got a computer laboratory, with 85% LAN and an LCR of 20:1 supporting CAI up to 100%, 21% are connected to internet and 95% able to access ICT technical support. In Qatar, 42% of school have a computer laboratory, with 39% LAN and LCR is at 10:1 in lower secondary supporting CAI up to 50%, with 12% connection to internet (UNESCO, 2014).

2.2.3 Adoption of ICT in T&L in African Countries

In Africa, the ratio of Learner to computer in lower secondary is low. For instance: in Botswana 15:1, in Gambia 66:1, Zambia 145:1, Niger more than 500:1 and Guinea more than 500:1. This is a clear indication that in most of African countries, computer resources are highly overstretched (UNESCO, 2015).

2.2.4 Adoption of ICT in T&L in Kenya

In Kenya a survey conducted by Digital International indicates that the proportion of schools, without electrical power range from 58% to 96% in some rural area making use of available

ICTs considerably difficult (MOE, 2006). Following the challenge on lack of electricity in most of public schools in kenya, the government of kenya started a programe to electrify all kenyan schools. This lead to electrification of 4,448 public schools out of 6,926, remaining with 2,427 to be electrified by the end of the year 2012 Ayeko(2011), see appendix XII.

Where there is electricity, other infrastructural factors hindering adoption of ICT in CAI include lack of internet connectivity and high cost if associated with digital equipment (MOE, 2006). About 90% of secondary school needs to establish standard Local Area Networks (LAN) in order to improve and allow for CAI (MOE, 2006). According to MOE (2006) in Kenya LCR is at 150:1 taking it as an average in all levels of education.

In summary, the literature reviewed above leads to appreciating that adoption of ICT in T&L has gained a lot of focus and effort in the world. Developed countries, developing countries and even low-income countries all invest in adoption of ICT with a lot of concern. Nevertheless, "There are surely huge variances amongst states whereby numerous states have complete assimilation, while others have very low assimilation levels, mainly in Central and South America" (Briggs, 2013). For Example, the "LCR ranges from 1:1 in Uruguay, where there exist robust policies concerning the assimilation of ICT in education, to 122:1 in the Dominican Republic" (Briggs, 2013). At times there is higher LCR higher of 500:1: in Zambia, Niger, Guinea, Madagascar, Lesotho and Guinea UNESCO (2015) in low income economy (WESP, 2013).

2.2.5 Levels of ICT Infrastructure Required for ICT Adoption

Technological infrastructures include hardware and internet connectivity (Menda, 2006; Janczewski, 1992, Pelgrum, 2003), Electricity supply, and the potential of portable and alternative energy technologies (Hennessy, Harrison and Wamakote, 2010).

To support adoption of ICT in developed countries and middle-income countries, basic electricity connection is established (UNESCO, 2014). A study done to examine national capacity to support the integration of ICT in education, revealed that in these countries failure of adopting ICT in education cannot be attributed to lack of infrastructure (UNESCO, 2014).

Developed countries use Telecommunication facilities to deliver the necessary infrastructure to improve numerous varieties of internet connectivity (UNESCO, 2014). Fixed transmission

media providing both broad band and narrow band internet is established. Again, varying mobile technologies provide connectivity including 3G and 4G (UNESCO, 2014).

Electricity supply and internet connectivity in developed countries in education institutions are at 100% mark (WESP, 2014). For instance, New Zealand being a high-income economy WESP (2014) has a 100% electricity and internet connectivity for T&L. At this point, it is therefore significant to look at some analysis on ICT infrastructure; electricity, internet, networks and computers.

In developed countries ICT infrastructure are: in Albania 90% of secondary schools with computer laboratories, 90% connected to a LAN, LCR of 60:1 and 3% access to internet. In Bulgaria 36% of secondary schools with computer laboratories 5% connected to a LAN, LCR of 50:1 and 65% access to internet. In Bosnia 50% of secondary schools with computer laboratories 64% connected to a LAN and LCR of 40:1. In Croatia 90% of secondary schools with computer laboratories 100% connected to a LAN, LCR of 17:1 and 100% access to internet. In Macedonia 100% of secondary schools with computer laboratories 100% connected to a LAN, LCR of 150:1 and 100% access to internet. In Moldova 54% of secondary schools with computer laboratories 54% connected to a LAN, LCR of 50:1 and 10% access to internet. In Romania 85% of secondary schools with computer laboratories 70% connected to a LAN, LCR of 25:1 and 85% access to internet. In Serbia and Montenegro 98% of secondary schools with computer laboratories 67% connected to a LAN and LCR of 32:1 see table 1 below.

Table 1:

TI in Developed Countries

Country	Computer Laboratory bought after 1995 %	Network [LAN] %	LCR	Internet	
				Dial up	Dedicated
Albania [ALB]	90	1	60	3	0
Bulgaria [BUL]	36	5	50	65	0
Bosnia [BIH]	50	64	40	-	-
Croatia [CRO]	90	100	17	99	1
Macedonia [MCD]	100	100	150	78	22
Moldova [MOL]	54	54	50	10	0
Romania [ROM]	85	70	25	80	5
Serbia & Montenegro [SCG]	98	67	32	-	-

Note. Adapted from, *(UNESCO 2005).*

In dissimilarity, electricity is a significant hindrance to integration of ICT in education in India and a number of least developed and developing countries (UNESCO, 2014). For instance, India has 68% of secondary schools connected to electricity, LCR of 89:1. Nepal has 24% of secondary schools connected to electricity, LCR of over 500:1. Myanmar has 4% of secondary schools connected to electricity (UNESCO, 2014). In Bangladesh secondary schools, 71% have electricity (UNESCO, 2014). Electricity though very basic in use of computers, remains a limited resource in most of least developed countries and developing countries, for example in Cambodia, where 24% of all public secondary schools are connected to a reliable power source to support the integration of ICT in the classroom with LCR of more than 500:1 (UNESCO, 2014).

Internet connectivity is another ICT infrastructure worth looking at in this study, as it is basic in adoption of ICT where to collaborate and share resources. Let us look at five Arab countries: Egypt Palestine, Jordan, Oman and Qatar. In Egypt, 42% of secondary schools have computer laboratory connected to internet up to 53%. In Palestine, 87% of secondary schools have computer laboratory with 45% connected to LAN, 31% connected to internet and an LCR of 30:1. In Qatar, 42% of secondary schools have computer laboratory with 39% connected to LAN, 53% connected to internet and an LCR of 10:1. In Jordan, 96% of secondary schools have computer laboratory with 81% connected to LAN, 87% connected to internet and an LCR of 15:1. In Oman, 95% of secondary schools have computer laboratory with 85% connected to LAN, 87% connected to internet and an LCR of 20:1 (UNESCO, 2013).

In sub-Saharan countries where there are computers in lower secondary school, research revealed that in Botswana all secondary schools are connected to electricity, LCR of 15:1 and 100% access to internet connection (UNESCO, 2014). In Mauritius, as well electricity connection is at 100% mark, LCR of 19:1 and 93% internet connection (UNESCO, 2014). In Gambia 53% of secondary schools connects to electricity power, LCR of 56:1 and 34% connectivity to internet. In Niger 11% of secondary schools connects to electricity, LCR of more than 500:1 and 2% connection to internet (UNESCO, 2014).

In Kenya, a survey conducted by Digital International indicated that the proportion of schools without electrical power range from 58% to 96% in some rural area, making use of available ICTs considerably difficult (MOE, 2006). About 90% of secondary schools need to establish standard Local Networks (LANs) in order to improve and allow for CAI (MOE, 2006). According to MOE (2006), in Kenya LCR is at 150:1, taking it as an average in all levels of education. In the same manner, let us look at figure 2 below summarizing levels of electricity and telecommunication facilities in some Asian Schools.

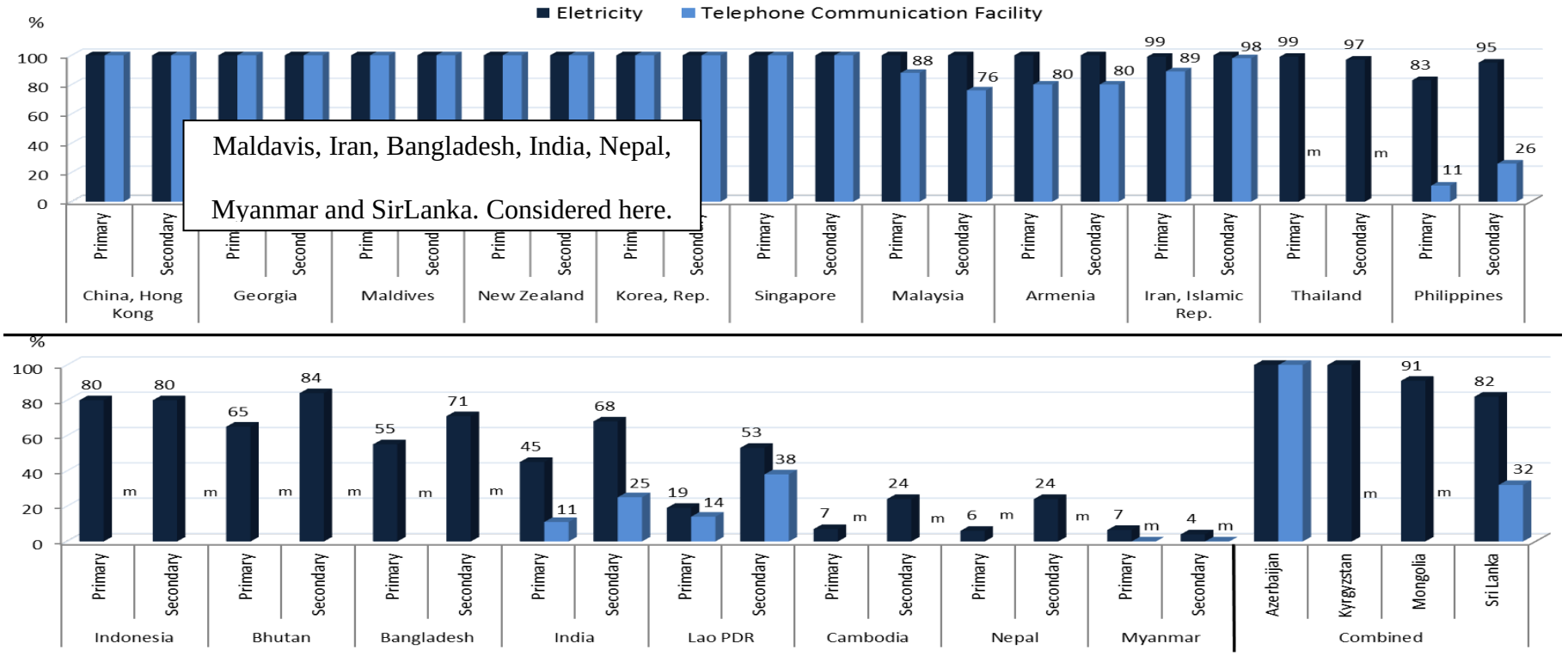

Figure 2. Proportion of educational institutions with basic electrical and telecommunications infrastructure by level of education, 2012

Source: A comparative analysis of ICT integration and e-readiness in schools across Asia (UNESCO, 2014)

On the contrary, as seen from figure 2 above, in least developed countries electricity is a significant hindrance to integration of ICT in education (UNESCO, 2014). This includes India having 68% of secondary school being connected to electricity. Nepal has 24% of secondary school being connected to electricity and Myanmar has 4% of secondary schools being connected to electricity (UNESCO, 2014). In Cambodia electricity is rare in schools, where only 24% of all public secondary schools are connected to a reliable power source to support the integration of ICT in the classroom (UNESCO, 2014). In Bangladesh and India, approximately one-half of primary school (55% and 45%) and two-thirds of secondary schools (68% and 71%) have electricity (UNESCO, 2014).

In Asia, the levels of internet connectivity vary. Internet connectivity is not common in countries with shortage of electricity and basic teleconferencing resource (UNESCO 2014). WWW connectivity is predominant low in South and West Asian states. For instance, in Leo PDR and Sir-Lanka 14% and 32% of secondary school connects to WWW (UNESCO, 2014). In contrast, Maldives, which has complete connectivity to electric power, also has WWW network connectivity, with 47% being a broadband (UNESCO, 2014). The Islamic Republic of Iran has also made progress in interconnecting its schools, with 89% of secondary schools, connected to WWW network (UNESCO, 2014).

In Asian developing countries CAI and computer workshops are entwined and similarly available in school; in Kyrgyzstan 86%, Azerbaijan 86%, Azerbaijan 84%, Maldives (40%) and in secondary education in Bhutan 66% and the Philippines 87% (UNESCO, 2014). See data shown in figure 3 above.

In African countries Secondary school, usually have moderately advanced levels of connectivity to electric power source (UNESCO, 2015). Evidently, in Niger where 77% of upper secondary schools connects to electric power likened to 4% of primary schools/ In Liberia where data is aggregated at school level, only 6% of primary and secondary schools combined have electricity (UNESCO, 2015). See more on electricity connection in African countries in figure 3 below.

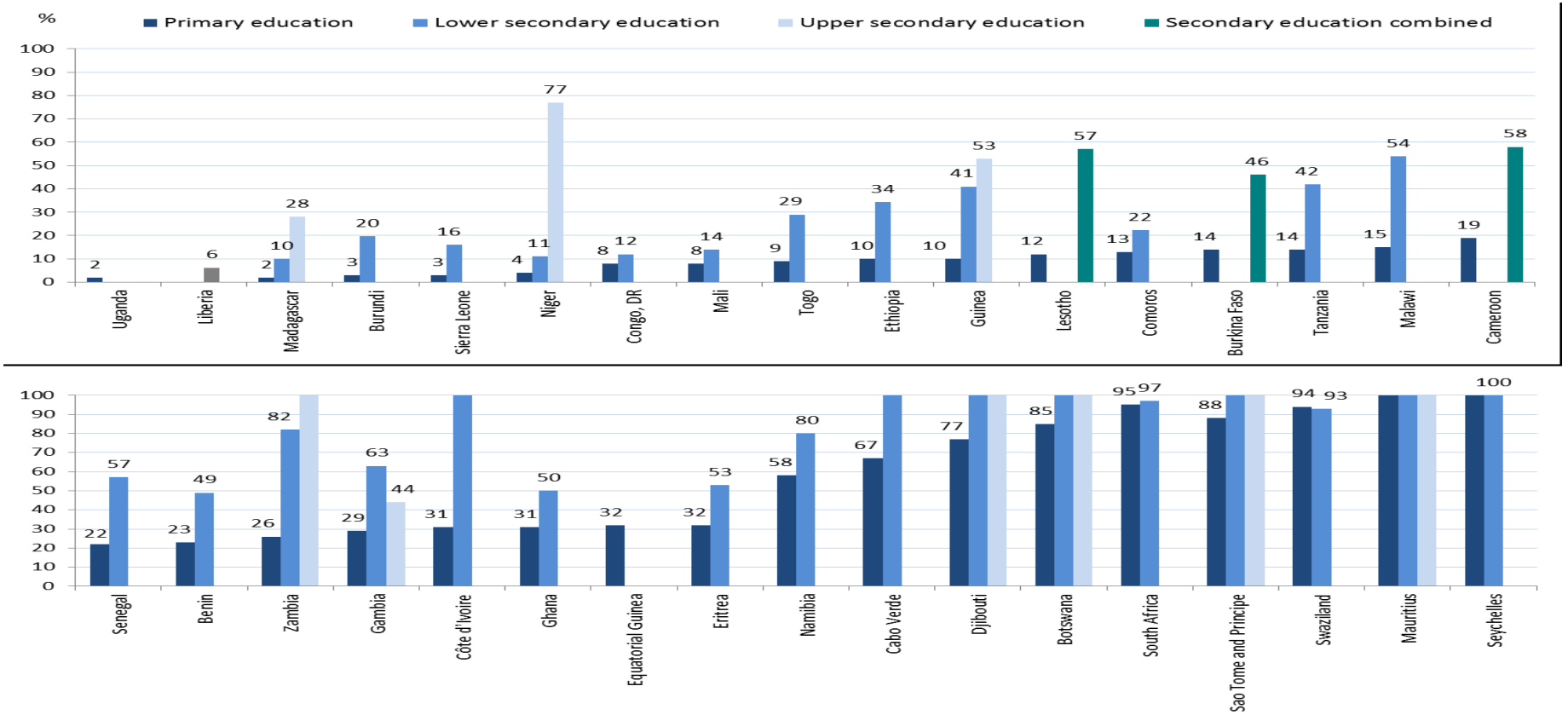

Figure 3. Electricity in public educational institutions, in primary and secondary education, 2013 source (UNESCO, 2015)

2.3 Trends in Adoption of ICT in T&L

In the world, there are essential progresses in the manner to which upcoming technologies are adopted. Obviously, there are varieties of new technologies applicable in T&L. This could help adopters reach their clients and continue delivering services to them outside confinement or restricted areas and buildings. Some of these technologies include Web 2.0 technologies (Davies and Merchant, 2009). Literature shows that there are adopters' worldwide employing ICT and Web 2.0 technologies in their daily activities.

The rapid development of ICT, improves hardware capability in less than 18 months (Al Geist, ORNL and Lucas, 2009). This rapid advancement on computer hardware introduces new technological factors influencing adoption of ICT. For instance, in the last 5 decades, the growing computational power of super computers have come from a doubling of clock frequency every one and a half year (Al Geist, ORNL and Lucas, 2009). This was arguably, made possible by increasing number of processors (Al Geist, ORNL and Lucas, 2009).

Increasing number of processor (core) in a single chip, lead to new technological factors; improved computational speed, but with constraints on overheating and new power requirements of the computer (Al Geist, ORNL and Lucas, 2009). Therefore, complexity of computer system results from continuous escalation of the number of CPU in the interest to increase the computer's power (Al Geist, ORNL and Lucas, 2009). In addition, the numbers of processors, in the computer of the next generation are to go higher than 100,000 processors (Al Geist, ORNL and Lucas, 2009). It is therefore important to research the emerging trends in ICT.

On emerging ICT trends, research revealed that far beyond development of computer hardware, advancement of ICT has seen a wide application in development of T&L tools like robots and e-learning software. In the same manner as the technology is rapidly developing, adopters are working hard to suit the intense developments in electronic environment (Han, 2012).

Today mobile technology, with popular devices such as iPhones, Android phones, and iPads, is steering our learning environment towards increasingly focusing on mobile learning or m-Learning (Han, 2012). Currently, most interfaces employ keyboards, mouse or touch technology, but some emerging input-interfaces use voice-based or marker-based gesture (Han, 2012).

Rapid development in ICT comes up with new compatibility issues with existing Computer Assisted Instructions (CAI). For instance, currently telepresence robots are in use, in some classrooms (Palk, 2010). Nevertheless, the gap between adoption of ICT in work place and ICT as a technology is very big. It is therefore important to research the technological factors emerging from ICT as technology advances. This study reviews the factors influencing adoption of ICT with bias to technological factors in adoption of ICT.

2.4 Technological Factors in Adoption of ICT

Considering availability of data, this study sampled countries to represent a given region. Available data were classified as from developed countries, non-African developing countries, African countries and sometimes South and East Africa.

2.4.1 Technological Factors in Adoption of ICT in Developed Countries

In developed countries, several studies have been undertaken. Some of these studies were revised to inform this study and the following were established on technological factors.

2.4.1.1 Technological Factors in Adoption of ICT in USA

To start with, a study conducted in United States of America by Accuosti (2014) states that absence of technical support is one of the external factors limiting not only the decision to deploy an innovation but also which specific innovation will be adopted.

On the other hand, Straub (2009) indicates that, lack of frequent use of technology by adopters may be attributed to the lack of technology resources. This is in line with findings of a study done by (Bauer, Reese and McAllister, 2003). Nevertheless, scholarly work done in North America indicates that accessibility of technological resources does not automatically interpret to better expected outcome this is basically due to incompetent application (Wozney et al, 2006; Ungerleider & Burns, 2002; Balanskat et al., 2006).

2.4.1.2 Technological Factors in Adoption of ICT in Israel

Regarding technical support, a study done in Israel by Verner and Korchnoy (2006) indicate that availability of technical literacy is useful in adoption of ICT in T&L. Acquisition of technical knowledge and skills as part of a professional training program can help engineering

students to develop the professional skills necessary for their careers (Verner and Korchnoy, 2006).

In Israel, ICT resources are available and used as an effective medium for T&L (Verner and Korchnoy, 2006). For instance, Verner and Korchnoy (2006) from Department of Education in Technology and Science, Technion Israel Institute of Technology, in their research on Experiential Learning through designing robots and motion behaviors, indicates that robotics have become an especially effective medium for engineering education as in line with (Pack, Avanzato, Ahlgren and Verner). Use of ICT (Robotics) involves students in professional communication, self-dependent knowledge acquisition, technical invention, interdisciplinary design, group assignments and exploration (Verner and Korchnoy, 2006).

2.4.1.3 Technological Factors in Adoption of ICT in Turkey

In Turkey, a study done in Turkish Cypriot pointed out on technical problems as well as absence of technical support (T.S) as hindrances to adoption of ICT. On the same vein Begum (2013), pointed out technical problems and inadequate technical support as factors that prevent use of ICT. In addition, providing high-level T.S on demand allows adopters to use ICT (Forgasz, 2006; Lim and Khine, 2006; Scrimshaw, 2004; Yilmaz, 2011; Assan & Thomas, 2012). Breakdown of ICTs causes interruptions. In the event that technical assistance lacks, then regular repairs lack hence adopters not using technology devices in work place (Jones, 2004).

Equally, access to ICT resources is important for adopters (Scrimshaw, 2004; Forgasz, 2006). Similarly, if adopters have the chance to interact with technology resources any time, they would tend to fit in them into their day-to-day activity (Scrimshaw, 2004). Necessary condition to the integration of ICT includes ICT infrastructure and resources (Plomp, Anderson, Law, and Quale, 2009).

2.4.1.4 Technological Factors in Adoption of ICT in Europe

In European countries, technical competence was found to be so influential in adoption of ICT in T&L. Lack of T.S in case there is a technical problem while using computers in T&L, discourages adopters from using ICT (Jones, 2004). Scholarly work done in five European countries, established that technical capability affected Italian adopters in use of ICT (Peralta and Costa, 2007).

Therefore, lack of T.S frustrates adopters, demotivating them from using ICT (Tong, and Trinidad, 2005). In the same vain, scholarly work done in Britain and the Netherlands shown that, schools have appreciated the importance of T.S support adopters to integrate technology (Korte and Husing, 2007). T.S influences adopters to apply ICT without wasting time troubleshooting computer system problems (Korte and Husing, 2007).

2.4.1.5 Technological Factors in Adoption of ICT in Asia

Asian Countries acknowledge that, ICT hardware and software are as significant in adoption of ICT in T&L. According to UNESCO (2014), most countries in Asia priorities have established ICT H/W resources at secondary level. For instance, in India policy plainly for instance India, where policy plainly gives priority to ICT for secondary Schools in (India, 2012). 17% of primary schools and 45% of secondary schools have computer laboratories. Likewise, in Philippines primary schools and secondary schools, has CAI and laboratories.

Institutionalization of ICT in education has already taken place through policy and formal recommendations in high-income countries in East Asia. These comprise states like Singapore, Hong Kong and special administration region of China (UNESCO, 2014). This ensures availability of computer laboratories and support services hence sustained program-offering CAI (UNESCO, 2014). In Central Asia (Georgia), all primary and secondary schools are provided with CAI, computer laboratory and support services (UNESCO, 2014, p.24).

Report by UNESCO (2014) records Georgia as an example of countries, which have achieved LCR of up to 7:1. In the effort to supply all schools with computers installed with education S/W, alongside with necessary services and T.S; which is regarded as a very influential factor in adoption of ICT, Deer Leap Program was launched in the year 2005. This was very important in laying foundation for overall integration of ICT in the entire system UNESCO (2014). For Georgia to significantly lower its LCR from 200:1 to LCR of 7:1 and update its computers, had to really relay on a reliable corporation, organized planning and a considerable budget (Georgia, 2007).

2.4.2 Technological Factors in Adoption of ICT in non-African Developing Countries

Scholarly works reviewed from developing countries to inform this study. For instance, India lacks nationwide strategy for ICT in education, hence lacking T.S (UNESCO, 2014). Lack of

T.S and access to ICTs, hinder the adopters from using ICT in T&L (Jones, 2004; Becta, 2004). Adopters lacking T.S and ICTs to overcome the barriers are blocked from using ICT (Osodo, Kibirige and Omollo, 2014). Lack of T.S to counter technical problems is a main obstacle to adoption of ICT in developing countries (Pelgrum, 2001; Sicilia, 2005). Technical obstacles include waiting for websites to open, failing to connect to internet, malfunctioning computers and adopters having to work on old computers (Sicilia, 2005).

In India among other countries, individuals share computers among learners and other members of the community. These way learners have limited access to computers. This calls for enactment of a very good schedule prioritising learners to facilitate reliable adoption of ICT (India, 2012). Access to ICT infrastructure and resources are necessities for adoption of ICT (Plomp, Anderson, Law and Quale, 2009). Inaccessibility of ICT resources may be resulting from lack of individualised contact with quality hardware, software and reliable resource organization (Becta, 2004).

India among other republics in Asian region prioritises on laying down of ICT hardware and networking structure at the secondary level. For example, India explicitly prioritises ICT for secondary schools (India, 2012). In India 45% and 17% of secondary school and primary schools respectively have computer laboratories (UNESCO, 2014).

Republic of Korea (ROK) has been able to implement ICTs within the education system since 1996 following three national principal plans. The first plan was to establish international standard ICT infrastructure, and the second one to ensure quality in adoption of ICT (Hwang, Yang and Kim, 2014).

In high-incoming states, including the Republic of Korea and Singapore, T.S highly integrated permitting sufficient time to use ICT by adopters (UNESCO, 2014). There exists worldwide permanent broadband WWW connectivity in Hong Kong Special, Australia, Brunei Darussalam, Japan, Administrative Region of China, Malaysia, Singapore, the republic of Korea and Thailand (UNESCO, 2014). Additionally, more T.S staff is required at institutional level. However, a help desk existed at the Metropolitan Provincial Offices, real time help and support can become available along with technical help at place of work (Hwang, Yang and Kim, 2010).

ICT resources are important in adoption of ICT, since ICT in education calls for incorporating digital technologies in the context. It is therefore a precondition to provide adopters with technology infrastructure such as WWW connectivity (Hwang, Yang and Kim, 2010). In the world, South Korea leads with the fastest Internet and most extensively connected internet (Grzybowski, 2013). Recently ROK introduced self-directed, motivated adoption resource (SMART) Education responsible for expansion and distribution of digital content and internet based online assessment systems (Grzybowski, 2013). SMART education helps in construction of an open atmosphere for the community and enables secure use of resources (Grzybowski, 2013). The main goal of implementing the SMART program helps digitalize the entire content, with reusability and interoperability of content and systems (Hwang, Yang and Kim, 2014).

ICT innovation compatibility issues were reported in Korea. In Korea Computer Assisted Instruction (CAI) was adopted in 1988-1995. However, numerous restrictions for incorporation of ICT into daily procedure were reported, because CAI was not suitable to daily procedures. Consequently, some authoring tools such as Korea Net, GREAT and GREAT II were developed to support adopters in their development of resources (Son, 2009) Again, issues related to standardization for reusability and interoperability, assurance and prevention of adverse effects become crucial (Hwang, Yang and Kim, 2014).

Korea is an ICT powerhouse becoming world's second-best ICT infrastructure, ranked the first in technology excellence and diffusion (Hwang, Yang and Kim, 2014, p.134). Republic of Korea is supreme in ICT systems for T&L (Raihan and Shamim, 2008). Reasons for recognising Korea ICT system as superior include; excellent ICT infrastructure availability of Software, excellent Internet speed for uploading and downloading e-Learning materials (Raihan and Shamim, 2008).

In Bangladesh, regulatory institution facilitates T.S (UNESCO, 2014). T.S provides for adoption of ICT. Therefore, adopters are not required to possess T.S but knowledge of the area of specialization (Morgan, 1996). Unlike ROK in Bangladesh, adopters have trouble in adopting ICT due to lack of infrastructure of ICTs and electricity (Raihan and Shamim, 2013). In Bangladesh adopters of ICT has trouble in accessing updated software (Raihan and Shamim, 2013). In the same manner adopters of ICT also have trouble in accessing broadband internet (Raihan and Shamim, 2013). According to UNESCO, (2014) Bangladesh with backing from the donors established an organization, BRAC which, presented seventeen movable ICT

laboratories enclosing computers and their relevant peripherals to cover a thousand institutions in rural areas as in agreement with (World Bank, 2010).

In Saudi Arabia, numerous scholarly works confirms scarcity of ICT infrastructure as the foremost hindrances in Saudi Arabian institutions (Al-Sobhi and Al-Harbi, 2008; Al-Ghaith et al., 2010; Al-Sobhi et al., 2010). A study on ICT Resources in Saudi Arabia; on success factors for ICT implementation, established some technological factors hindering adoption of ICT in T&L (Albugami and Ahmed, 2015). Research has established there is lack of proper infrastructure and access to ICT resources, in access to T.S and maintenance, which are the main hindrances to adoption of ICT (Albugami and Ahmed, 2015).

It is principally difficult to adopt ICT without T.S as Newhouse framework emphasize the thinking of Lim and Khine (2006) that prances of resources without T.S makes ICT tools difficult to integrate. Newhouse adopts a systematic approach with an opinion that all interactions have an impact on each other. For example, the presence of resources, T.S and no skills or knowledge to implement ICT suggests there will be no positive outcome Lacks of resources, lack of T.S are obstacles negatively influencing the implementation of ICT (Albugami and Ahmed, 2015).

Lack of enough ICT resources along with T.S and maintenance are obstacles limiting adoption of ICT (Bingimlas, 2009). In the same manner lack of incentives for the adopters, concerning the adoption of technology is another obstacle limiting adoption of ICT Earle (2002).

According to Ensminger (2004), it is significant to offer full time T.S to aid in the process of ICT incorporation. Finally, numerous studies have long established that deficiency in ICT infrastructure is one of the leading obstacles in countries like Saudi Arabia (Al-Sobhi and Al-Harbi, 2008; Al-Ghaith bet al., 2010; Al-Sobhi et al., 2010).

2.4.3 ICT Technological Infrastructure for T&L in Africa

Step number one in making ICT accessible is the physical access to ICT infrastructure (Hennessy et al., 2010). Insufficient technological infrastructure limit adopters contact to ICT and pose obstruction to its integration in most countries of Sub-Saharan Africa (Menda, 2006; Janczewski, 1992).

SEACOM cable connects Southern African and Eastern coastline countries, this helps to link India and Europe (Hennessy et al., 2010). Another cable called EASSy (The Eastern Africa Submarine Cable System) connected Southern Africa and Eastern (Hennessy et al., 2010). The widest networking with the widest and highest capacity established known as WACS (West Africa Cable System) and accomplished by 2011. This followed a number of initiatives, financed by world organizations for improving the ICT connectivity in Africa. These world organizations comprising the World Bank's Worlds Link, United Nations Development Program's (UNDP) IT for Development, (Hennessy et al., 2010).

Considering T.S in Ghana, there are numerous encounters, among which are limited access to technology resources, connectivity, and proficiency, which make technology edification in economically growing populations a difficult undertaking (Dias, Mills-Tettey, and Nanayakkara, 2005). To overcome these difficulties creative course designs capitalizing on international partnership should be developed (Dias, Mills-Tettey, and Nanayakkara, 2005).

There are many challenges, including restricted access to technology devices, connectivity, and proficiency, that make technology edification in economically growing populations a difficult undertaking (Dias, Mills-Tettey and Nanayakkara, 2005). Research reviewed on South Africa, T.S in T&L, revealed that ICT adoption factors in South Africa include T.S without which connectivity cannot be sustained (Keong et al, (2005). Survey done in Malaysia established that lack of T. S is a hindrance to the successful integration of ICT (Keong et al., 2005). These findings are in line with views of (Jones, 2004).

A study done in Malysia, on adoption of ICT established lack of resources as one of technological factors (Jones, 2004; Hennessy et al., 2005). However, to improve access to ICTs, "Microsoft's (2007) Partners in Learning (PiL) Platform brings together governments and educational leaders in nineteen African Countries: (Algeria, Burkina Faso, Angola, Gabon, Botswana, Egypt, Ghana, Morocco, Kenya, Mozambique, Madagascar, Mauritania, Namibia, Rwanda, Nigeria, Seychelles, Senegal, Ugandan and South Africa) ensuring availability of technology resources in classroom, alongside teachers training guarantee ICT is applied successfully" (Hennessy et al., 2010, p.87).

2.4.4 ICT Technological Factors in East Africa

Technological factors were identified in East African countries among which are; Kenya, Tazania, Uganda, Burundi and Rwanda. Among other emerging issues influencing adoption of ICT in T&L are technical expertise, technology infrastructure, supply of electricity the prospective of portable and substitute energy technologies (Hennessy et al., 2010). On the same vein Hennessy, Harrison and Wamakote (2010) indicates that internet access, bandwidth, hardware and software provision are factors influencing adoption of ICT. In addition to commonly outlined issues of infrastructures, there are technical faults and network configuration problems (Minish-Majanja, 2007).

In Uganda, lack of electricity and internet connectivity remains a challenge in adoption of ICT but with a number of schools having computers and WWW connectivity (Hennessy et al., 2010). Computer laboratories are overcrowded with users and 10 to 20 computers fitted with a television receiver. User are scheduled to access facilities three times per week (Farrell, 2007, pp.7-8).

In line with Ugandan ICT policy, New Partnership for Africa Development (NEPAD) provided generators and computers E-Schools software and upgraded the computers and secured contracts with Uganda Telecom for voice and data connectivity (Hennessy et al., 2010).

In Ugandan T&L, when computer break down when using ICT to teach and there is no technical assistance, this frustrates adopters and make them avoid using computers in work place (Ali, Haolader, and Muhammad, 2013). Similarly, Yilmaz (2011) noted to the need to offer adopters with T.S in respect to repair for the sustained use of ICT. Consequently, lack of T.S for adopters may lead to giving up and avoid using ICT (Tong and Trinidad, 2005).

2.4.4.1 Resources Accessibility

Access to ICT H/W, S/W and connectivity is an essential condition in adoption of ICT (Plomp, Anderson, Law and Quale, 2009). Operational implementation and assimilation of ICT into daily activities rely mainly on the accessibility of ICTs such as H/W, S/W among others (Buabeng-Andoh, 2012). Apparently, if computer users cannot access computers then they cannot use them. Consequently, access to, updated computers, S/W and H/W are key essentials to effective integration and adoption of technology (Buabeng-Andoh, 2012). The same way

previous studies established that access to technology is a basic requirement to its adoption (Yildirim, 2007).

Going with definition given by Sife, Lwoga and Sanga (2007), T.S includes matters like installation, maintenance, operation, security and network administration as in line with (Nawaz and Qureshi, 2010). Tanzania started internet connectivity in 1989 with a "store-and-forward" email system (Sheriff, 2007). Nevertheless, T.S lacked; thus, adopters had to learn basic technical skills on how to trouble shoot in order to deal with technical challenges, as they emerged in adoption of ICT (Sife, Lwoga and Sanga, 2007).

In Tanzania, there lack enough technical experts to implement and maintain ICTs (Bakari, Tarimo, Yngstrom and Magnusson, 2005). In addition, according to Sife, Lwoga and Sanga, (2007) just like any other African countries, the application of electronic learning platform in Tanzanian universities is still very low.

Access to ICT resources are constraining factors in adoption of ICT in T&L in Tanzania (Hennessy et al., 2010). The factors encountered in technology connectivity comprise of low electrification, poor infrastructure and high prices for ICTs (Hennessy et al., 2010). However, to ensure placement of ICT infrastructure the government in Tanzania has established dirrect involvement (Hennessy et al., 2010).

To ensure that Tazanians realise the potentials of adopting ICT in T&L, Internationa Institution for Communication and Development (IICD) and UNESCO, in cooperation with Tanzania's Ministry of Education and Vocational Training (MoEVT) deployed and developed a countrywide e-learning system. The international bodies involved include: Swedish International Development Agency SIDA, IICD and UNESCO (Hennessy et al., 2010).

Functionally, e-learning comprises a varied learning approaches and ICT application for sharing information and acquiring knowljedge (Lwoga and Sanga (2007). ICT applications consist of radio and television ; mobile technologies; Compact Disc (CDs) and Digital Versatile Disc (DVDs); web-based technologies; video conferencing; and electronic learning platforms (Sife, Lwoga and Sanga, 2007).

Rwanda government using National SchoolNet as indicated in a study done by Harrison and Wamakote (2010) do not only provide connectivity, but also facilitate sharing and learning

resources. In addition adopters of ICT in T&L are noted to welcome required S/W delivered by the various associations and even realissation that adopters could develop their own application resources (Harrison and Wamakote, 2010). Adopters demostrated substantial intensifications in their technical skills and self-reliance capacity, even though T.S, repair and maintenance funding were occasionally challenging (Harrison and Wamakote, 2010).

Regarding ICT resources for T&L, Rwanda government ensure reliable support for ICT progress leading to notably first growth in ICT adoption in the last decade (Hennessy et al., 2010). This is inline withtraining of morethan 2000 adopters on ICT use (Farrell, 2007). On the same vein Rwanda government is putting some effort in the development of programs promoting the acquisition of ICTs by adopters,this promotes connectivity and sharing of resources (Hennessy, Harrison and Wamakote (2010).

In the same manner, Kenyahas introduced varieties of ICT initiatives. The participation of numerous partners under the umbrella of the MOE if well engaged might lead to highly sustained adoption of ICT (Hennessy et al., 2010). However, in Kenya and Tanzania, restrictive concerns faced in technology comprise high costs of acquiring ICT and poor infrastructure (Hennessy et al., 2010).

Regarding ICT resources in Kenyan T&L process, the Intel Corporation has played a great role in backing transition from traditional T&L methods to eLearning. This is done by integrating ICT in basic T&L (Karsenti, 2009). Intel Teach has paid a great role another integration of ICT in T&L, focusing on improved performance by adopters (Hennessy et al., 2010).

Quest for generation of e-content led Intel Teach to training 25 Kenyan professionals from various sectors. Founding this on policy initiatives by GOK, Kenya Education Staff Institute lay strategies on how to influence the entire population of intended adopters (Hennessy et al., 2010).

In EAC countries, Kenya was among the first to join the Intel World Ahead Program in 2007 (Intel News Release, 2007; 2008). In line with information Assistant Minister, Kenya's involvement in the Intel-Supported eLearning Africa conference is as per the plan to establish Digital Villages entire Kenya (Hennessy et al., 2010). This ensures increased access to the internet from 2.7 million to 6.0 million" (Hennessy et al., 2010).

Focusing on T.S in Kenya, there are substantial intensifications in technical skills and self-confidence levels, although T.S, repair and maintenance funding are challenging (Hennessy et al., 2010). There is little evidence of integrated use of ICT or (Hennessy et al., 2010).

2.5 ICT Technological Factors in Adoption of ICT in T&L

Technological factors in adoption of ICT in T&L are factors emerging from the technology characteristics as in this context. Identified ICT attributes includes relative advantage, compatibility, and complexity, observable and easy to try (Rogers, 1995).

Spreading and rapid rate of diffusion of ICT is highly influenced by underlying technological factors (Dillon and Morris, 1996). Some of these factors identified by Dillon and Morris (1996) include; compatibility with existing practices, low complexity, easy to try and observable. Consequently, adopters perceiving ICT as an advantageous instrument, well-matched with their present happenings, easy to use and have noticeable results, they will establish optimistic attitudes towards adopting ICT.

Drent and Meelissen (2007) studied factors influencing the inventive use of ICT, by adopters in Netherlands. Drent et al., (2005) study established several factors including computer knowledge and individual free enterprise of the adopter ensure a straight positive inspiration on the inventive assimilation of ICT. To focus on the interest of this study, let us look at each of the technological factor identified from different research.

2.5.1 Complexity of Adopting ICT in Teaching

ICT complexity is the level to which ICT is perceived as reasonably difficult to comprehend and use. Adopters lacked reliable practical knowledge and skills on technology to combine their day-to-day activities with the ICT skills they have. It was therefore observed that countries interested in adopting ICT and integrating ICT in daily activities, determines how best to develop adopters' technological knowledge and skills, through well laid out drill programs that are aligned to local requirements (Cubukcuoglu, 2013). Otherwise, adopters will continue lacking ICT skills, useful in ICT adoption and thus not confident enough to integrate ICT in their day-to-day undertaking, as they cannot be able to convert their daily procedures to ICT based material. This is in line with Charles (2012) who observed that adopters lack ICT skills, confidence and follow up on innovations.

In developed countries for adopters to be acquainted with technology, there is need to invest their time to learn and acquire skills on H/W and S/W as well (Fabry and Higgs, 1997; Manternach-Wigans et al., 1999). On the contrary, adopters are occasionally not able to utilize ICT fully in that they do not devote time required to formulate e-materials competitively, ICT based procedures, predominantly where this encompasses online and multimedia content (Fabry and Higgs, 1997; Manternach-Wigans et al., 1999).

Adopters in this context argue that they lack enough time to design, improve and combine ICT into their daily procedures and activities (Afshari et al., 2009; Beggs, 200; Newhouse, 1999; Ihmeideh, 2009). Therefore, there is need for assistance form technical experts to impart adopters with necessary ICT skills (Preston et al., 2000).

At times adopters devote their time to learn and use ICTs, but some technological factors make it difficult for them. For instance, some software are difficult to learn and use, currently Open Sources Software (OSS) uses icons and Graphic User Interface (GUI) that varies from Proprietary Software (PS), which makes OSS products, complicated to use (Kamau and Sanders, 2017). On the same manner, innovations that offer low complexity have more extensive and quicker rate of integration (Dillon and Morris, 1996).

2.5.2 Compatibility Challenges

Compatibility is one of technological factors influencing the decision to adopt and integrate ICT in work place (Rogers, 1995). It is termed as the most problematic technological factor (Johnston, Begg and Tanner, 2013). In a Work Practice Compatibility to Preferred Practices is an important originator influencing Perceived Usefulness of an innovation (Ford, 2012). Even slight organizational changes may influence adoption of innovation, as the system may lose compatibility to support cross organization functionality (Stephenson and Blaza, 2001). Further research conducted in South Africa between November 2007 and March 2008 indicates that open source software non-compatibility with proprietary software is a main challenge in the OSS adoption (Mtsweni and Biermann, 2008).

Richardson (2004) did a similar study adopting structural modeling technique, to examine the influence of technology resources and computer characteristics. They established that 61% of variance was explained by availability of ICT resource and their attributes (Buabeng-Andoh, 2012). Computer attributes including complexity, relative advantage, observables and image

are characterized as the major factors in predicting adopters' intention to make use of technology (Rogers, 1995). Research indicates that technology offering compatibility with existing platforms have more extensive and rapid rate of adoption (Dillon and Morris, 1996).

Innovations with compatibility problems make adopter find it difficult to develop content for their use in adoption of ICT (Veen, 1993). This therefore calls for training to equip adopters with necessary ICT skills (Preston et al., 2000). This finds support in the study done by Hennessy, Harrison and Wamakote (2010) who stated that "Those applying technological resolutions require to guarantee that they are context specific and adjusted to indigenous requirements and circumstances" (p.44). It is Important that all countries pinpoint how best to develop adopters' technological knowledge and skills (Cubukcuoglu, 2013).

Compatibility with current skills is another factor that contributes to the adoption of computer open source software (Deidrick and West, 2004). In some cases, the users and IT support staff have to give time to adapt to incompatibilities between OSS and other proprietary products (Deidrick and West, 2004).

It is also important to ensure that ICT creativities are maintainable and operational by guaranteeing that the technologies implanted within them meets the request adopters in suitable ways. Research indicates that there exist compatibility problems with current technology, skills and tasks (Morgan & Finnegan, 2007). Therefore, adopters require reliable understanding of how to use new ICTs constructively and develop a culture of relating work place practices and technology positively (Leach, Ahmed, Makalima and Power, 2005).

In developing countries, research reveals that in ability of adopters to develop content useful in achieving their day-to-day objectives, calls for invitation of technology experts, to be involved in developing useful content in the context of adopters. In this regard, software designers and adopters should work in collaboration (Mumtaz, 2000). Collaboration will help technologist and adopters develop software, which are able to support different skills useful in in day-to-day activities. This will help to develop content based on context-specifications and adapted to local requirements and situations (Hennessy et al., 2010).

2.5.3 Technical Support in Adoption of ICT in Teaching

Lack of T.S as noted by Ertmer (1999) is serious barrier to integration of ICT. Technical experts impart adopters with necessary ICT skills (Preston et al., 2000). Lack of T.S leads to lack of access to ICT resources and technical problems (Becta, 2004). On the same vein, lack of technical support for open sources software ranked as one of significant drawbacks to computer OSS adoption (Morgan and Finnegan, 2007).

The National Council for Accredition of Teachers Education NCATE described nonexistence of T.S as one of the key obstacles that caused computers underutilization in daily procedures (Morgan et al., 2009). Adopters are discouraged to use computers because they are not sure on what to do in case of a technical problem while using computers (Morgan et al., 2009). Typically, technical support team is responsible of providing; technical assistance to adopters as well as repairing and maintaining ICT resources and technological infrastructures among other services as described below.

2.5.3.1 Maintenance of ICT Technological Infrastructure

Technological infrastructure defined as the organizational unit of the firm that has the responsibility for managing information resources (Afaneh, AlHadid and AlMalahmeh, 2015). Information resources in this case are ICTs. ICTs are defined as "technologies used processing and communication purposes" (Zhang, Shelly and Sun 2008, p.628).

2.5.3.2 Provision of Technical Support

Technical Support as used in this study refers to provision of assistance on technology complex skills and professional specialties. It is therefore essential to offer ICT T.S for resolving glitches when using an ICT / IT application (Markus and Keil, 1994; Prescott and Conger, 1995; Kueppers and Schilingno, 1999). Training and T.S directly helps use on application as it offers them with the contextual knowledge of ICT that helps users to solve problems of adopting ICT (Peansupap and Walke, 2005).

2.5.3.3 Maintenance of Computer Hardware and Software

The roles of technical support to adopters are very important to facilitate ICT reliability Morgan et al., (2009). Technical staff should inspire the procurement of extremely dependable

technologies. Ensure improved systems for inspection and maintaining required technologies Morgan et al., (2009). ICT head should test new technology setups before they install them.

2.5.3.4 Ensure Access to Technical staff

Facilitators should ensure that rapid response systems are in place to deal with a wide range of problems (Butler and Sellbom 2002). For instance, a study done in Korea indicates that; although a Help Desk existed at the Metropolitan Provincial Offices of Education (MPOE) level, support and real-time help can only become available along with T.S at work place (Hwang, Yang and Kim, 2010).

In developed countries, Lack of Technical support in adoption of ICT hinders ICT adoption and integration. At times ICT equipment universally, tend to experience technical faults, hence adopters have trouble in adopting ICT in their day-to-day undertaking. A report done by British Educational Communications and Technology Agency on the review of the research literature on barriers to the uptake of ICT by adopters shows that; Repetitive faults, and the anticipation of faults happening through a session tend to lower adopter's assurance (Becta, 2004; Jones, 2004).

2.5.3.5 Handling Recurring Faults

Recurring faults and the expectation of faults causes adopters to avoid using the technology in future (Russell and Bradley, 1997). Therefore, this calls for a consistent technical support and, in the event, that it lacks, then this leads to adopters avoiding use of ICT, for fear of a fault arising that cannot be resolved and programs failing as an outcome (Cuban, 1999; Preston et al., 1999). On the same vein, levels of available technical support directly affect the confidence to use technology (Ertmer et al., 1999; Becta, 2004).

ICT technical (technological) support in developing countries seems to be so basic in facilitating adoption of ICT. Research indicates that, lack of T.S to adopters is one of the key influences hindering adoption of ICT in Nigeria (Tella et al., 2007). On the same vein, those applying ICTs to solve a given problem should ensure that the application is context based and suitable to the situations (Hennessy et al., 2010).

A study done on adoption of ICT in Bangladesh indicates that, a first order barrier to adoption of ICT includes lack of T.S among other resource-related issues (Snoeyink and Ertmer, 2001; Khan, Hasan and Clement, 2012). To tackle the issue of lack of T.S, integrating technology in daily procedures require knowledge of work, intertwined with an understanding of how to integrate ICT in doing the work and a level of technical expertise (Morgan et al., 1996).

Previous studies show that in Kenya the state of internet connectivity is so poor; that is 75% of the adopters prefer cyber cafes to provide reliable internet connectivity (Pretorial, 2009). In line with Snoeyink and Ertmer (2001), first order obstacles include absence of resources, undependability of devices and absence of T.S among other resources related matters (Khan, Hasan, and Clement, 2012). Therefore, lack of T.S is very demanding for the adopters, which may affect adopters' enthusiasm in the implementation of ICT (Morgan et al., 2009).

2.5.3.6 Supporting ICT Coordinators

On the other hand, appointing an ICT coordinator or head of the ICT department helps to assure administrative support for the adopters (Morgan et al., 2009). One should not confuse this appointment with that of a technical or technology assistance.

The ICT coordinator should advise the adopters on ICT solutions to their undertaking (Morgan et al., 2009). Coordinator helps adopters to obtain ICT resources and required skills, valuation of adopter's ICT-related capacity and counseling them on their proficiency (Bangkok, 2004). Regarding to the importance of technical coordinator in work place, The National Center for Education Statistics reported that, about 68% of the adopters surveyed believed that lack of T.S regarding ways of using technology delayed use of technology (Morgan et al., 2009).

The survey also found that adopters lacking technical coordinators were more likely to cite lack of T.S as an obstacle to their use of technology, than adopters where there is technical coordinator. In addition, 64% of the adopters surveyed identified absence of T.S as a barrier to adopting ICT in their classes. Hence, lack of on-sit support is one of the reasons that adopters do not use technology in their work (Morgan et al., 2009).

2.5.3.7 Team up with Administrative Support

Some of the factors that allow adopters to effectively employ innovative practice include: (i) backing at high-ranking management level for effecting new strategies and providing for financial requirements; (ii) participation of numerous members of staff; (iii) promoting culture within schools of collaboration and common backing and finally (iv) enthusiasm to take risks (Bosley and Moon, 2003; Morgan et al., 2009).

Role of the management is fundamental in in meeting these preconditions. In fact, adopters require both T.S and administrative support when they decide adopt technology (Morgan et al., 2009). Even though infrastructure is essential, leadership is a necessary element in founding technology as part of organizations culture (Anderson and Dexter, 2000).

In addition, research revealed that ICT supported infrastructure is lacking as well as technological resources in low-income countries (Sara, David and Leonard, 2010). Additionally, various adopters are at work in conditions that are not favorable to supporting use of ICT Sarah (2010), some of which include lack of stable power supply necessary for ICT adoption (UNESCO, 2014). In addition, some potential adopters lack primary technological training (Sara, David and Leonard, 2010).

2.5.4 Computer Hardware Architectural Rapid Change

Computer H/W rapid change evolving within 18 months, pose a great challenge to adopters. As seen from Al Geist, ORNL and Lucas (2009) who states that in a period of five years computer architectures changes from 1000 CPUs to 100,000 CPUs and the subsequent generation systems are going to have in excess of a million CPUs. The revolution from using faster CPUs to using multi-core CPUs is as disruptive to scientific S/W as the shift from vector to distributed memory supercomputers fifteen years ago (Al Geist, ORNL and Lucas, 2009).

Computer designs will necessitate radical modifications on the S/W used to control them and applications that runs on them (Al Geist, ORNL and Lucas, 2009). This technological factor requires a completely incorporated approach to influence S/W design, adaptation, structure and used in other applications (Al Geist, ORNL and Lucas, 2009).

The ICT adopters' requirement rate of change is very high introducing new technological challenges. International Data Corporation (2014) estimates that ICT spending covering hardware, software, Information Technology (IT) and communication services has grown from 8.9% of Gross Domestic Product (GDP) in 2006 to an estimated 12.1% of GDP in 2013.

2.5.5 Software Sustainability

Rapid change on computer hardware like migration from faster to multi-core CPUs is disruptive to scientific S/W (Al Geist, ORNL and Lucas, 2009). This poses difficulties in making software that are easy to sustain; in terms of portability, adoptability and technical support.

2.5.5.1 Software Portability

Software portability as used in this study refers to making software usable in different hardware platforms, with little or no modification. On the other hand, adoptability means ability of software to work in different environment with little or no modification at all. Technical support requires up to datedness of technology advancement, while as research reveal lack of technical support to adopters.

2.5.5.2 Software Sustainability

Software sustainability in terms of adaptability, portability and technical support are important technological factors for consideration in this study. In the same manner (Al Geist, ORNL and Lucas, 2009) states that with the advance of hardware rapid change leads to the main encounters to Parallel File System are scaling, performance, and fault tolerance (Al Geist, ORNL and Lucas, 2009).

It is therefore important to note that software requires updating or redesigning to suit new hardware architecture capabilities, new scientific applications introducing new debugging issues and huge data, hence high demand for technical support (Al Geist, ORNL and Lucas, 2009). Additionally, the S/W challenges comprise the rapid intensification in parallelism, the memory wall, system heterogeneity and fault tolerance (Al Geist, ORNL and Lucas, 2009).

2.5.6 Software Usability

To use ICT, hardware requires equivalent software; therefore, software usability is of great importance in influencing simplicity or complexity of using a given ICT hardware resource. Operability among other factors defines S/W usability (ISO / IEC-9126-1, 2001). Previous studies show that, refining the usability aspects such as operability has a constructive influence on the overall usability of S/W (Raza, Capretz, & Ahmed, 2011). On the other hand, improved usability of a software leads to lowered complexity of adopting ICT, as with low complexity there is rapid rate of ICT adoption (Dillon and Morris, 1996). On the same vein, usability is one of the limitations that make OSS unattractive to ordinary users making it a hindrance to its adoption because it looks complex to the users (Kamau and Sanders, 2013).

2.5.7 Relative Advantage on Adopting Technology

Adopters, with little knowledge about the advantages of using ICT in daily undertaking, are less likely to adopt ICT. Therefore, it is essential to assure the potential adopters the benefits adopting ICT (Cox, Preston and Cox, 1999). Research established relative advantages as shown in reviewed literature as: Complexity, Compatibility, Observability, Trialability, Cost, Technologies Opportunities, Centrality, Divisibility, Communicability, Profitability and Social approval (Huang et al., 2003; Peansupap and Walke, 2005).

Technical users who are able to use free S/W, which require technical skills to download, install and user could enjoy relative advantage of reduced cost linked to software licenses, upgrades (Johnston, et al., 2013).

Actually, informed adopters from developed and developing countries do not hesitate to adopt technology but rather invest heavily on technology adoption. Taking example of countries like South Korea, they have one of the highly advanced ICT infrastructures in the world (Shah, Hoque and Alam, 2010). Robot teachers complements the small number of teachers for English in Korea. In Tokyo and in Japan they use Robot teachers (Parvin,2013). Therefore arguably, indicating that robots as part of ICTs has some relative advantages (Peansupap and Walke,2005). Advantages of using robots includes; Compatibility, Trialability, Observability, Technologies opportunities, Divisibility, Cost effectiveness, Profitability, Communicability, Social approval (Huang et al.,2003).

2.5.8 Availability and Access to ICT Resources

ICTs includes; computers, TV and Radio (Wallet and Melgar, 2014; UNESCO, 2014). In reality, incorporation of ICTs to various professional undertaking requires electricity power, including; grid/mains connections, wind power, hydropower, solar power, or fuel generated power (Wallet and Melgar, 2014). In addition, many countries experience regular power surges and brownouts obstructing the reliable usage of ICT (Wallet and Melgar, 2014).

Lack of ICT is not a factor hindering adoption of ICT in developed countries as identified by Wallet and Melgar (2014) "Armenia, Azerbaijan, Georgia and Kyrgyzstan in Central Asia; Hong Kong Special Administrative Region of China, Malaysia, New Zealand, the Republic of Korea and Singapore in East Asian; and in Maldives is South and West Asia" (p.14). In contrast, electricity is a significant obstacle to integration of ICT in education in India among the least-developed countries (Wallet and Melgar, 2014). Kenya rolled out a program to ensure connection schools to power supply (Ayeko, 2011).

2.5.9 Access to Fast and Reliable Internet

Internet support: sharing of resources over the network hence lowering the cost of buying sharable resources. For instance, Internet-assisted instruction (IAI), depend on stable internet (Wallet and Melgar, 2014). Numerous studies have shown that reliable internet connectivity and access is paramount to adoption of ICT in teaching, in that internet provide reference resource and provide reliable means of communication amongst the adopters (Khalid, 2009). In addition, Internet provides access to numerous web-tools for adopters as outlined by Writer (2012), which are reliable and effective technologies useful in increasing user motivation and facilitate clear thinking and development of interpretation skills with data (Khalid, 2009).

Using up-to-date H/W and S/W resources is termed by Gulbahar (2005) as a vital feature to diffusion of technology. Recently, most of the institutions are equipped with diverse ICTs; one Australian school established various ICTs for adoption by its members. These ICTs include personal notebook computers, private web space, email access and workspace (Wallet and Melgar, 2014). Video conferencing is accessible and the school has established its own intranet, placing all its resources on-line (Wallet and Melgar, 2014).

ICTs for T&L are accessible through radio connections from one point to the other (Richardson and Schaffer, 2004). In such an Australian school, the use of radio appears as an innovation, which is completely changing the nature of T&L. Many adopters integrate technology into their daily activity and procedures (Richardson and Schaffer, 2004).

According to Pelgrum (2001) this consciousness started when they realised prospects of on-line lessons and the likely hood of making shared, net-based teaching resources. Therefore, H/W, S/W and network must be accessible to integrate ICT in T&L (Wallet and Melgar, 2014). Appropriate resourcing and flexible forward-looking planning, connected closely to what adopters actually require at any given stage is essential.

2.6 Research Gap

Over a long period, studies on adoption of innovations have been conducted (Sherry and Gibson, 2002). Findings of these studies formed basis of identifying a long list of technological factors in adoption of ICT. The long lists of technological factors identified in this study, shown in the background of this study chapter 1.1. Following is the discussion on ICT adoption gaps, research gaps and model gaps thereafter.

2.6.1 ICT Adoption Gap

ICT adoption gap is evident in this study as literature reveals assimilation gap (Fichman and Kemerer, 1999). The adopters' rates of organizational assimilation trail behind their rates of organizational adoption (Fichman and Kemerer, 1999). Even in the world largest regions both in land mass and population like Asia, presenting more than 60% of earth‘s populace (UN population Division 2014). The internal digital divide taking place in economically growing are increasing rapidly as Urban centers swiftly embracing ICT while it remains inaccessible for rural and remote (UNESCO, 2014).

2.6.2 Knowledge Gap

This study identified gaps in this study, whereby research reviewed fails to inform on important technological factors useful in adoption of ICT in T&L. To understand adoption determinant of ICT in T&L in public secondary schools in Kenya a few studies have been conducted. Concentrating on developed countries like UK, USA, Australia and some northern European

countries, including Norway and Finland (Begum, 2013). In this regard, past studies call for a similar research on adoption of ICT in T&L, as it is the case of UK, Australia, USA and some Northern European countries, including Finland and Norway (Begum, 2013). Literature revealed that; similar enablers affects adopters while integrating technology regardless of background, culture and country. Although, there are evident context-specific issues to address (Begum, 2013). Finally, Begum (2013) state "There is a need for similar research to be undertaken in other areas" (p.58), which is a distinct contribution this study makes.

In Kenya Maina and Nzuki (2015) conducted a study on adoption of ICT innovation (e learning) under a tittle: Adoption determining factor of eLearning system in institution of high learning in Kenya. There is need for further research at the lower level institutions of learning, to support penetration of the technology in T&L (Maina and Nzuki, 2015).

Maina and Nzuki (2015), reported on barriers to adoption of ICT. Further, Becta (2003) established the need for further research on factors influencing adoption of ICT in education. Therefore, it is essential to recognize identification of a number of factors encouraging and enabling adopters to integrate ICT into their teaching (Becta, 2003). Having noted the research gap, Becta states intent to conduct further work on this topic (Becta, 2003). The intent to research on this topic by Becta further confirms the need for this study. Lei (2016) studied on determinant of IT Innovation Diffusion from Dynamic Perspective Review and Prospects. Lei (2016) calls for further theoretical research from dynamic perspective useful in deepening the knowledge on factors influencing adoption of ICT in T&L.

In further justification of this study's research gap, developed countries have conducted a number of studies on adoption of ICT (Becta, 2003). See justification in chapter 1.6 of this study. On the other hand, Alimazighi and Bouchbou (2009) noted lack of common agreement on factors influencing ICT adoption. Bearing in mind that technological factors cut across the board with a few differences research has established that; little research vave been undertaken to examine the technological factors that are contributing in adoption ICT in Kenya (Gikandi and Bloor, 2010; Macharia and Nyakwende, 2010; Magutu et al., 2010).

2.6.3 Little focus on ICT Adoption Technological Factors

Research holds that similar technological factors influence adoption of ICT in T&L. Adopters are affected by similar enablers integrating technology irrespective of background or state, even

though there are obviously context-specific issues to be addressed (Begum, 2013). However, research further discloses some of enables for ICT integration but, none of the components has quantifiable amounts to show the degree to which it can impact or contribute to the adoption process of ICT (Geist and Lucas, 2009). They only suggest the probability of outstanding integration of ICT in T&L opportunities (Geist and Lucas, 2009).

Oftenly, S/W tools are developed lacking of full understanding of the adopter and application requirements (Al Geist and Lucas, 2009). Equally, adopters are repeatedly unconscious of the technical complications essential instrument design and support (All Geist and Lucas, 2009). Linking this gap with a collaborative S/W development and extension process, where promising thoughts are acknowledged and timely confirmed. These thoughts are then improved and reinforced across the application development and support cycle reducing the anticipations gap (Al Geist and Robert Lucas, 2009). Finally, the following table was used to analyse the research Gaps.

Table 2:

Summary of the Research Gaps

Research Gap	Author	Research
ICT exhibits an assimilation gap, where adopters' rates of organizational assimilation trail behind their rates of organizational adoption.	Fichman and Kemerer (1999),	The Illusory Diffusion of Innovation: An Examination of Assimilation Gaps. Information Systems Research, 10, 255-275
"Despite the role's ICTs can play in education, secondary schools in Nigeria have yet to extensively adopt them for teaching and learning. Efforts geared towards integration of ICTs into the secondary school system, have not had much impact" p.5)	Adomi(2010)	"Application of ICTs in Nigerian Secondary Schools," Dr. Esharenana E. Adomi. Dr. Emperor Kpangban.
The internal digital divide of developing countries has also increased significantly, as urban centers quickly adopt ICT while it remains out of reach for rural and remote regions	UNESCO (2014)	A comparative analysis of ICT integration and e-readiness in schools across Asia

Table 3:

Continuation of Summary of the Research Gaps

Research Gap	Author	Research
Calls for further research stating that: "A similar research should be conducted at the lower institutions of learning to facilitate easy penetration of the technology use in learning." p.247.	Maina and Nzuki (2015)	Adoption Determinants of E-learning Management System institutions of Higher Learning in Kenya: A Case of Selected
Established the need for further research on factors influencing adoption of ICT in education. Intends to conduct further work on this topic (Becta, 2003)	Becta (2003)	Universities in Nairobi Metropolitan What the research says about barriers to the use of ICT in Teaching
Calls for further theoretical research from dynamic perspective useful in deepening the knowledge on factors influencing adoption of ICT in T&L.	Lei (2016)	Determinants of IT Innovation Diffusion from Dynamic Perspective - Review & Prospects
Individual applications have their own distinctive requirements calling for unique considerations. ("there is no concrete reference or framework for the integration of ICT into education but only that numerous barriers are encountered in the attempt to realise the ICT integration strategy" p.8)	(Kyalo and Nzuki, 2014).	Determinants of Information and Communication Technology (ICT) Integration in Tertiary Institutions

Table 4:

Continuation of Summary of the Research Gaps

Research Gap	Author	Research
Calls for a similar research on adoption of ICT in T&L, as in, UK, Australia, USA and some northern European countries, including Finland and Norway. ("need for similar research to be undertaken in other areas" Begum 2013, p.58)	Begum (2013)	Factors enabling the use of technology in subject teaching Eastern Mediterranean University, North Cyprus
"it is questionable whether the model can be applied to analyse every instance of IS/IT adoption"	Lee, Hsieh and Hsu (2011)	Adding Innovation Diffusion Theory to the Technology Acceptance Model: Supporting Employees' Intentions to use E-Learning Systems. Educational Technology & Society, 14 (4), 124–137.
There is the need to develop on site models for adoption, as technologies are not discrete packages, with distinct and measurable features.	Lyytinen, and Damsgaard (2001)	What is Wrong with the Diffusion of Innovation Theory? The Case of Complex and Networked Technology.

Table 5:

Continuation of Summary of the Research Gaps

Research Gap	Author	Research
To bridge the gap as seen in many empirical studies, there is need to integrate two or more theories. Integration of two or more theories helps to develop a model that copes with rapid changes in ICT, and improve specificity and explanatory power.	(Carter & Be´langer, 2005; Legris, Ingham & Colerette, 2003)	The utilization of e-government services: Citizen trust, innovation and acceptance factors. Information Systems Journal, 15(1), 5-25.
some of enablers for ICT integration but none of the components have a quantifiable measure to show the extent to which it can influence or contribute towards the ICT integration process.	Al Geist and Lucas (2009)	White paper on the Major Computer Science Challenges at Exascale February 2009
users are often unaware of the technical difficulties underlying tool design and support	All Geist and Lucas, (2009)	Major Computer Science Challenges at Exascale February 2009

2.6.4 ICT Technological Adoption Model Gap

Research shows that there are many theories used in adoption of ICT among other technologies. According to Wade (2009) there are many theories used in information systems (IS) research. This study is interested in ICT adoption theories only. The most used theories as seen in Oliveira and Martins (2011) are "the Technology Acceptance Model (TAM) (Davis, 1986; Davis 1989; Davis et al., 1989), Ajzen (1991). Theory of Planned Behavior (TPB) (Ajzen 1985, Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003) and the TEO framework (Tornatzky and Fleischer 1990)" (p.10), (Lai, 2017) and DOI (Rogers 1995). To justify the gaps established, elements of identified theories were analyzed and tested.

Research has established that, existence of computers is not a sign for ICT adoption, but there is more for adoption to take place, including a reliable model to guide this (Cuban et al., 2001; Gordon et al., 2014). Adopters of ICT in T&L lack a reliable technological model. Kyalo and Nzuki (2014). "underpins the significance of appropriate valuation of the factors of ICT assimilation that are suitable in the tertiary education atmosphere demonstrated on the inferential model that reflects beyond insights of the participants for the ICT assimilation" (p.8). Research reveals that "there are is no tangible reference or framework for the integration of ICT into education but, only that many obstacles are faced in the effort to realise the ICT integration strategy (Kyalo and Nzuki, 2014,p.8).

Equally, reviewed studies reveal that various models reviewed could not be self-sufficient and serve in all categories of circumstances (Davis, 1989). Individual applications have their own distinctive requirements calling for unique considerations. This is strongly in line with Lee, Hsieh and Hsu (2011) as mentioned in section 1.2. Therefore, this leaves this study with a gap that calls for model that suit specific scenario, as claimed by Lyytinen, and Damsgaard (2001) that there is the need to develop on site models for adoption, as technologies are not discrete packages, with distinct and measurable features.

On the other hand, to accommodate new technologies and facilitate their adoption, this study found that it is necessary to modify, combine and develop new models. Supporting the research at hand, Oliveira and Martins (2011) calls for a study that fills the identified gap. They state, "In terms of more research, it is wise for more complex innovation adoption, it is essential to

unify multiple theoretical model to attain an enhanced understanding of the IT adoption phenomenon" (p.120).

In the same understanding (Carter and Be´langer, 2005; Legris, Ingham, and Colerette, 2003) support that to bridge the gap as seen in many empirical studies, there is need to integrate two or more theories. Integration of two or more theories helps to develop a model that copes with fast changes in ICT, and advance specificity and descriptive power (Carter and Be´langer, 2005; Legris, Ingham and Colerette, 2003).

In the effort to summarize the elements of the identified models, showing technological factors in adoption of ICT in subsequent table 8. The table shows the research gaps in models, equally using the Key of labels in table 7 below.

Table 6:

Key for Empirical Facts Labels

Label	Factors Reviewed
A	Compatibility
B	Complexity
C	Trialability
D	internet connectivity
E	access to ICT resources / infrastructure / hardware
F	Relative Advantage: perceived Benefits / Profitability/ Tangible/Intangible benefits
G	Technical support for ICT adoption in T&L
H	Cost of Technology
I	Communicability
J	Divisibility
K	Inter connectivity
L	Social Approval
M	Observability
N	Interoperability
O	compliance to standards
P	Technical support for ICT adoption (in others but not T&L)
Q	Training
R	Hardware Architectural Rapid Change (HARC)
S	Software Portability and Adaptability (SPA)
T	Technological Infrastructure (TI)

Table 7:

Technological Factors gaps in Analysed Studies

#	Gap	Author	Model	Elements of the research
1	A,B,C,F,R, S,T, N & G	Theory of Reasoned Action (TRA) (Fishbein & Ajzen, 1975)	TRA	"Attitude towards Act of Behaviour", "Subjective Norm" & "Perceived Behavioral Control".
2	A,B,C,F,R, S,T,N & G	Davis et al., (1989), (TAM)	TAM	perceived usefulness & perceived ease of use
3	A,C,R,S,T & G	Tornatzky and Fleischer, (1990)	TOE	technological context of IOS; E, F,N,O & organizational technology context; B
4	G,R,S,T	Rogers, (1995)	DIO	A,B,C,F,M
5	A,B,C,F,R, S,T,N & G	Iacovou, Benbasat, and Dexter (1995) model	Iacovou et al. (1995)	perceived benefits, organizational readiness, and external pressure
6	A,B,C,F,R, S,T,N & G	(Venkatesh et al., 2003)	UTAUT	Combined elements of TRA, TAM and TPB,
7	A,B,C,F,R, S,T,N & G	(Ajzen, 1985)	TPB	user acceptance & usage behavior of IT
8	G,R,S,T	(Peansupap and Walke, 2005)		A,B,C,F,N, P&Q,

Significantly the analysis of the research gap, demonstrated in table 8, clearly show G, R, S & T as a justifiable research gap. Evidently, from the analysis none of the researched model had considered the T.S in adoption of ICT. In addition, none of the models analyzed in table 4 clearly indicate T.S as a factor in adoption of ICT in T&L. However, models analyzed in table 8 fail to express technical support as one of dominant factor among the identified constructs, in adoption of ICT, while later study done by Waithaka, Kimani, Korir and Muathe (2013) indicates that technical support is paramount in adoption of ICT.

In support to this claim Khan, Hasan and Clement (2012) research outlined lack of T.S as a first order obstacle. This is in agreement with the findings of the study by (Markus and Keil 1994; Prescott and Conger 1995). Therefore, Technical support for ICT adoption in T&L, Hardware Architectural Rapid Change (HARC), Software Portability & Adaptability (SPA) and Technological Infrastructure (TI) i.e. G, R, S & T are therefore justifiably good research gaps, worth investigation. This is the strong agreement that ICT exhibit an assimilation gap, where their rates of organisation adoption (Fichman and Kemerer, 1999).

To emphasis on this Fichman and Kemerer (1999) points out that ICT exhibit an integration gap, where adopters' rate of organizational assimilation trail behind their rate of organizational adoption. Therefore previous studies call for further research to facilitate easy penetration of the technology use (Maina and Nzuki, 2015).

Development of an onsite model will help minimize inconsistencies that these theories and models have not explained as noted by Li (2003). The new model will bring improved specificity and explanatory capability Carter and Be´langer, 2005; Legris, Ingham and Colerette, 2003). A study done by Lyytinen and Damsgaard (1991) to exermine usifulness of DIO identified a theoriticacal gap in DIO as it is inline with this study. The table adopted from Legris, Ingham and Collerette (2003) shows some of these inconsistences, in the statement of the problem of this study.

In addition, Rogers (2003) noted absence of research, on the influence of perceived attributes of innovation, including T.S and technological rapid change. Likewise, in further support Lyytinen and Damsgaard (2001) argues that it is not clear whether the list of technological factors in Roger's model are exhaustive or not leaving more to be investigated.

Finally, this study holds that, technologies are not discrete packages as DOI research relates an innovation with distinct and quantifiable features (Hai 1998' Premkumar et al., 1994; Rogers 1995; Tornatzky and Klein 1982). With this sort of definition, several complications arise and consequently the need to examine the suggested model.

2.7 Theoretical Framework

The research used theoretical framework as in line with definition given by Gabriel (2008), to explain, predict and understand ICT adoption in T&L in the effort to bridge the knowledge gap. In the same effort, this study reviewed a number of ICT adoption models as follows.

2.7.1 ICT Adoption Models

In the quest to find a reliable model for adoption of ICT in T&L, this study critically, reviewed ICT adoption models developed in the past. These models include the Technology Acceptance Model (TAM) by Davis and Venkatesh, the Theory of Planned Behaviour (TPB) by Ajzen and Diffusion of Innovation Model by Rogers. In the following, a conceptual model derived from the above-mentioned theories was drawn. To explains the major line of thoughts, the following section expounded on models reviewed.

2.7.2 Theory of Planned Behaviour (TPB)

Theory of TPB used in developing theory of TAM by Davis and Venkatesh. Subsequently, explanation of this theory came first, in order to comprehend the theory of TAM. The theory of TPB is an extended model of the TRA by Ajzen and Fishbein and consist of the attributes "Attitude towards Act of Behavior", "Subjective Norm" and "Perceived Behavioural Control".

The factors" Behavioural Intention" and "Actual Behaviour" are to some extent influenced by these two attributes. The factor "Attitude towards the Act of Behaviour" indicates the belief of a person that certain behavior will lead to certain results. On the other hand, the factor "Subjective Norm" indicates the belief that a certain person is of the opinion that one should or should not perform certain behavior. Moreover, Schiffman et al., (2008) state that, "Perceived Behavioural Control" indicates whether or not persons are able to act according to their actual intentions.

TPB mainly assume that, both intention and behavior correlate with the natural personality of individual, the external or social influence and control (Ajzen, 2005). Davis proposed the TAM in 1985, basing it on TRA and the theory of TPB, in order to predict behavioural intentions in relation to technological innovations.

2.7.3 Technology Acceptance Model (TAM)

TAM is an alteration of TRA specifically tailored for modeling user acceptance of information systems (Davis et al., 1989). Additionally, the model offers useful beginning for locating the influence of external issues on internal beliefs, attitude and intentions (Davis et al., 1989). The two constructs of TAM are mainly Perceived Usefulness and Perceived Ease of use. Perceived usefulness refers to the level to which an individual believes that using a technology will require no effort (Davis et al., 1989). On the same vein previous study hypothesized that, overall attitude towards using a given system influences the decision to use or not to use it (Davis, 1989).

TAM suggests that behavioral intent influence real system usage and attitude and perceived usefulness influence behavioral intent. Both Perceived usefulness and perceived ease of use also affects perceived usefulness. External variables indirectly influence behavioral intents, through perceived usefulness and perceived ease of use. The proportional strength of the usefulness-usage relationship versus the ease of use-usage relationship was a significant finding and particularly important for designers.

Evidenced in various researches, most researchers have found perceived usefulness to be a key determinant in innovation acceptance, there has been mixed results for the perceived ease of use construct (Adams et al., 1992; Hu et al., 199; Igbaria et al., 1995; Ndubisi et al., 2001). Subsequent research refined TAM suggesting that the mediating effect of attitude could be excluded (Venkatesh, 1996). Empirical evidence established that the attitude element did not fully mediate the influence of perceived usefulness on intention to use.

Users will not use a system unless they perceive it useful, regardless of how easy or difficult it is to use. If at all, users think that a system is useful to them, then it is easy to overcome the difficulty in using it. Therefore, Davis improved his original TAM model establishing a stronger support, for perceived ease of use construct with usefulness rather than with intention to use.

TAM derived from the theory of TRA offers a powerful explanation for user acceptance and usage behavior of IT.

TAM having been proven to be empirically valid has remained one of the most influential models applied and expanded for application in varied studies, examining the determinants of ICT acceptance (Cha, 1996; Davis, 1989; Mathiesin, 1991; Adams, Nelson and Todd, 1992; Segars and Grover, 1993; Igbaria, 1992, 1995; Igbaria, Zinatelli, Cragg and Cavaye, 1997; Jantan, Ramayah and Chin, 2001; Koay, 2002, Ramayah, Siron, Dahlan and Mohamad, 2002). Therefore, TAM theorizes that individual behavioural intent to use a system is determined by both perceived and perceived ease of use (Davis, 1989).

Among studies which have used TAM include the following. A study for examining factors influencing personal computer acceptance, by small and medium-sized companies in Malaysia (Jantan, Ramayah and Chin, 2001). A study using TAM was done to understand other factors influencing ICT adoption in in Mauritian secondary T&L (Teeroovengadum, Heeraman and Jugurnath, 2017). TAM model was used in examining various factors associated with acceptance of online shopping behaviour (Basyir, 2000). Another study adopted TAM that explicitly incorporates self-efficacy and its determinants as factors that affect perceived ease of use, perceived usefulness and that use of the Internet (Fok, 2001). Refined TAM was stretched to examine the impact of extrinsic and intrinsic motivational factors influencing individual's acceptance of Internet job such (Wong, 2001). TAM model was used examining receptivity of E-banking by consumers in Malaysia is (Koay, 2002). Despite existence of convergent outcomes from IT acceptance research, influence of some factors continues to be debatable.

According to Davis (1985), perceived usefulness shows the extent to which individuals believe that incorporation of a specified system would better their performance. On the other hand, the factor perceived ease of use, demonstrates to which extent individual believes the use of a specified system will exclude the physical or mental effort. Due to these attributes, TAM is the commonly used model to explain, as well as to predict individuals' attitude towards technology innovations.

2.7.4 Diffusion of Innovation Model (DIO)

The process of adopting innovation has been studied for over 30 years (Sherry and Gibson, 2002). One of the most popular adoption models is described by Rogers is described as

Diffusion of Innovations. Researchers from wide range of disciplines have used the model as a framework. Some of these Disciplines include communications technology and education (Dooley, 1999; Staurt, 2000).

Rogers' DIO theory is usually applied in examining the adoption of technology in education (Medlines, 2001; Parisot, 1995). Indeed, much diffusion research involves technological innovations, so Rogers (2003) commonly used the word "technology" and "innovation" as synonyms. He defines "technology as a design for instrument action that reduces the uncertainty in the cause-effect relationships involved in achieving a desired outcome" (Rogers, 2003, p. 13). The design instrument comprises of two parts H/W and S/W.

Here H/W refers to "the tool that embodies the technology in the form of material or physical objects," on the other hand S/W refers to "the information base for the tool" (Rogers, 2003, p. 259). Since S/W (as a technological innovation) has a low observability, its rate of adoption is quite slow.

In this case adoption is defined as a decision of "Full use of an innovation as the best course of action available" and rejection is a decision "not to adopt an innovation" (Rogers, 2003, p. 177). Defines diffusion as "the process in which an innovation is communicated through certain channel over time among the members of a social system" (Rogers, 2003, p. 5).

As articulated in this definition, innovation, communication channel and social system are the four key components of the diffusion of innovations (Rogers, 1995). Within the element innovation, there are certain characteristics that have an effect on whether or not and to what degree an individual is eager to early adopt or admit new technologies. Relative advantages indicate whether users treasure the innovation as a better conventional product. Complexity point to the encounters to comprehend the innovation, whereas Trialability indicates to what extent, the innovation requires further investigation before induction. Compatibility deals with the experience, while as Observability deals with the results after adoption of the innovation.

Despite the fact that substantial studies support the TAM as an outstanding model to explain the acceptance of ICT, it is debatable if the model applies in examining each occurrence of ICT adoption and implementation (Yi-Hsuan Lee, Yi-Chuan Hsieh and Chia-Ning Hsu, 2011). Numerous empirical studies endorse unifying two or more theories to manage the speedy

changes in ICT and advance specificity and explanatory capability (Carter and Be'langer, 2005; Legris, Ingham and Colerrete, 2003).

TAM and IDT relates in a way and supplement each other to inspect the adoption of ICT. Notably constructs working in TAM are fundamentally a subset of perceived innovation attributes. Unification of these two theories give better results than either of them used independently (Wu and Wang, 2005; Chen, Gillenson and Sherell, 2002). Previous research combined some theories, and achieved better results (Sigala, Airey, Jones and Lockwood, 2000; Chen et al., 2002). On the same vein, this study agrees and opts to combine the DIO technological factors constructs with technical support and ICT technological infrastructure, compatibility, portability, observability, relative advantage, software portability, Trialability and hardware technological rapid change. For the purpose of this study, constructs of other theories reviewed in this study were left out, following that they are not technological (i.e. emergent from technology) in nature. In this study, the focus is on factors emergent from technology or innovation characteristics (Rogers, 1995).

This study opts to adopt a theoretical paradigm IDT (Rogers, 1995; Moore and Benbasat, 1991). After reviewing literature on technology acceptance, the research synthesized the major theories and empirical research and then proposed a model that unified main constructs involved in adoption of ICT in T&L. Five constructs of IDT emergent from innovation characteristics considered are relative advantage, compatibility, complexity, Trialability and observability. To generalize the model successfully for acceptance within T&L context, appropriate modifications is required.

In this context, the Diffusion of Innovation Model by Rogers (1962) was used. In the effort to; first make predictions (After all, if the theory is generally true, the predictions from the theory should be true, too), second allows for systematic approach to adoption of innovation to observe or measure only some variables, third benefit clarify what is happening, using the terms of the theory. This leads indirectly to empowerment, since the control of the explanatory forces leads to improvement, finally put the theory under stress to improve it. If the theory does not do a good job in predicting, managing, or explaining, it needs to be improved. Hence, the quest for the theory is intimately, entwined with the quest for improvement and mastery (Licker, 2008). Let us look at constructs of Innovation Diffusion Theory by (Rogers, 1995).

Innovation Diffusion Theory (Rogers, 1995)

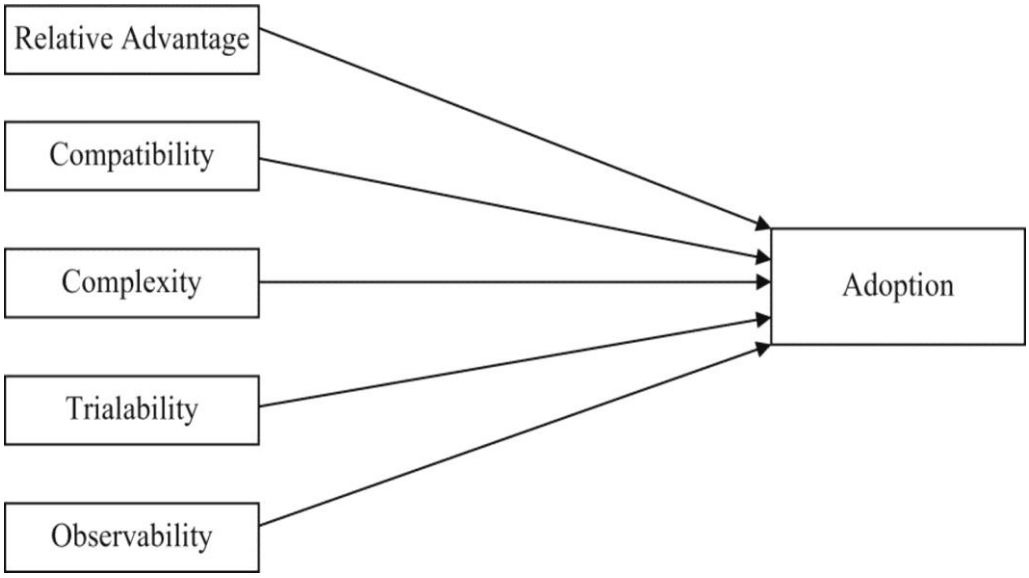

Figure 4: Innovation Diffusion Theory (Rogers, 1995).

According to Rogers (2003) "diffusion is the process in which an innovation is communicated via certain channels over time among the members of social system. It is a special type of communication, in that the messages are concerned with new idea" (p.5). In Roger's model, there are four essentials; i) Innovation (Rogers, 2003, p.12). ii) Communication channel; (Rogers, 2003, p.5). (iii) time and (iv) Social system (Rogers, 2003, p.23).

Within the element innovation, there are some characteristics that have an effect on whether or not and to what degree an individual is eager to adopt or admit new technologies. These elements include Relative Advantages, Compatibility, Complexity, Trialability and Observability (Rogers, 2003). Relative Advantage: indicates whether users find an innovation superior than similar conventional products. Complexity: Indicates the challenge to understand the innovation, whereas Trialability: indicates the extent of studying the innovation before it can be launched (Rogers, 2003). Compatibility: "indicate the degree to which an innovation is perceived as consistent with the present standards, earlier experiences and requirements of possible users" (Rogers, 2003, p. 15).

According to Sahin (2006), the process of studying adoption of innovation happens over the last thirty years. On the other hand, one of the popular adoption models is described by Rogers in his book Diffusion of Innovations. On the same vein, "much research from abroad variety of

disciplines has used the model as a framework" (Sahin, 2006, p.14). Some of these disciplines are; political science, public health, communications, history, economics, technology and education mentioned several of these (Dooley, 1999; Stuart, 2000). They defined Rogers' theory as a widely used theoretical framework in the area of technology diffusion and adoption.

This is further in agreement with Isleem (2003) who noted that many studies use Rogers' theory as a framework, with only few of them considering it for adoption in use of computers for instructional purposes. Among other models reviewed was Technology Acceptance Model (TAM) although they seemed to lack more on technological factors in addition to other inconsistences (Long, 2003). In agreement to the findings of Isleem (2003), this study opted to use Rogers's theory as a framework in the effort to understand technological factors in adoption of ICT in T&L.

2.7.5 Weakness of DIO Theory:

Past studies reveal that technologies are not discrete packages as DOI research associates an innovation with distinct and measurable features (Hai, 1998; Premkumar et al., 1994; Rogers, 1995; Tornatzky and Klein 1982). With this sort of definition, several difficulties emerge. To begin with, it is not clear whether the list is complete and covers all features that affect adopters' behavior; for instance, why technical styles do not appear in the lists, though the past studies on technologies demonstrate the contrary (Hughers, 1987). On the same vein, this led this study to the discussion, whether all innovations share similar set of technological attributes.

Technological attributes claimed by various studies comprise; Tornatzky and Klein (1982) who discussed ten attributes listed in 23rd paragraph of section 1.1 of this study. Premkumar et al., (1994) used this list for investigation of EDI diffusion. Hai (1998) used a different set of six attributes as listed in the discussion of background of this study, section 1.1. More attributes identified by Waithaka et al., (2013) including internet connectivity. Nevertheless, the ICT rapid growth brings up new technological factors (Al Geist, ORNL and Lucas, 2009). For instance, its observed that; the shifting from using faster CPUs to using multi-core CPUs is as disruptive to scientific S/W as the shift from vector to distributed memory supercomputers fifteen years ago (Al Geist, ORNL and Lucas, (2009).

Previous studies Premkumar et al., (1994) showed that the attributes of innovation (technology) influencing the implementation and adoption of innovations like EDI. A study on meta-analysis

of a general innovation research identified three attributes compatibility, relative advantage and complexity, which relates to the adoption of an innovation (Tornatzky and Klein, 1982). In terms of EDI as an inter-organisational system, Prekumar et al., (1994) argue that communicability, cost and elapsed time to be added, to these original three attributes when considering this specific technology.

A research examined the relationship between characteristics of EDI; Complexity, compatibility, relative advantages, cost communicability and elapsed time and several features of the diffusion of EDI using a survey of 201 companies (Premkumar et al., 1994). This study established three attributes (compatibility, relative advantage and elapsed time) are key predictors for adaptation, diffusion and implementation success of EDI (Premkumar et al., 1994).

Individual innovation and applications have their own distinctive requirements calling for unique considerations. This finds a strong support from Lee, Hsieh and Hsu (2011) as indicated earlier in section 1.2. Therefore, this leaves this study with a gap that calls for model, which suits this specific scenario. In further support Lyytinen, and Damsgaard (2001) noted the need to develop an onsite model for adoption, as technologies are not discrete packages, with distinct and measurable features.

ICT technologies are learning intensive in that resources require continuous supply into their maintenance and modification (Heikkila, 1995). In agreement with Lyytinen and Damsgaard (2001), this study established that the DOI theory needs a careful consideration in the context of ICT adoption in T&L in particular. This calls for development of a model, which will suit this study; there is the need to develop DOI theories at the site by using multiple levels of analysis (Lyytinen and Damsgaard, 2001).

DOI theory does not offer adequate constructs to deal with collective adoption behavior. Due to inattention to critical factors of adoption of ICT in T&L, there is need to introduce important factors in model matched for adoption of ICT in teaching and learning.

Further review of IDT shows that it is lacking on very important attributes. The lacking attributes are of paramount interest in adoption of ICT for T&L process, which could be the reason why innovation adopters have been reluctant in considering it for instruction purposes

(Isleem, 2003). Following is the discussion of the nine technological factors identified in this study.

IDT is lacking on technical support, whereas studies show that availability of all other ICT resources without technical support cannot amount up to ICT adoption and integration. Equally, this calls for change in mindset that presence of computers is an indicator for ICT adoption (Gordon et al, 2014). This agrees with previous research emphasizing on the need for adequate mentoring, access and T.S (Sherry and Gibson, 2002).

Supply of technological infrastructure for T&L has received a lot of attention from the stakeholders (Means, 2000). Nevertheless, we are far from realising seamless, convenient, robust and reliable T.S structure for all the adopters (Means, 2000, p.186). Indeed, lack of T.S is serious barrier to integration of ICT (Ertner, 1999). Lack of T.S leads to inaccessibility to ICTs and technical problems, as there is now one repair or maintain them (Becta, 2004). Finally, as in support to this study, previous research on Rogers' diffusion theory, suggested for increased computer training and T.S (Blankenship, 1998).

Despite considering IDT as an appropriate model for this study, introduction of other constructs was proposed. Proposed constructs include technical support, H/W Architectural Rapid Change, S/W Portability with Adaptability and Technological Infrastructure, it evident that they have significant influence on the adoption of ICT in T&L.

Elementary infrastructure is vital for sustenance of ICT-assisted instructions includes; electrical and telecommunication capacity, number of computers, computer laboratories, T.S and internet for sharing of resources (Wallet and Melgar, 2014). This is in agreement with other studies that Technological infrastructures include: hardware and internet connectivity (Menda, 2006; Janczewski, 1992), Electricity supply and potential of portable and alternative energy technologies (Hennessy et al., 2010).

The NCATE report that lack of T.S as the major contributor to computers underutilization in T&L processes (Morgan et al, 2009). Therefore, lack of T.S is very demanding for adopters (Morgan et al., 2009). This may affect the adopters' willingness in the adoption of ICT as in agreement with (Tong and Trinidad, 2005). This study thus proposes a mode that includes technical support as seen below.

Scholarly work shows that there is lack of research on the effects of perceived attributes of innovation (Rogers, 2003). The list of technological factors identified is incomplete, as well as lacking an all-inclusive model. The reviewed models do not cater for technological factor identified as influencing adoption of ICT in this context. Explanation by Rogers equally informs this study that the DIO model is not sovereign and serves in all manner of situations, as seen in paragraph 18, section 1.1 of this study

2.8 The Conceptual Framework

The conceptual framework based on technological factors influencing adoption of ICT in T&L, it consists of: Relative Advantage [RA], Perceived Compatibility [CPA], Perceived Complexity [CPL], Perceived Trialability [TBL], Perceived Observability [OBS], Hardware Architectural Rapid Change [HARC] and Software Portability with Adaptability [SPA], Technological Infrastructure [TI] Technical Support [TS] and two moderating factors Institutional policy and Government policy as seen in Figure 5.

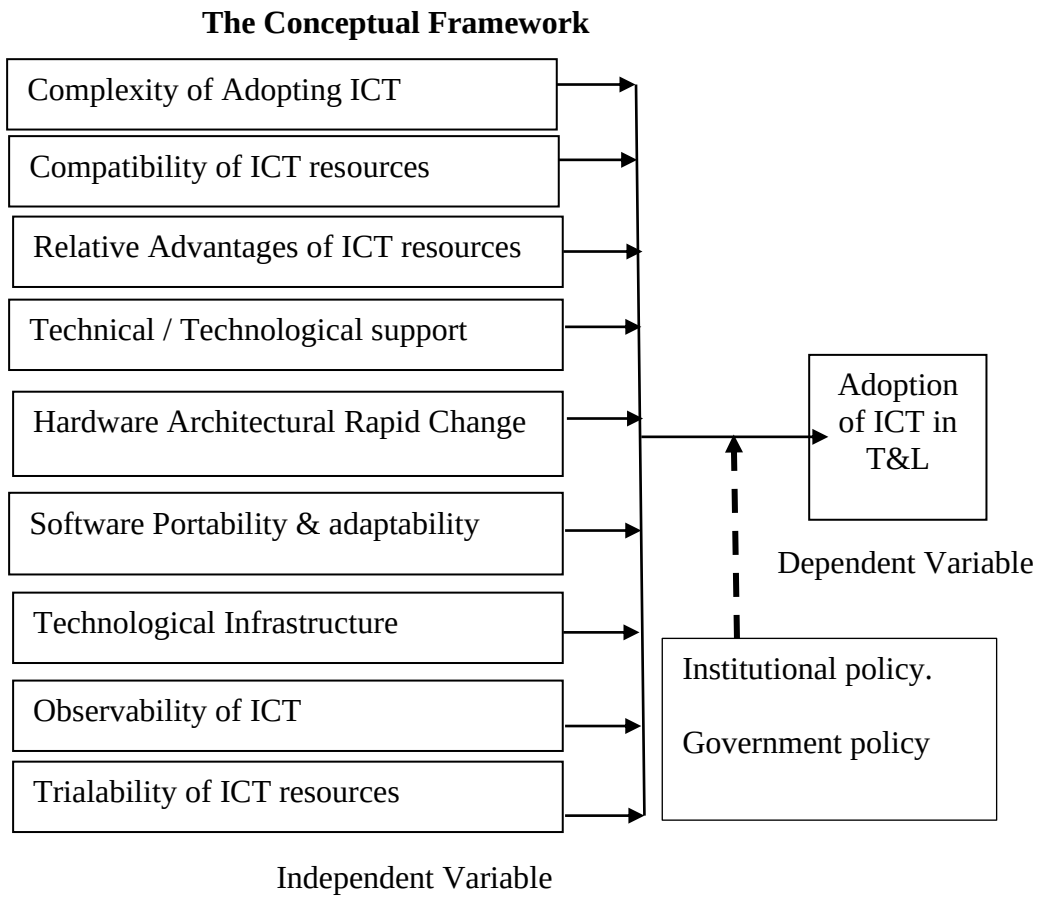

Figure 2. Conceptual Framework

Table 8 below shows set of indicators informing each variable used in conceptual framework above.

Table 8:

Variables Indicators

Variable: Technological Infrastructure (TI)			
Indicators	Operational Definition	Purpose	Source
i. Access to Computer systems ii. Access to LAN, iii. Access to ICT Laboratory, iv. Access internet	They are ICTs hardware and connectivity resources required for adoption of ICT	Measure of TI available to enable adoption of ICT	Adopters
Continuation, Variable: Complexity of Adopting ICT (CPL)			
i. Relative Ease of understanding IT ii. Available basic knowledge, iii. Convertibility of resources to e-resource	The degree to which ICT perceived as relatively difficult to understand and use (Rogers, 1995).	Measuring ICT complexity influencing adoption of ICT	Adopters

Table 9:

Variable Indicators OBS, HARC and TS

Variable: ICT Observability (OBS)			
Indicators	Operational Definition	Purpose	Source
i. ICT Share ability, ii. ICT Speed, iii. Multimedia Quality, iv. ICTs Flexibility	Degree to which the results of an innovation are visible to others.	Measuring ICT OBS influencing adoption of ICT	Adopters
Variable: Hardware Architectural Rapid Change (HARC)			
i. Upgradability ii. Up to datedness iii. High speed iv. High Storage	its requirement rate of change is very high introducing new technological challenges	Measuring ICT HARC influencing adoption of ICT	Adopters
Variable: Technical Support (TS)			
i. Access to TS ii. Office for TS iii. TS staff iv. TS training	The provision of assistance on technology complex skills and professional specialties Becta (2006).	Measuring level of ICT TS available to support adoption of ICT	Adopters

Table 10:

Variable Indicators TBL, CPA and SPA

Variable: Trialability (TBL)			
Indicators	Operational Definition	Purpose	Source
i. Easy to try ii. Safe to try iii. Afford to try iv. Availability of basic skills to try	The degree to which an innovation may be experimented with a limited basis.	Measuring ICT Trialability influencing adoption of ICT	Adopters
Variable: Compatibility (CPA)			
i. Able to use with ii. Able to make iii. Able to combine iv. Able to share	The degree to which an innovation perceived as consistent with the existing needs of potential adopters	Measuring ICT Compatibility influencing adoption of ICT	Adopters
Variable: ICT Software Portability and Adaptability (SPA)			
i. s/w availability ii. use diverse H/W platform iii. Modern S/W iv. Share S/W	software that can be used in different hardware platforms, with little or no modification	Measuring ICT SPA influencing adoption of ICT	Adopters

Table 11:

Variable Indicators RA

Variable: Relative Advantages (RA)			
Indicators	Operational Definition	Purpose	Source
i. ICT Technologies Opportunities, ii. ICT Centrality iii. Social Approval, iv. Communicability	The degree of perceiving an innovation as better than the idea it supersedes (Rogers 1995, p.215).	Measuring ICT RA influencing adoption of ICT	Adopters
Adoption of ICT in T&L			
i. Learner computer ratio ii. Availability of ICT policy iii. Access to Technical Support iv. Integration of ICT in daily activities	full use of an innovation as the best course of action available	Measure the level of ICT adoption in T&L	Adopters

Note. For each variable described above used a questionnaire, interview schedule and observations.

2.10 Recap of Literature Review

The review focused on synthesis of the literature on adoption of ICT, focusing on the technological factors in adoption of ICT. In so doing, the review helped to point out determinant factors that influence adoption of ICT. This involved consideration of various models for review informing proposal and development of a practitioner's model.

ICT is termed as a key drive of economic development and social change worldwide (Komza, 2005). ICT plays a major role in, economic, political, social and cultural development. It has rapidly transformed the manner in which individuals do work, access information, services and communicate among themselves (Kelles-Viitanen, 2003).

Kenya Government has largely financed integration of ICT in education. Key initiatives supporting in the integration of ICT in classroom teaching including; laptop project for primary schools' kids. Kenya's government allocated kshs 980 million to fund ICT infrastructure necessary for e learning in secondary schools (MOE, 2011b). Again, the report by MoE (2011a), indicates that Kenya Institute of Curriculum Development (KICD) has been mandated by government to provide digital content for eLearning, benefiting 1021 public secondary schools countrywide.

Literature informs this study that; Based on Rogers' Innovation Diffusion Theory, there are five perceived attributes of innovation that will lead to adoption of ICT in T & L. ICT technological factors are important factors that can lead to higher rates of ICT adoption. Therefore, based on the conceptual foundation provided by Rogers (1995), the main research question of this study is "What are the technological factors that influence adoption of ICT in T & L in Kenya?"

Technological factors: Technological factors commonly identified in the past studies includes; compatibility, complexity, Trialability, observability, relative advantage, technical support, hardware rapid technological change, software portability with adoptability and ICTs infrastructure; internet connectivity and access to ICT resources.

2.11 Research Gap

Previous studies done lack on consideration on technological factors in adoption of ICT. Rogers' model though most widely preferred for adoption of ICT is highly questioned, to

whether able to suit all instances of adoption of ICT. Rogers' model lacks important constructs: Technical Support, Hardware Architectural Rapid Change, Software Portability & Adaptability and Technological Infrastructure. This calls for development of a model that integrates already established constructs.

Informed by the review of empirical studies, this study established that there are other technological factors, emerging from the technology attribute, as noted by Rogers (1995) among which this study conceded compatibility and complexity. ICT Technical support as identified as a major obstacle in adoption of ICT in education by NCATE as revealed in Morgan et al., (2009) is also considered in this study as technological factors. This study ascertains that there is an integration gap, in adoption and integration of ICT in work place procedures worldwide. This found a lot of support from various studies reviewed. In support to this, past studies explain that ICT exhibit an integration gap; in that speed of adopters' incorporation of ICT in their day-to-day undertaking indicate a strong disparity to their rates of adoption (Fichman and Kemerer, 1999). Too much investment take place on ICTs, but too little adoption and integration in return.

This study found that past studies failed to research on technological factors affecting adoption of ICT in T&L. Again, on reviewing models used for ICT adoption, bearing in mind that no single model can suit all instances established that there lacks an ICT adoption model, designed to suit adoption of ICT in education. Further empirical review clearly indicated that even the generalized models lacks on technical support in their construct. This found a great support from Lyytinen and Damsgaard (2001) who explains that, the list of technological factors could not be complete in Roger's model. Therefore, from the past research it is evident that, there is the need to investigate further and develop an on-site model for adoption of ICT (Lyytinen, and Damsgaard, 2001). Again, technologies are not discrete packages, with distinct and measurable features (Lyytinen, and Damsgaard (2001). The same way examining of ICT adoption in diverse environments cannot depend on one model (Lee, Hsieh and Hsu, 2011).

2.12 Conclusions

Adoption and integration of ICT in education in general is the focus of all education systems in the world. The world education systems agree on benefits of ICT in education and economy growth among others. Literature reviewed, clearly shows the need for TS for ICT adoption in education. Empirical studies further revealed that; ICT TS, HARC, SPA and TI are not only

influential factors in adoption of ICT in Kenya, but also the entire world as from least developed country to the mighty and most developed countries. Some countries like Korea termed as an educational powerhouse (Hwang, Yang and Kim, 2014, p.134). Korea has good laid down structure for TS, to the adopters of ICT in education. Korea puts more effort to achieve a real-time help and TS at schools (Hwang, Yang and Kim, 2010).

Kenya among many other countries lack on mechanism for giving technical support to adopters of ICT in education in general. If there is T.S given in most countries, then their performance is decimal. In addition, empirical literature revealed lack of an ICT adoption model designed specifically to handle technological factors affecting adoption of ICT in education. This called for development of conceptual framework useful in adoption of ICT in T & L. See Figure 5 conceptual framework in chapter 2.8.

In conclusion, this study established that ICT adoption suffer various gaps namely; Research gap, ICT adoption gap, knowledge gap and model gap. Finally, the subsequent chapter shows testing of factors affecting the adoption and integration of ICT in T&L as identified in chapter two, as well as showing the applied methodologies and process. This testing aligned with explanation by Frost (2013), that regression test provides important statistical controls, which isolates the role of one variable from all the others in the model.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction of the Methodology

In this chapter the researcher describes the methodology used; research design, location of the research, target population, research sample, research instruments, and description of research instruments, validity, reliability of the instruments and the data collection methods and techniques.

3.2 Research Method

The researcher employed descriptive survey design. This design is useful in capturing, describing, analysing and interpreting conditions. This study neither did organize on how event will happen nor influenced the variable. The survey was interested with circumstances and relationships existing; opinion that are held; current process; effects that are evident or trends that are developing.

Survey method of summarizing secondary data was an important step in the research process for defining the research problem. It involves collecting information by either interviewing or administering a questionnaire to a sample of individuals. Therefore, this study involved collecting primary data from adopters, about technological factors influencing adoption of ICT in T&L process, hence better placed to give useful data for this study.

Secondary data collected from literature survey in order to include all the relevant variables of interest to this study. Literature survey available on the internet; journals and relevant books published by other researchers; whereas observation schedule, interview schedules and questionnaires were used to collect primary data. The study gathered data on technological factors influencing adoption of ICT in T&L.

The study combined both quantitative and qualitative method of data collection; mixed method approach. Mixed methods approach described by Creswell (2003) as one in which the researcher tends to base knowledge claims on pragmatic (realistic) grounds. It also represents data, which are quantitative and qualitative information. This approach was essential to improve

the statistical reliability of the results. In this study, qualitative and quantitative method was useful in determining if certain conjectures substantiated.

This study considered a quantitative research approach important, ensuring a systematic investigation of scientific, mathematical properties and their relationships. This study was involved in the testing of whether technological factors influences adoption of ICT in T&L. The measurements being quantitative were later analyzed using statistical techniques. Despite that, this approach calls for additional time, because of the need to capture and analyse both qualitative and quantitative data. This approach is therefore fit for this study since it provides both the flexibility of qualitative inquiry and the structure of quantitative research.

An in-depth investigation, which was more descriptive than numerical, attained through a qualitative approach, as case studies usually provide qualitative and quantitative data for analysis and interpretation. Qualitative approach involves the interpretation of phenomena without depending on numerical measurements or statistical methods. Qualitative data refer to information gathered in a narrative form through interviews and observations. It therefore aimed at classifying features, counts them and constructs statistical models in an attempt to explain what is observed (Neill, 2007). Combination of both qualitative methods used as this method allows many approaches to collect and analyse data rather than subscribing to only one way (either qualitative or quantitative).

The researcher conducted interviews on one-to-one basis, which allowed for interaction with the respondents during data collection and made it possible for clarification of unclear issues. The quantitative data was collected using questionnaires, converted into numeric codes and analyzed statistically. Therefore, the descriptive research was useful in describing the phenomena, as it was. This design was the most appropriate for this study as studying of the determinants took place in the field without manipulation.

3.3 Research Design and Method

Descriptive survey design was adopted in this study. This design found to be the most appropriate for this study as this study seeks to describe identified technological factors and deliver a profile of technological factors in adoption of ICT in T&L.

3.4 The Location of the Research

The study being an academic research, the researcher limited it to an accessible geographical area, set time frame, within which to gather desired information and with the workable budget. On the same vein, this study opted to use disproportionate sampling, as it is easier, simpler and less expensive to collect data from one or more strata than from others. Again, the number of schools with computer resources is small in Githunguri sub-county (strata).

The researcher carried out the study in Githunguri sub-County, Kiambu county-Kenya approximately 25 kilometers from Nairobi. The number of learning institution is ideal for providing reliable amount of data. In this area there are fairly good infrastructures such as good roads, communication equipment that include radio stations and good electrification. These make the setting accessible and permit instant rapport from the respondents. No similar study has been carried out in the setting and thus this justifies why this setting.

3.5 The Target Population

This refers to a set of individuals the study wants to generalize results of study (Borg and Gall, 1989). Sample will rarely be the perfect duplication of the population from which it is drawn. Therefore, this study selected the sample in scientific way, to be reasonably sure that the sample statistic is fairly close to the population parameter.

Githunguri sub-County having 32 public secondary schools, were considered because there are schools of all categories with teachers from all levels of education and regional backgrounds as enlisted in "2016 KCPE Secondary School Choices List National Schools" (KNEC, 2016). Schools in this area differs in level of resource, some have got well-equipped computer laboratories, some do not have computer laboratories, but have some few computers and others have neither computers nor computer laboratories.

3.6 Sample Design and Sampling Procedures

The researcher used purposive sampling to capture sample schools and teachers whom the study felt that they have required information. This study sampled schools in which information technology resources are available. These include computers systems and other peripheral devices. The researcher used judgment sampling of purposive sampling as it involves the choice

of subjects best positioned to provide the information required. Interviewer interviewed respondents involved in tasks involving use of ICT resources and or training adopters on how to use ICT. In this study, 16 institutions gave sample size representing 66% of the total population. However, a scientific way (sample size formula) was employed to be reasonably sure that the sample statistic is close to the population parameter.

Yamane (1967 pg. 886), provides a simplified formula to calculate sample sizes as n = N / (1 + N (e)^2 and mean as n 0 = (Z2δ2) / e^2 Where n is the sample size, N is the population size and e is the level of precision. However, in this case sample size for the study was calculated using Mugenda and Mugenda (2003), formula for sample size determination for population less than 10,000;

Where: nf = the desired sample size (when the population is less than 10,000), n = the desired sample size (when the population is more than 10,000) N = the estimate of the population size

A total of 32 schools gave a total of 960 teachers as the estimate population size. Using the above formula nf= [384 Teachers] / {(1+ ([384 Teachers] /960)} Accessible Teachers), =275 Teachers.

There are two County schools, one boys' and one girls school. There are eight sub county boarding schools including four boys' and four girls' schools. There are two sub county schools included in the sample, in sub county boarding category, sampled two schools to represent each gender. The rest sampled from the mixed boarding day and as outlined in the sample grid. For every subject two or three questionnaires were given in each sampled school. Therefore (3 respondents per subject X 14 Subjects X 16 Schools gives 672 respondents). From this sample, size 637 respondents returned their questionnaires. See table 3.1 below.

Table 3.1

Category of Schools, Population Size and Sample Size of Respondents

Category of School	Population	Sample size of Respondents	Percentage sample Size
Day	480	314	65%
Day / Boarding	245	170	69%
Boarding	235	153	65%
Total	960	637	66%

The study used formulated questions targeting a number of sample groups. The questionnaire entailed relevant questions. The sampled group expected to respond to the questions in reference to the options given. The purpose of using this method was to obtain usable records for future references and easy access to details that calls for lesser effort. One of the limits accompanying this method was that it could not serve to the blind and those who cannot read at all.

The study used the interim schedule, involving going to the field interviewing the target population. The advantage of this method was that the interviewer was able to get immediate feedback from the interviewees. In addition, this method intended to accommodate face-to-face communication, which involved eye contact. This enhanced researchers' certainty on the feedback on reliability.

To collect qualitative data this study employed use of observations. Observation allowed collection of facts relating to what was currently happening and not complicated by either the past behaviour or future intentions or attitudes of respondents (Kothari, 2004). Observation scheduled to collect qualitative data, as observation is exploratory in nature. Observation was useful to capture qualitative data on ICT resources used, factors influencing adoption of ICT and pattern regarding these phenomena. This was useful in formulating research questions for subsequent testing. This case study attempted to obtain information about ICT from schools and other stakeholders such as ICT champions, education officers and teachers among others, using purposeful or judgmental sampling method. The researcher used a sample frame as a complete listing of all the sampling units or elements that can adequately represent that population.

However, this study did not find a complete official list that can adequately satisfy this study as sample frame (Brook, 2013). In such instances, the study develops a sample frame that produces a representative sample of the population elements with the desired characteristics of attributes.

Previous research established that, within this method, the study chooses the subjects favorably placed and in the best position to provide, the facts required (Uma et al., 2004). Therefore, the study focused on all the 32 schools registered for K.C.S.E by Kenya National Examination Council (K.N.E.C), in Githunguri sub-county. See appendix VI.

3.7 Research Instruments

Questionnaire was used to gather bio data about the respondents, institution and use of ICT. Structured questions were used in questionnaire. Questionnaire facilitated collection of large amounts of information from a large number of individuals in a short period and in a relatively cost-effective way. Data collected using questionnaire were analyzed more scientifically and objectively than other form of research. Observation helped to gather crucial and first-hand information that is unattainable through interviews and questionnaires. Through observation, information obtained relates to what is currently happening and is not complicated by either the past behaviour or future intention or attitudes of respondents. The earlier mentioned qualities of observation method out ways it is higher cost, with limited information collection.

To gather information from the principals used interview guide. Telephone interview was convenient for respondents who are very busy and or rare to meet face to face. Despite the fact that interview method of data collection depends upon the ability of the interviewer largely, interview was useful in getting detailed data, which at times calls for a one-to-one explanation and emphasis. Let us now look at how each of these instruments was developed.

3.7.1 Questionnaires

Questionnaires used in this study were structured and consisted of twenty-four closed ended questions. A closed ended question asks for the answer and gives the respondents fixed responses from which to choose. Using Likert scale questions, the questionnaire has a measuring scale of 1 to 5 as seen in appendix: III section B. In particular, the set of questions shown in Table 13, were set to probe on ICT technological factors in adoption of ICT in Secondary T&L.

Table 12

Set of Questions

	A. ICT Observability [Independent Variables]
1	Use of ICT in teaching makes it easy for teachers to share resources
2	Use of ICT in teaching process makes teaching procedure faster & timely
3	Use of ICT in teaching facilitate use of Quality Multimedia teaching AIDs
4	Sharing of Multimedia teaching AIDs lowers Cost of preparing AIDs
	B. ICT Technological Infrastructure
5	I do access working computer system in our school for teaching process
6	Our computers are connected together (LAN), allowing sharing of resources
7	I do access computers connected to internet for sharing teaching resources
8	We have working and spacious computer laboratory for our students
	C. Hardware Architectural Rapid Change
9	We have outdated computers which we could not repair and user
10	Our old computers could not be upgraded to use with new hardware & S/W
11	Modern computers are faster and work faster than the older ones
12	Modern computers store a lot of data and support newer S/W e.g. office 2016
	D. Complexity of adopting ICT in T & L
13	I find it relatively difficult to understand and use ICT in T&L
14	I do not have reliable technical knowledge and skills to use ICT in T&L
15	It finds it difficult to convert my teaching AIDs into electronic content
16	I need technical assistance if I have to use ICT resources in teaching
	E. Trialability of ICT in teaching
17	I find it easy to try different ICT applications in Teaching process
18	ICT resources are safe to try and user even without prior experience
19	I find cost of trying use of ICT in teaching being manageable
20	I do not use ICT in teaching due to the fear of technology failure

	F. F. Technical Support on ICT adoption
21	The Technical Staff give clear guidelines on adoption of ICT in T & L
22	Technical Staff in place gives technical support for adoption of ICT in T& L
23	Technical Staff trains us on technical skills in adoption of ICT in teaching
25	There is technical staff in our institution
	G. ICT Compatibility
24	I use ICT resource in our institution to present my lesson comfortably
25	Teachers share ICT resources to present their different lessons regular
26	I find it easy to combine traditional teaching AIDs with E-Content
27	Teachers with little or no technical skills get Technical assistance
H.	I. Software Adaptability and Portability
28	I do use readily available software in school computers to present my work
29	I do use my phone to update my work or even computers in school
30	I am able to use modern ICT applications with our old Pentium ii computers
31	School management software in our school are useable in my phone
	J. ICT Relative Advantage
32	Using ICT, I enjoy Technologies opportunities; newer and better ways
33	Use of ICT ensure Centrality; all resources seem to come from one source
34	Use of ICT ensure Communicability; easy to express
35	Use of ICT in teaching improves my social approval; Learners enjoy and prefer lesson presented using ICT resources

3.7.2 Interviews Schedule

Interviews were illustrative, reflective and critical. Therefore, the researcher followed a rigid procedure and looked for answers to a set of thorough personal interview. Preconceived structured questions of interview are similar to the 'self-administered quantitative questionnaire in both its form and underlying assumptions. On the same vein, structured interview yielded numerical data used to report concisely in tables and graphs.

There lacks fixed method of analysing interview data in the literature but the researchers cautiously dealt with it as it affects the validity and reliability of the whole study (Alshenqeeti, 2014). The interviewer managed to interview ten head of institutions, this resulted from financial constraints, geographical distribution of respondent, time constrains and ability to use ICT. At least one interview per school was important, as access to participants was time-consuming and expensive (DiCicco-Bloom and Crabtree 2006).

National Center for Research Methods Review Paper explains that: real matters to take into account include "the level of degree, the time available, institutional committee requirements and both philosophically and pragmatically, the judgment of the epistemic community in which a study or research wishes to be or is located, is another major consideration" (NCRM, year not specified, p.42). Interviewer collected data from respondents using interview schedule. See Appendix IV: Interview Questions.

3.7.3 Observation Schedule

In Observation method of data collection, the researcher collected data by observing, viewing what is currently happening, taking note and or capture photos on current events. See Appendix V: Observation Schedule

3.8 Testing for Validity and Reliability / Trustworthiness

To ensure sound measurement tests of validity, reliability and practicality are required. In this study, testing was possible through exposing research instrument to a trial situation. In fact, trial situation is the replica and rehearsal of the main survey.

3.8.1 Piloting

The researcher did a pilot study, to test the certainty of the research instrument before the real-life undertaking. Testing the questionnaire and revealing of any possible weaknesses required pilot research. Research instruments used to collect data from the sampled respondents. This study found it necessary to present the data collection instruments prior their usage in the research purpose.

Piloting involved using the research instrument with a small number of respondents to test reliability and validity of the tool. Piloting of research instruments were exercised in to schools and the procedure repeated after two weeks for refinement of the instruments. Piloting facilitated elimination of any ambiguity in research instrument to ensure they generated valid results for the study (Johnson and Scholes, 2002). To avoid biased results, this study treated findings of piloting as part of the study sample. Finally, data was analyzed and necessary changes appropriately made where necessary based on the results.

3.8.2 Instruments Validity

Questionnaire was designed with considerations on validity and reliability. Validity as in (Kombo 2006; Orodho 2009; Mugenda and Mugenda 2003; Kothari 2004), is a measure of how well a test checks on what it is meant to evaluate. It is actually the degree to which results obtained represent the phenomenon under study. Validation as a process involves collecting and analysing data to access the accuracy of an instrument. In this case, two statistical tests were essential to assess the validity of the instrument done through the pilot research.

3.8.3 Content Validity

Content validity guarantees that the measure includes sufficient and representative set of items that tap the concept. The more the scale represents the domain or universe of the concept being measured, the greater the content validity.

To ensure appropriateness of an instrument’s contents, the study did content, validity test (Mugenda and Magenda, 2003). In other words, the measure (questions in this case), accurately assess what the study wants to know (Kothari, 2004). Hence, achieved this by the test-retest done through piloting which was satisfactory.

3.8.4 External Validity

To establish the extent of generalizing results of the study from a sample to a population did external validity test. This is specifically essential because a sample should be an accurate representation of a population. In the case of this study, this was critical in order to justify sampling technique and the sample size of the research.

3.8.5 Research Instruments Reliability

Reliability test ho consistently a measuring instrument measures whatever concept it is measuring. That is, does the instrument consistently measure what it should measure? Reliability relates to the validity of the measure. Goodness of measuring attest to the reliability and validity of measures. Validity test how well an instrument that is developed, measures the particular concept intended to measure as proposed by (Sekaran, 2003). Two methods; Test retest method and Cronbach test were used as shown in subsequent sections in order to counter deficiencies of either methods by combining both methods and thus capitalizing on their individual strengths.

3.8.5.1 Test Retest Method for the Research Instruments

Achieved reliability of the questionnaire by two pretests in two schools different from the ones researched later and results analyzed in order to make appropriate correction. Used test-retest method to test the reliability and validity of the instruments. Test-retest technique involved administering the same instrument twice to the same group within two weeks. Reliability correlation coefficient (r) was calculated using spearman rank order.

Rho(r), = Where: r = Spearman's coefficient of correlation.

d=difference between ranks of pairs of the two variables

n=the number of pairs of observation

A correlation co-efficient of 0.91 showed a strong reliability of the research instrument. There was a 70% return rate on the questionnaires and 66% interview rate on the principals' interview schedules, as most of the principals did not honour their appointment. In order to be certain with

questionnaire responses, the researcher used triangulation method as proposed by Yeasmin and Rahman (2012), to compare interview and observation results, with those of questionnaire.

3.8.5.2 Cronbach's Reliability and Consistence Test for the Research Instruments

To achieve reliability of the research instrument used Cronbach's alpha reliability coefficient. Cronbach's alpha is a reliability coefficient, which "indicates how well the items in a set are positively correlated to one another" (Sekaran, 2003, p.232). The results of Cronbach's alpha reliability coefficient were reliably high as shown in table 14 below.

Table 13:

Cronbach's Alpha Reliability Coefficient

	Item	Cronbach's Alpha	Reliability Results	Inter-item correlation	Item to Total Correlation	KMO
TI:	5	.811	Good	425	.554	.433
TBL:	5	.806	Good	391	.625	.579
TS:	5	.815	Good	406	.524	.477
CPL:	5	.806	Good	377	.602	.579
RA:	5	.826	Good	347	.389	.722
CPA:	5	.830	Good	239	.369	.507
HARC:	5	.809	Good	325	.571	.408
OBL:	5	.818	Good	285	.483	.472
SPA:	5	.814	Good	441	.524	.625

3.8.5.3 Kaiser-Meyer-Olkin (KMO) Test for Factors Analysis

The Kaiser-Meyer-Olkin (KMO) tests suitability of the data for factor analysis (Sekaran, 2003). The test measures sampling adequacy for each variable in the model (Sekaran, 2003). When the KMO value ranges between; 0.4 to 1, it means that the variable sampling is adequate (Sekaran, 2003). In the table above, all the KMO values are above 0.4 meaning that, the variable sampling was adequate for factor analysis.

3.8.5.4 Item Internal Consistency Test

Item-to-total correlation is another common measure that assesses the internal consistency for each item in a set. This measure determines how well an item in a set independently measures the concept so that the subjects can have the same overall meaning in each of the questionnaire items (Sekaran, 2003).

In this study, the results of the 78% item-to-total correlation were above 0.5, which was an indication that individual items were consistent with each other. Finally, the single alpha value for the entire set of indicators was 0.830 suggesting that the set of indicators has a considerably high level of consistency hence the questionnaire considered valid.

According to Straub (1989), high correlation between alternative measures or large Cronbach's Alphas is usually signs that the measures are reliable; Reliabilities of 0.7 and over considered acceptable (Muathe, Wawire and Ofafa, 2010). The actual value for Cronbach's alpha realised in this study indicated a high level of internal consistency for the scale used.

Table 14
Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.830	.832	9

A reliability analysis was carried out on the perceived task value scale including 9 items. Cronbach's alpha showed the questionnaire to reach acceptable reliability, $\alpha = 0.83$. Most items appeared to be worthy of retention, resulting in a decrease in the alpha if deleted. The one

exception to this was CPA and OBL, but their removal could result in lowering the alpha to α = 0.814 when CPA alone is removed, the alpha to α = 0.818 when OBL alone is removed and the alpha to α = 0.797 when both are removed. As such, retention of this item considered.

3.8.6 Questionnaire Reliability and Consistency

The researcher checked internal consistency of each set of questions for a given variable. Internal consistency refers to the degree to which the items that make up the scale hang together (Sekaran, 2003). That is, are they all measuring the same underlying construct?

3.9 Data Collection Methods and Procedures

The researcher stated the data collection procedure by posting letters to the Principals of the sampled schools seeking permission to conduct research in their respective schools. The study involved personal administration of the instruments to the respondents who were readily reachable. The researcher sought consent of respondent to ensure voluntary participation and deliberate response to research questions. The information collected was used for research purpose only. Clarification was done to respondents on request. Respondents were neither threatened nor victimized for declining or withdrawing from the research. See appendix II: Informed consent.

The researcher distributed questionnaires respondents, Interviews conducted and observation taken in sampled schools. Appointments to the sampled schools were organized a month earlier than the visiting day to avoid inconveniences to the respondents.

3.10 Data Analysis Techniques and Procedures

The researcher examined and analyzed the data collected in the survey making deductions and inferences. In the data analysis steps, the data gathered were statistically analyzed to confirm whether respondents responded to the questions as intended. The researcher analyzed data using SPSS and presented analysis results using Excel. Use of Ms Excel ensured excellent presentation of graphs and charts. Descriptive statistics involved transformation of raw data into a form that provided information to describe technological factors in adoption of ICT.

This study collected data quantitative data using questionnaire and qualitative data using interview schedules and observation schedules as well. The researcher coded the data for

processing using SPSS, keyed it into SPSS software, analyzed and exported it to MS Excel for presentation. From the analysis results, the study examined the descriptive and inferential statistics. The study established of Cronbach's alpha for the measures, descriptive statistics such as the mean, standard deviation and variance, the Pearson correlation matrix and the general trends, which involve tabulating, graphing and describing data.

3.11 Logistical and Ethical Issues

The school of postgraduate studies of the university approved this study. The government through the National Commission for Science and Technology and Innovation (NACOSTI) provided a research permit, which was used during the study process. Office of County Commissioner and County Director of Kiambu County permitted the study to take over. See appendix IX: research permits, clearance from University School of Post Graduated and permission letter from County Commissioner Kiambu County.

3.12 Problems or Limitations with the Research Methodology

The researcher experienced no major problem with the methodology despite that it was not easy to develop valid and reliable instrument at first attempt. To improve on validity and reliability of the tools, the researcher did a number of adjustments as guided by results of piloting. This problem mainly could emerge from the fact that a good number of respondents are not conversant with ICT, hence difficulties in understanding some terms as used in technology. Getting the principals of the schools was not an easy task due to their tight schedules.

The study had no major problem with the methodology despite that it was not easy to develop valid and reliable instrument at first attempt. The study did a few adjustments on the research tools, to improve on validity and reliability as results of piloting showed. This problem includes difficulties in understanding some terms as used in technology. Some respondents had tight schedule, some did not like photographing and voice recording.

3.13 Summary and Conclusions

This study targeted ICT adopters in secondary schools (administrators and teacher) in Githunguri sub-county Kenya. The study used a descriptive survey. The researcher collected data using questionnaire and interview schedules. The researcher evaluated the validity of these

research instruments, using a pilot study carried out at one of the schools identified by the researcher, these results did not form part of the final sample population. The results of the pilot study later analyzed and the results evaluated for reliability. To test reliability, the researcher employed the Cronbach's alpha statistics.

In advance of data collection, the researcher obtained ethical clearance from Mount Kenya University Ethics committee of the school of post-graduate studies. The researcher then acquired a research permit from NACOSTI for carrying out data collection. Upon receiving the permit, the researcher requested permission from the county commissioner of Kiambu County and from the county director of education to carry out research. The researcher visited the schools to administer both the questionnaires and interview schedules. The researcher used both descriptive data and inferential statistics to analyse data, as presented in the next chapter.

Inconclusion the researcher followed data collection techniques and methods to collect desired data using questionnaires, interview schedules and observation schedules. The study took place with the approval of the school of postgraduate studies as well as with permission from NACOSTI who provided research permit. The collected data were validated successfully and packaged for analysis in subsequent chapter.

CHAPTER FOUR

RESEARCH FINDINGS, ANALYSIS AND PRESENTATIONS

4.1 Introduction

In this chapter the researcher presents the findings of this study, showing technological factors influencing adoption of ICT in secondary education. Data collected using methodology applied in chapter three are analysed in this chapter. The findings were presented using tables, percentages and textual explanation.

4.2 Presentation of Descriptive Statistics

In this section, the researcher shows the data analysis of the data collected using the questionnaire. The questionnaire results were analysed using a descriptive approach so as to describe certain trends from the data and to determine the factors affecting adoption of ICT in T&L. The researcher established the nature of relationship between the different variables using regression analysis: Overall methodology that aimed at predicting the value of a variable was informed by the definition given in the multiple regression analysis based on the value of two or more variables (Nayal, 2015).

4.2.1 Questionnaire Return Rate

Response rate from public secondary schools in Githunguri sub county, Kenya is shown in table 16 below. The table indicating that 580 questionnaires filled out of the 637 questionnaires distributed.

Table 15

Questionnaire Return Rate

Administrative Responsibility		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Principal	10	1.6	1.7	1.7
	Deputy Principal	13	2.0	2.2	4.0
	Dean	13	2.0	2.2	6.2
	HOD	12	1.9	2.1	8.3
	Subject Head	64	10.0	11.0	19.3
	Subject Teacher	315	49.5	54.3	73.6
	Others	153	24.0	26.4	100.0
	Total	580	91.1	100.0	
Missing	System	57	8.9		
Total		637	100.0		

As presented in the table above the total response rate of 91.1%, which matches well with a response rate of 70% as recommended by (Yun and Trumbo, 2008). The high rate of feedback showed in the table above explains the nature of sensitivity of information wanted from respondents, as most of respondents were at ease to share their views and experiences on adoption of ICT in T&L.

4.2.2 Demographic Characteristics of the Respondents

The demographic information included the personal information of the teachers and head teachers. It consists of gender and academic qualification of the teachers and sample school categories.

4.2.3 Distribution of Respondents by Gender

The researcher administered questionnaires to both male and female teachers and head teachers. Therefore, the study sought to investigate the gender of the respondents. This was important in establishing and specifying the exact number of male and female respondents as shown in table 16 below.

Table 16

Gender of the Respondents

Gender					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	483	75.8	75.8	75.8
	Female	154	24.2	24.2	100.0
	Total	637	100.0	100.0	

According to the findings, 75.8% of teachers were male while 24.2% were female. This is a clear indication that representations of both genders are good without favoring any gender.

4.2.4 Academic Qualifications of the Respondents

The researcher sought to establish academic qualifications of respondents. This was important informing this study on their ability to respond to the research questions. See table 17 below.

Table 17:

Academic Qualifications of the Respondents

		frequency	%	valid-%	cumulative %
Valid	Others	77	12.1	12.2	12.2
	Masters	43	6.8	6.8	19.1
	Bachelor	269	42.2	42.8	61.8
	Diploma	240	37.7	38.2	100.0
	Total	629	98.7	100.0	
missing	system	8	1.3		
total		637	100.0		

Respondents were of different academic qualifications ranging from Diploma 38.2%, Bachelor 42.8% and masters 6.8%. 1.3% never indicated their academic qualifications. This gives a clear indication why only a few respondents could not give all the details sought by this study.

4.2.5 Categories of Sample Schools

As shown in table 18 below, the percentage of the total number of respondents from boarding / Day school was 26.3%, lower compared to percentage of the total number of respondents from the public Boarding schools that were 23.7% and less than that of Day Schools, which was 50%.

Table 18

School Categories

School Categories

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Boarding	144	22.6	23.7	23.7
	Boarding / Day	160	25.1	26.3	50.0
	Day	304	47.7	50.0	100.0
	Total	608	95.4	100.0	
Missing	System	29	4.6		
Total		637	100.0		

4.2.6 Availability of ICT Technological Infrastructure

Table 19 below show summary of observation of the participants in relation to the use, accessibility and reliability of ICT Infrastructure, motivating adoption of ICT in teaching.

Table 19

Availability of ICT Technical Infrastructure influences Adoption of ICT

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	3	.5	.5	.5
	Disagree	29	4.6	4.6	5.1
	Uncertain	106	16.6	16.8	21.8
	Agree	264	41.4	41.8	63.6
	Strongly Agree	230	36.1	36.4	100.0
	Total	632	99.2	100.0	
Missing	No answer	5	.8		
Total		637	100.0		

As seen in the table above, 78.2% of the respondents indicated that lack of ICT infrastructure hinders adoption of ICT in Secondary T&L. 16.8% were not certain, while 5.1% were of contrary opinion.

4.2.7 ICT Observability Influences Adoption of ICT in T&L

The researcher sought to establish whether ICT observability influences adoption of ICT in Secondary T&L in any way. The respondents asked whether ICT observability influences their decision to adopt ICT in teaching. The data collected from respondents are summarised in table 20 below.

Table 20

Observability Influences Adoption of ICT in T&L

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	41	6.4	6.7	6.7
	Not Sure	150	23.5	24.6	31.3
	Agree	298	46.8	48.9	80.2
	Strongly Agree	121	19.0	19.8	100.0
	Total	610	95.8	100.0	
Missing	No answer	27	4.2		
Total		637	100.0		

As observed from table above, 68.7 % of the respondents indicated that ICT observability influences ICT adoption in teaching, while 6.7% of respondents are of different opinion. The remaining 24.6% indicated uncertainty on ICT observability.

4.2.8 ICT H/W Architectural Rapid Change Influences Adoption of ICT

The researcher sought to investigate whether hardware architectural influences adoption of ICT in teaching. The respondents gave the following response shown in table 21 below.

Table 21

Hardware Architectural Rapid Change [HARC]

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	5	.2	.8	.8
	Disagree	28	4.4	4.4	5.2
	Uncertain	40	6.3	6.3	11.5
	Agree	191	30.0	30.0	41.4
	Strongly Agree	373	58.6	58.6	100.0
	Total	637	100.0	100.0	

As observed from table above, that 88.6% of the respondents indicated that ICT Hardware Architectural Rapid Change influences ICT adoption in teaching, while 6.1% of respondents are of different opinion. The remaining 6.3% were not sure and could not give specific answer for the question.

4.2.9 Perceived Complexity in Adopting ICT in Secondary T&L

The perception that adopting ICT is complex is likely to hinder adoption of ICT. The table 22 below show varying response on perception on complexity of adopting ICT in teaching in secondary school.

Table 22

Complexity Influence the Decision to Adopt ICT in T&L

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	8	1.3	1.4	1.4
	Disagree	37	5.8	6.3	7.7
	Uncertain	147	23.1	25.0	32.7
	Agree	250	39.2	42.6	75.3
	Strongly Agree	145	22.8	24.7	100.0
	Total	587	92.2	100.0	
Missing	No answer	50	7.8		
Total		637	100.0		

As presented in table above, 67.3% respondents were of the opinion that adopting ICT technology was complex to understanding and use, while 7.7% were of the opposing view. The remaining 25% were not sure and could not give specific answer for the question.

4.2.10 Relative Advantages of ICT Influences Adoption of ICT in T&L

On asking whether an ICT relative advantage influences adoption of ICT in teaching, respondents' responses were as summarised in table 23 below.

Table 23

ICT RA Influence the Decision to Adopt ICT

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	6	.9	.9	.9
	Uncertain	22	3.5	3.5	4.4
	Agree	147	23.1	23.1	27.5
	Strongly Agree	461	72.4	72.5	100.0
	Total	636	99.8	100.0	
Missing	No answer	1	.2		
Total		637	100.0		

As observed from the table above, that 95.6% of respondents agreed that ICT relative advantages influences ICT adoption in teaching, while 0.9% of respondents are of a different opinion. The remaining 4.4% were not sure and could not give a specific answer for the question.

4.2.11 ICT Trialability Influences Adoption of ICT

The study investigated the levels to which an innovation may be experimented with unlimited basis (Khosrowpour, 2000). The researcher queried whether ICT Trialability influences adoption of ICT in teaching. The data collected are as in the table 24 below.

Table 24

Trialability Influences the Decision to Adopt ICT in T&L

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Disagree	10	1.6	1.6	1.6
	Uncertain	59	9.3	9.5	11.1
	Agree	272	42.7	43.8	54.9
	Strongly Agree	280	44.0	45.1	100.0
	Total	621	97.5	100.0	
Missing	No answer	16	2.5		
Total		637	100.0		

As observed from table above, 88.9% of respondents agreed that ICT perceived Trialability influences ICT adoption in teaching, while 1.6% of respondents are of different opinion. The remaining 9.5% were not sure and could not give specific answer for the question.

4.2.12 ICT Software Portability Influences Adoption of ICT

The researcher sought to establish whether software portability and adaptability influences adoption of ICT in teaching. The respondents indicated the following as summarised in table 25 below.

Table 25

SPA Influences ICT Adoption

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	5	.8	.8	.8
	Disagree	39	6.1	6.5	7.3
	Uncertain	138	21.7	23.0	30.3
	Agree	276	43.3	45.9	76.2
	Strongly Agree	143	22.4	23.8	100.0
	Total	601	94.3	100.0	
Missing	No answer	36	5.7		
Total		637	100.0		

As observed from table above, 69.7% of respondents agreed that ICT perceived Trialability influences ICT adoption in teaching, while 7.3% of respondents are of different opinion. The remaining 23% were not sure and could not give specific answer for the question.

4.2.13 Compatibility of ICT Resources Influences Adoption of ICT in T&L

This study sought to investigate whether ICT compatibility influences adoption of ICT in teaching. Table 26 below show the results of responses, while they tested on how they perceive ICT compatibility in their daily T & L methods.

Table 26

ICT Compatibility Influences the Decision to Adopt ICT

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	1	.2	.2	.2
	Disagree	9	1.4	1.6	1.7
	Uncertain	97	15.2	16.7	18.4
	Agree	205	32.2	35.3	53.8
	Strongly Agree	268	42.1	46.2	100.0
	Total	580	91.1	100.0	
Missing	No answer	57	8.9		
Total		637	100.0		

As observed from table above, 16.7% of respondents were not able to tell whether ICT resources available in school are compatible with other teaching resources or not. 81.5% were of the opinion that both resources are compatible for effective teaching, with the other 1.8 % finding it hard to combine both ICT resources with other teaching resources.

4.2.14 Availability of Technical Support in Adoption of ICT in T&L

This study sought to establish whether availability of technical support influences adoption of ICT in teaching. Respondents indicated the following as summarised in table 27 below.

Table 27

Availability of ICT Technical Support Influences Adoption of ICT

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	7	1.1	1.1	1.1
	Disagree	65	10.2	10.3	11.4
	Uncertain	135	21.2	21.3	32.6
	Agree	291	45.7	45.9	78.5
	Strongly Agree	136	21.4	21.5	100.0
	Total	634	99.5	100.0	
Missing	No answer	3	.5		
Total		637	100.0		

As observed from the table above, 67.4% of respondents indicated that they do not get any form of technical assistance on the effort to adopt ICT in secondary school teaching. 11.4% of respondents argued that they could get some kind of assistance from teachers trained to teach computer studies in their schools and or from some software developers online, where internet is available. 21.3% were not certain if they do get any reliable assistance in the effort to adopt ICT in teaching.

4.2.15 Software Portability and Adaptability

This study sought to establish whether software portability and adaptability have any influence on adoption of ICT in teaching. The respondents indicated the following as summarised in table 28 below.

Table 28

Software SPA Influences Adoption ICT

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	5	.8	.8	.8
	Disagree	39	6.1	6.5	7.3
	Uncertain	138	21.7	23.0	30.3
	Agree	276	43.3	45.9	76.2
	Strongly Agree	143	22.4	23.8	100.0
	Total	601	94.3	100.0	
Missing	No answer	36	5.7		
Total		637	100.0		

The respondents gave the following data analyzed in table above. 7.3 % of respondents indicated that SPA does not have any influence on adoption of ICT in teaching. 69.7 % of respondents were of contrary opinion and 23% of respondents were not sure if there is any relationship between SPA and adoption of ICT in teaching.

4.2.16 Adoption ICT in Secondary T&L

This study sought to establish whether there was any adoption of ICT in secondary T&L. The respondents indicated the following as summarised in table 29 below.

Table 29

Adoption ICT in Secondary T&L

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	148	22.4	23.8	23.8
	Disagree	280	43.3	46.9	70.7
	Uncertain	138	21.7	22.0	92.7
	Agree	38	6.1	6.5	99.2
	Strongly Agree	6	.8	.8	100.0
	Total	602	94.3	100.0	
Missing	No answer	36	5.7		
Total		636	100.0		

The respondents gave the following data analyzed in table above. 70.3 % of respondents indicated that there was some form of ICT adoption in T&L. 18 % of respondents were of contrary opinion and 11.7% of respondents were not sure if there is adoption of ICT in secondary T&L.

4.3 Presentation and Interpretation of Inferential Statistics

In this section, inferential statistics enabled the researcher to make descriptions of data and draw inferences and conclusions from the respective sample data.

4.3.1 Non-Parametric Independence Test

According to Conover (1999), statistical method is non-parametric if it satisfies at minimum of one of the following criteria: One, the methods may be used on data with nominal scale or ordinal scale of measurement. Two, the method may be used on data with an interval or ratio scale of measurement, where the distribution function of the random variable producing the data are unspecified (or specified except for an infinite number of unknown parameters). In the same manner, a statistical method is non-parametric if the method uses ordinal scale of measurement (Conover, 1999, p.118).

The Chi-Square ($\chi 2$) can provide significance of any observed differences, as well as providing detailed information on exactly which categories explains any differences found (Jayashree, 2015). The Chi-Square test is a non-parametric statistic, also called a distribution free test (Jayashree, 2015).

To determine the association between the categorical variables, Kolmogorov-Smirnov test was undertaken giving a significance value of 0.00. This called for another test, hence Chi-square test taken. Statistically, there are some situations when it is clear that outcome does not follow a normal distribution (Conover, 1999). These include a case of ordinal variable or rank, as it is the case in this study. According to Hsiao-Mei Wang (2009), the K-S test may be preferred over the chi-square test for goodness of fit when the sample size is small. Computing time for the K-S test is longer than that of the Chi-square test (Hsiao-Mei Wang, 2009).

Unlike parametric methods, which use exact solution to approximate problems, non-parametric method uses approximate solutions to exact problems (Conover, 1999). Hence, this study used Chi-square to determine the association between the categorical variables used. The associations between variables were statistically significant; the asymptotic significance was (2-sided) < 0.05 in the case of this study.

4.3.2 Chi-Square Independence Test Report

To determine the association between the ordinal variables, Chi Square Independence Test was undertaken. The findings used to conclude whether there are reliable associations between variables used in the model. The associations between variables are statistically significant if

asymptotic significance (2-sided) < 0.05 is applied. Chi-square Test resulted to the following results as seen in table 30 below.

Table 30

Chi-Test Statistics

	TI:	TBL:	TS:	CPL:	RA:	CPA:	HARC:	OBL:	SPA:
Chi-Square	433.522[a]	383.605[b]	357.136[c]	320.726[d]	839.786[e]	483.276[f]	760.323[g]	226.892[h]	374.166[i]
df	4	3	4	4	3	4	4	3	4
Asymp. Sig.	.000	.000	.000	.000	.000	.000	.000	.000	.000

Using spss, output on chi square test gave the following. An association between TI and adoption of ICT in T&L is, $X^2(4) = 433.522$, $p<0.001$. This infers that there is an influential relationship between TI and adoption of ICT in T&L. There is an association between TBL and adoption of ICT in T&L, $X^2(3) = 383.605$, $p<0.001$. This infers that there is an influential relationship between TBL and adoption of ICT in T&L.

An association between TS and adoption of ICT in T&L is, $X^2(4) = 357.136$, $p<0.001$. This infers that there is an influential relationship between TS and adoption of ICT in T&L. An association between CPL and adoption of ICT in T&L is, $X^2(4) = 320.726$, $p<0.001$. This infers that there is an influential relationship between CPL and adoption of ICT in T&L.

An association between RA and adoption of ICT in T&L is, $X^2(4) = 839.786$, $p<0.001$. This infers that there is an influential relationship between an association between RA and adoption of ICT in T&L. An association between CPA and adoption of ICT in T&L is, $X^2(4) = 483.276$, $p<0.001$. This infers that there is an influential relationship between CPA and adoption of ICT in T&L. An association between HARC and adoption of ICT in T&L is, $X^2(4) = 760.723$, $p<0.001$. This infers that there is an influential relationship between HARC and adoption of ICT in T&L.

An association between OBL and adoption of ICT in T&L is, $X^2(4) = 226.892$, $p<0.001$. This infers that there is an influential relationship between OBL and adoption of ICT in T&L. An association between SPA and adoption of ICT in T&L is, $X^2(4) = 374.166$, $p<0.001$. This infers that there is statistical significance association between SPA and adoption of ICT in T&L.

4.4 Established Technological Factors in Adoption of ICT

Chi-Square, independence test results described in the section above helped the researcher to establish statistically significant association between technological factors identified in section 2.4: TI, TS, SPA and adoption of ICT. This helps to meet objective number [i]of this study answering the research question; "What are the technological factors that influences adoption of ICT in T&L in Kenya?" The ICT technological factors established; TI, TBL, TS, CPL, RA, CPA, HARC, and SPA used to develop the proposed model as shown in subsequent section.

4.5 Triangulation of Results

Triangulation is a way of confirmation that improves intensifications of validity by combining several perspectives and methods (Yeasmin and Rahman, 2012). Triangulation involves collection of data from different sources for the same study (Yeasmin and Rahman, 2012). According to Yeasmin and Rahman (2012, p.1), "Triangulation aims at deepening and widening one's understanding". Methodological triangulation was therefore done in this study to attain credible and valid results as recommended by (Yeasmin and Rahman, 2012).

Interview schedule were used to gather qualitative data from the school managers and the respondents in charge of ICT in the institution. Qualitative data collected was used to enhance understanding of the meaning of the numbers produced by quantitative methods (Yeasmin and Rahman, 2012). In this study interview method of qualitative data collection proceeded as preliminary inquiry, questionnaire method of collecting quantitative data followed as auxiliary methods (Yeasmin and Rahman, 2012).

In this section study findings from questionnaire (quantitative data) were compared with those of interview and observation (qualitative data). Triangulation was useful in countering deficiencies of qualitative and quantitative method by combining both methods and thus capitalizing on their individual strengths (Yeasmin and Rahman, 2012).

4.5.1 Interview Results

Interview guide were useful in collecting information from the institution managers. Telephone interview was convenient for respondents who were very busy and or rare to meet face to face (Kothari, 2004). See appendix IV: Interview Schedule and Questions.

The detailed response noted from the participants was later arranged into categories (Creswell, 2009). Charts were used to make interpretation easier. Following are the responses for different interview questions

Do you have ICT technological infrastructure necessary for adoption of ICT in T&L? The interviewees explained their answers leading to pattern analysis shown 31 below.

Table 31

Interview on Technological Infrastructure

Availability of ICT Infrastructure	frequency	percentage
Do not have ICT resources in your school	8	80%
Do not have an internet provider	2	20%
Do not have a functional computer laboratory	2	20%
Do not have a computer local network	1	10%
Do not have computer used for T&L	1	10%

As seen in the table above, 20% of the respondents explained that they have ICT infrastructure, the other 80% were not able to explain any ICT infrastructure for T&L. On further probing, adopter explained that for internet services they either use personal smartphones or go to cyber cafes for any voluminous internet usage. Other sharable resources like; projectors and laptops are shared, normally placed in a common room where those in need can access them when need to. From the table above the following figure 3 was developed for easy of interpretation.

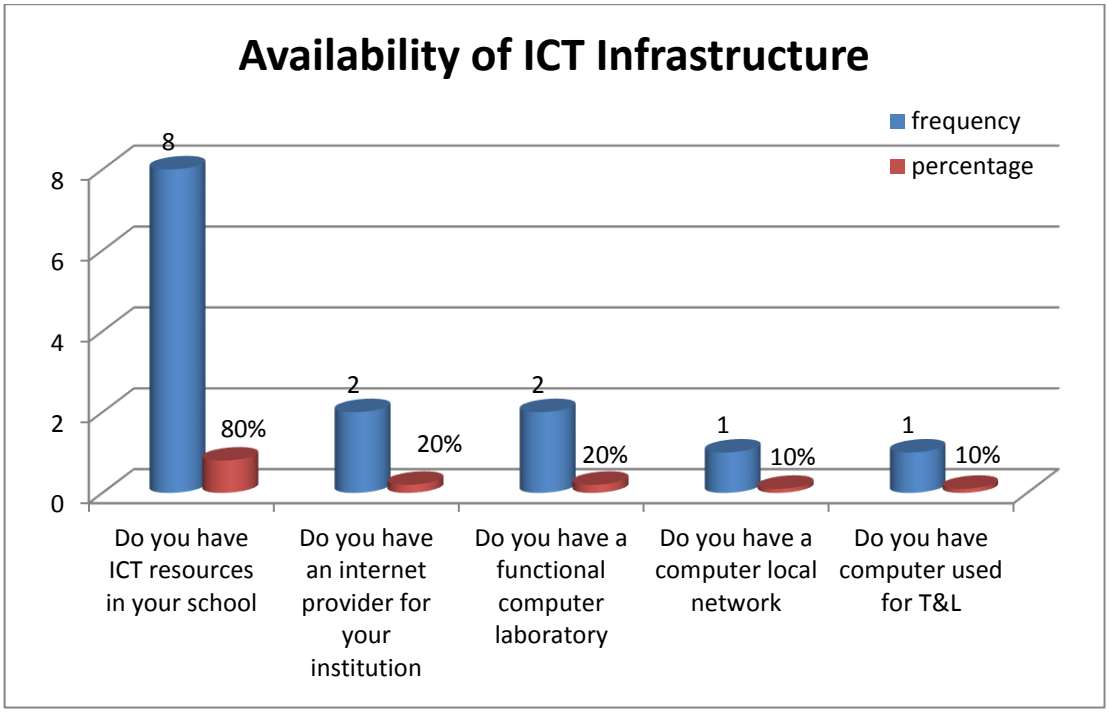

Figure 3: Availability of ICT Infrastructure (Researcher, 2018)

Do you find ICT Observable advantages like re-usability, time saving, better quality and ease to modify, influential to your decision to use ICT in T&L? The interviewees explained their answers leading to pattern analysis shown in table 32 below.

Table 32:

Interview on ICT Observability

ICT Observability	frequency	%
Observability Influence the Decision to Adopt ICT	7	70%
Found ICT resources more re-usable resources	1	10%
Found use of ICT to be more Time saving	2	20%
Found ICT results to be of better Quality	2	20%
Found ICT resources to be more Easily to modifiable	2	20%

As seen in the table above, 68% of the respondents explained that ICT observability influences ICT adoption in teaching. 32% were not used to adopting ICT thus no experiences on observability. See the figure below.

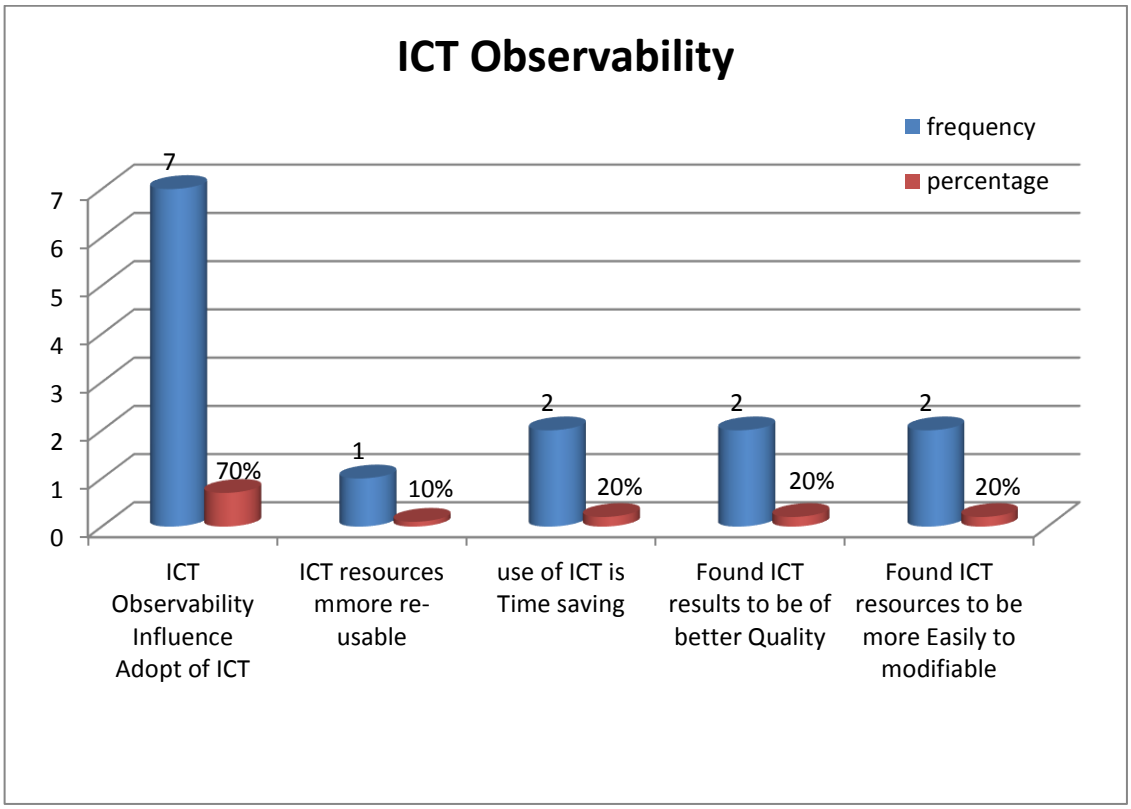

Figure 4: Interview ICT Observability (Researcher, 2018)

Do computer H/W Architectural Rapid Change influences adoption of ICT in T&L? The interviewees explained their answers leading to pattern analysis shown 33 below.

Table 33

Interview on Architectural Rapid Change Influences

Architectural Rapid Change influences adoption of ICT	frequency	%
HARC: ICT Hardware & Software Technologies' Rate of Change Influences the Decision to Adopt ICT	9	90%
Found that hardware out datedness limiting use of modern software designed for modern computer architecture	2	20%
Found that Un upgradable machines were note fit for use with latest versions of software and peripheral devices	1	10%
Modern high-speed processors require multiple thread i.e high speed software for processors efficiency	2	20%
Modern software versions require high storage capacity	3	30%

As indicated in the table above, 90% of the respondents explained that ICT Hardware Architectural Rapid Change influences ICT adoption in teaching, while 10% were not sure and could not give specific answer for the question. From the table 33 above the following figure 5 was developed for easy of interpretation.

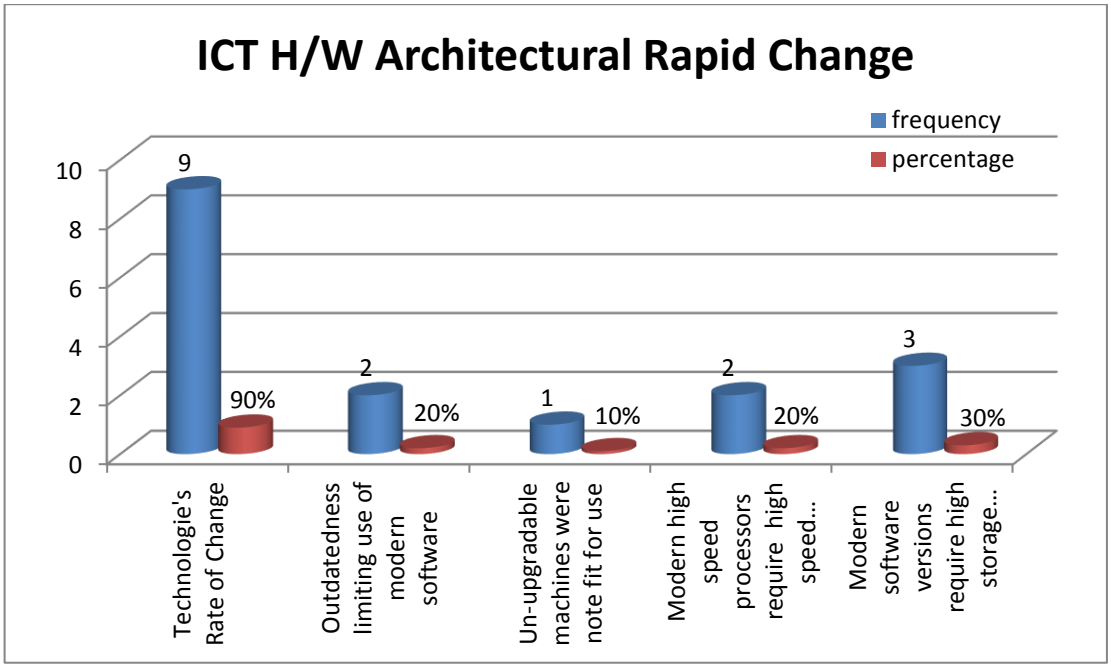

Figure 5: Interview ICT HARC (Researcher, 2018)

Do ICT Software Portability and Adaptability influence your decision to adopt ICT in T&L? The interviewees explained their answers as shown in table 34.

Table 34:

ICT Software Portability and Adaptability

SPA: ICT Software Portability and Adaptability	frequency	%
ICT SPA Influences Adoption ICT in Teaching	7	70%
Most of the software they used are readily available	2	20%
Most of software they use work on different platforms	1	10%
Modern software suits modern hardware technologies	2	20%
Latest versions of software they use suit most of the current market needs	2	20%

The respondents gave the data analyzed in table above. 70% of respondents clarified that SPA influences adoption of ICT in teaching. 30% were not sure if there is any relationship between

SPA and adoption of ICT in T&L. From the table above and the following figure 6 was developed for easy of interpretation.

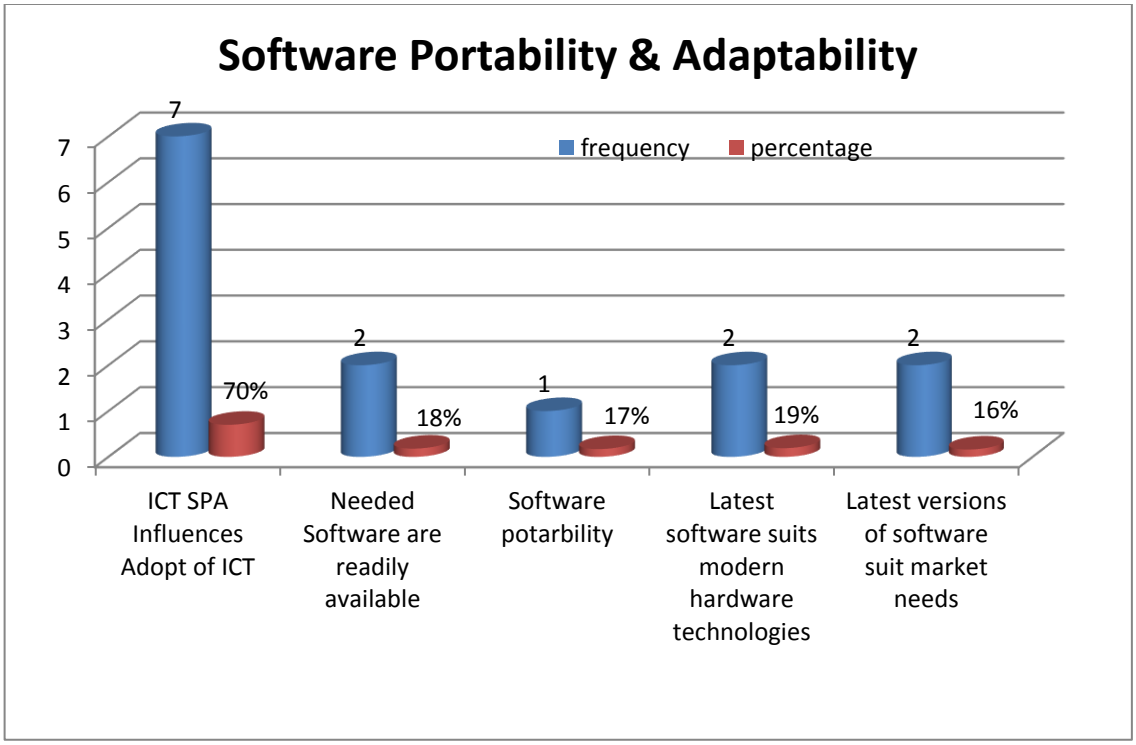

Figure 6: Software Portability & Adaptability (Researcher, 2018).

Do Relative Advantages of ICT (RA) influence adoption of ICT in T&L? The interviewees explained their answers leading to pattern analysis shown in table 35 below.

Table 35

Relative Advantages Influences Adoption of ICT

RA of ICT influences adoption of ICT in teaching	frequency	%
ICT relative advantages influences ICT adoption	9	90%
Found that ICT have got good Technology opportunity	2	20%
Found that ICT have got good social approval	2	20%
Found that ICT have got good communicability	3	30%
Found that ICT have got good centrality	2	20%

As indicated in the table above, 90% of interviewees explained that ICT relative advantages influences ICT adoption in teaching, while 10% were not sure and could not give specific answer for the question. From the table 35 above the following figure 7 was developed for easy of interpretation.

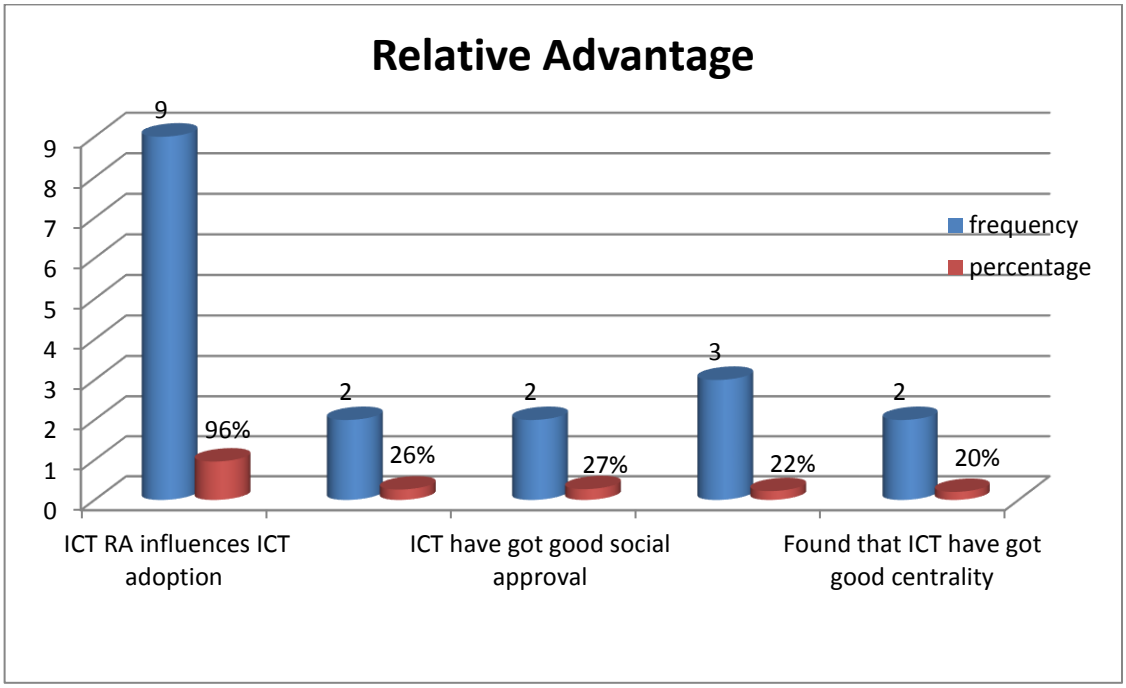

Figure 7: Interview Relative Advantage (Researcher, 2018).

On ICT Trialability: The interviewees were asked whether, they have ever tried or witnessed a colleague try use of ICT resource such as teaching and learning software, projectors, screens and internet in teaching: 90% of respondents in this study have tried or witnessed use of ICT resource in teaching. Among the used ICT resources are computers, projectors and smart phones.

On further probing it was established that some users had used laptops, modems to connect to internet. Projectors were used for illustrations and smart phones for Google search and you tube. The study noted that the main reason why adopters have tried and used these resources is that they are; affordable, readily availability, ease to try and reuse. The interviewees explained their answers leading to pattern analysis shown 36 below.

Table 36

Interview on ICT Trialability

ICT Trialability	Frequency	Percentage %
Has tried to use any ICT resources	9	90
Has used desktop computer	3	30
Has used micro computer	4	40
Has used projectors	1	10
ICT storage devices; flash disc CD & DVD	1	10

From the interview results, 10% were not specific in their responses. 90% of the respondents explained to have made some trials in using ICT in T&L process as shown in chart below. From the table above the following figure 8 was developed for easy of interpretation.

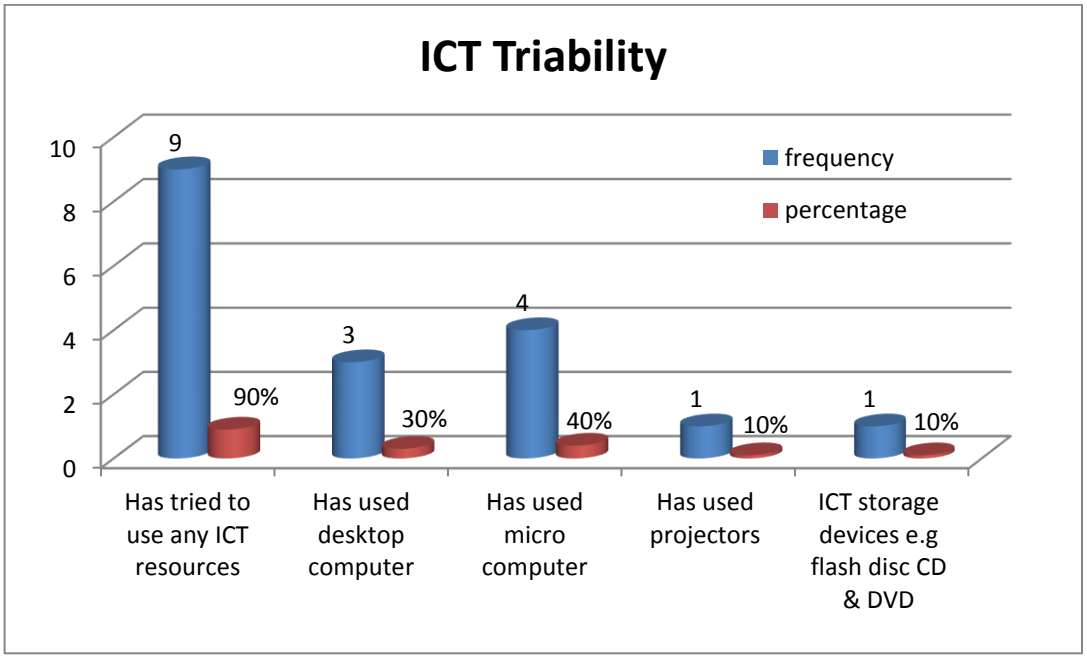

Figure 8: Interview ICT Trialability (Researcher, 2018)

Do you find ICT resources compatible with other methods you use in T&L? The interviewees explained their answers leading to pattern analysis shown 37 below.

Table 37: Interview on CPA: ICT Compatibility

CPA: ICT Compatibility	Frequency	%
ICT Compatibility Influences the decision to adopt ICT	8	80%
Use ICT resources together with other methods	4	40%
It easy to use a computer in different ways	4	40%

As observed from table above 80% were of the opinion that ICT resources are compatible for effective teaching. 20% finds it hard to combine both ICT resources with other teaching resources. From the table 38 above the following figure 9 was developed for easy of interpretation.

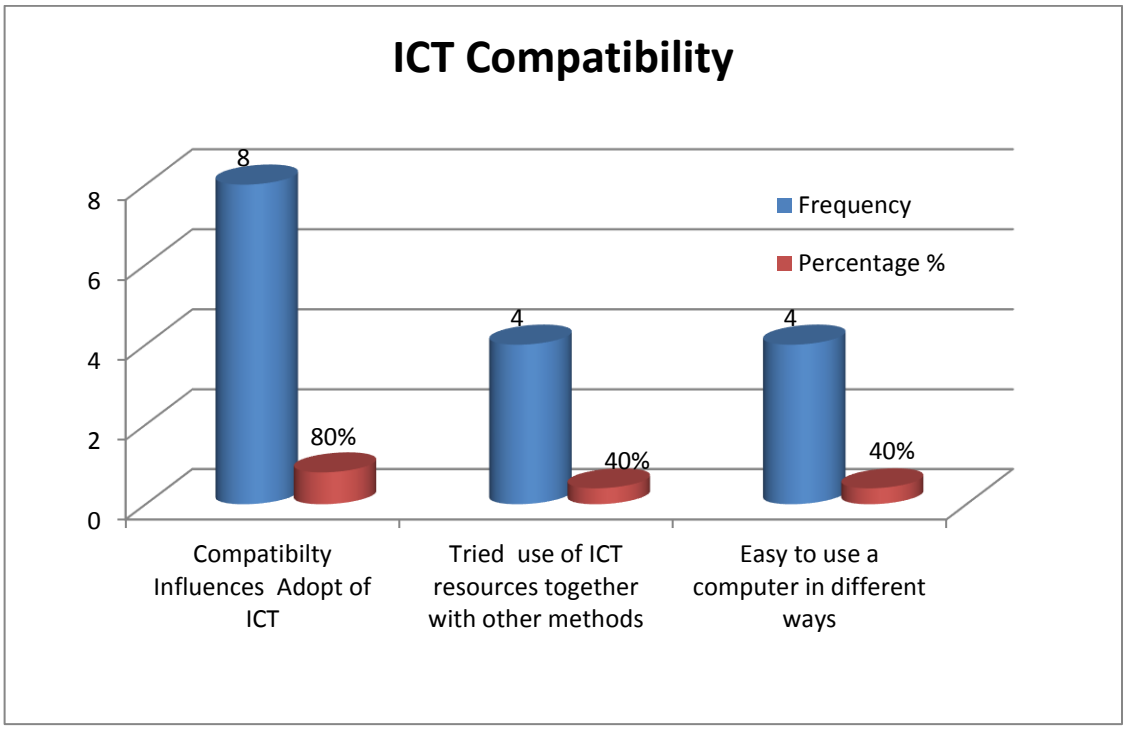

Figure 9: Interview ICT Compatibility (Researcher, 2018)

Does Availability of ICT Technical Support influence your decision to adopt ICT in T&L? The interviewees explained their answers see table 38 below.

Table 38

Interview on Availability of ICT Technical Support

TS: Availability of ICT Technical Support	frequency	percentage
TS Influences the Decision to Adopt ICT	7	70%
Found no TS from an organised formal source	2	20%
Had no training schedules	1	10%
Could not get instant technical support	2	20%
Had no technician	2	20%

As observed from the table above, 70% of respondents explained that they do not get any form of technical assistance on the effort to adopt ICT in secondary school teaching. 20% of respondents argued that they could get some kind of assistance from teachers trained to teach computer studies in their schools and or from some software developers online, where internet is available. 10% were not certain if they do get any reliable assistance in the effort to adopt ICT in teaching. From the table 38 above the following figure 10 was developed for easy of interpretation.

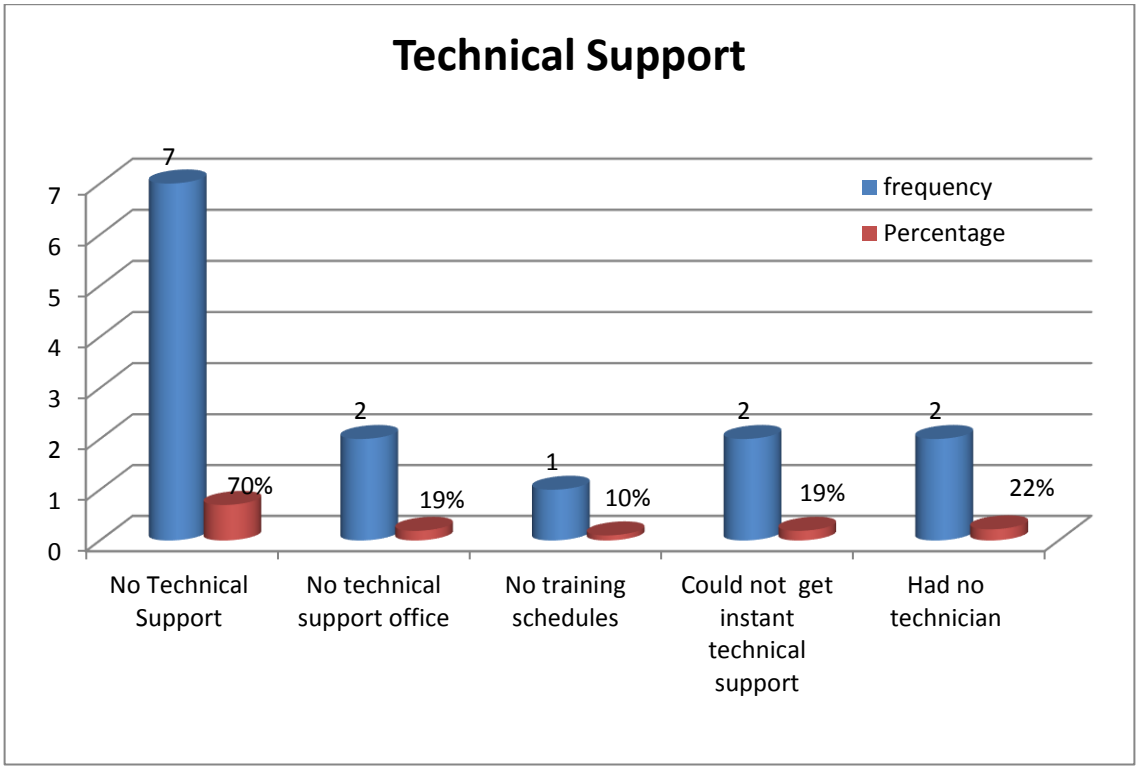

Figure 10: Interview Technical Support (Researcher, 2018)

Interview results taken from 10 respondents gave similar results to the responses of questionnaire filled by various respondents from the same schools. The interviews established that technological factors influence adoption of ICT in T&L, which is in agreement with questionnaire findings. The results obtained from the interviews indicate that the biggest number of the respondents either agreed or strongly agreed that technological factors influence their decision to adopt ICT in T&L. On the other hand, it is clear that only a few respondents had the opinion that technological factors identified have got little or no influence in their decision to adopt ICT in T&L. Few respondents were not sure whether technological factors influence adoption of ICT in T&L or not.

4.5.2 Observation Results

Observation was scheduled to collect qualitative data as observation is exploratory in nature (Sekaran, 2003). Observing the way T&L activities are carried out using ICT resources, observation revealed some ICT resources being used, factors influencing adoption of ICT and pattern regarding these phenomena. This was useful in formulating research questions for subsequent testing (Kothari, 2004). Observation was useful in ensuring that researcher gathered

important and first-hand information, that could not be obtained through questionnaire and interviews (Kothari, 2004). Through observation, information gotten relates to what is happening now and not made complex by either the past behaviour or future intentions or attitudes of the participants (Kothari, 2004). See appendix V: Observation Schedule.

In order to ascertain the claims on availability of technical support, observation was necessary. This was helpful to the researcher to understand whether there was technical support in deed. Observation as in agreement with questionnaire results indicate that 50% of respondents required TS for adoption of ICT in T&L. 20% were observed to have basic technical skills and did not require technical support to use ICT in T&L. Some users were able to troubleshoot simple software problems. Some were able to install peripherals like printers and configure them. The remaining 30% although they had ICT related resources were not observed making use of them in anything related to T&L using ICT. See table 39 below, on Observation on availability of ICT TS.

Table 39

Observation on Availability of ICT Technical Support

TS: Availability of ICT Technical Support	frequency	%
Had no technical skills required to adopt ICT in T&L	5	50%
Demonstrated basic technical skills to adopt ICT	2	20%
Had no activity indicating adoption of ICT in T&L	3	30%

It was therefore observed that at least 80% of potential adopters required technical support, which they could not in deed access from the work place.

For ease of interpretation, see the figure 11.

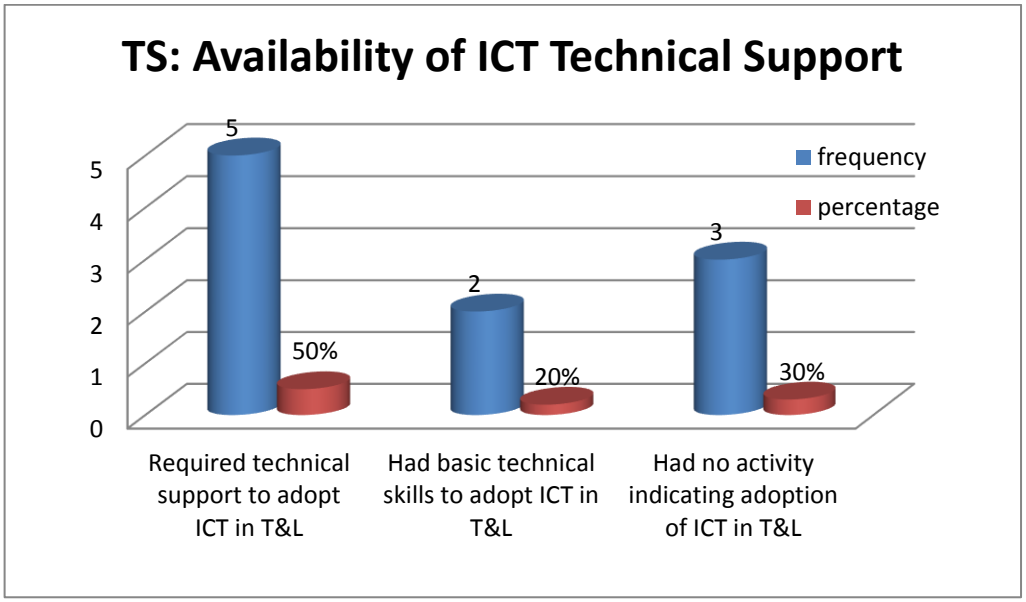

Figure 11: Observation on Availability of TS (Researcher, 2018)

In order to determine the claims on availability of technological infrastructure observation was necessary. This was helpful to the researcher to understand whether there was technological infrastructure in deed. 80% of adopters used of personal mobile phone for internet connectivity. They were also using personal laptops and palmtops to share teaching notes in softcopy. See table 40 below, on observation on availability of ICT Infrastructure.

Table 40:

Observation on Availability of ICT Infrastructure

Availability of ICT Infrastructure	frequency	percentage
Had no reliable internet and computer laboratory	8	80%
Did not have internet provider	2	20%

From the table 40 above figure 12 was developed for easy of interpretation.

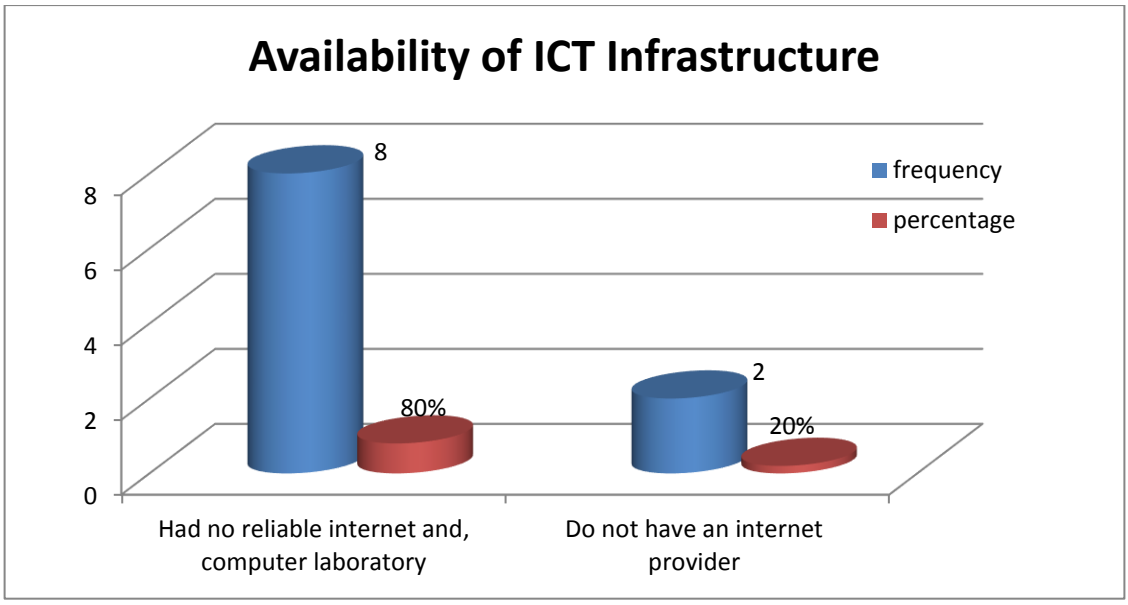

Figure 12: Observation on Availability of TI (Researcher, 2018)

In order to establish the claims on software portability and adaptability observation was necessary. This was helpful to the researcher to understand whether software used were portable and adaptable to the different available hardware platforms. 70% of adopters were sharing common software versions in their personal digital platforms like laptops and school desktops. 10% of observed respondents had electronic devices either not compatible or not adoptable with available modern computer software. Some of these electric devices include: electric bell, old mobile phones, microscopes, Pentium II computer systems among others. A pattern analysis on the observation, see table 41.

Table 41

Availability of ICT Portability & Share-ability

SPA: Software Portability and Share-ability	frequency	percentage
Shared common software versions in their personal digital platforms like laptops and school desktops.	7	70%
Had electronic devices either not compatible or not adoptable with available computer software.	1	10%
Had no activity indicating adoption of ICT in T&L	2	20%

From the table 41 above the following figure 13 was developed for easy of interpretation.

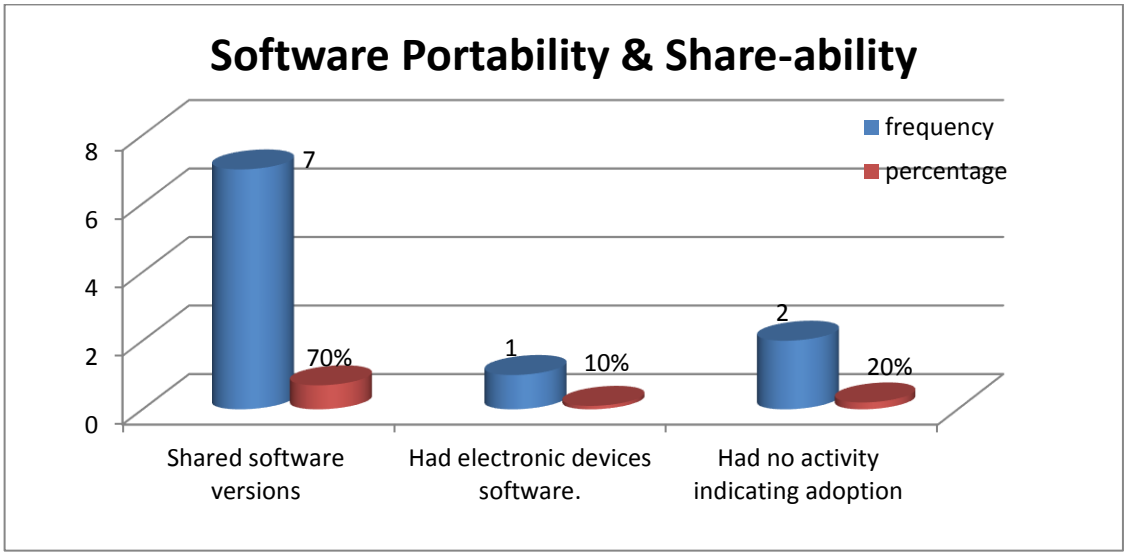

Figure 13: S/W Portability & Share-ability.

4.6 Discussion of Research Analysis Results

In this section findings of questionnaire results analysis are discussed in the effort to satisfy objective number [i] of this study; "To establish the extent of influence of identified ICT technological factors". In the same way, this attended the research question. The discussion starts with the availability of ICT technological Infrastructure for ICT adoption in T&L.

4.6.1 Availability of ICT Technological Infrastructure

A positive correlation of 0.413 and p-value of p<.001 was obtained in the relationship between adoption of ICT in T&L and accessibility of ICT infrastructure. This indicates a positive linear relationship between adoption of ICT and availability of ICT resources. This indicates a positive linear relationship between ICT adoption in teaching and availability of ICT resources. P-value of p<.001 indicates 0% chances of finding a correlation found in the sample of this study. An association between TI and adoption of ICT in T&L is, $X^2(4) = 433.522$, $p<0.001$. This infers that there is an influential relationship between TI and adoption of ICT in T&L. The study therefore confirms statistically that lack of ICT infrastructure influences adoption of ICT in teaching.

Internet is one of the ICT infrastructures. It supports sharing of resources over the network. This lowers the cost of buying sharable resources. It facilitates communication between parties who are geographically apart and thus improved efficiency. Lack of access to ICT infrastructure is a principal obstacle directing to lack of computers and internet connection (Empirica's, 2006).

Similar study done by Chigona and Chigona (2014) in South Africa revealed that lack of access to computer laboratories, insufficient technology resources were issues hindering willing adopters from incorporating ICT into their undertakings. Findings of this study therefore explains the fact that availability reliable ICT infrastructure motivates a school to adopt ICT in teaching. In support of these findings, the study done by Kashorda and Waema (2006) holds that the state of internet connectivity in Kenya is so poor, that 75% of the learners prefer cyber cafes to provide reliable internet connectivity over those available in institutions of learning.

Numerous studies have shown that reliable infrastructure; internet connectivity and access is paramount to adoption of ICT in teaching, in that internet provide reference resource as noted by Murphy (as cited Khalid, 2009), and provide reliable means of communication amongst the learners and teachers. In addition, Writer (2012), study shows that, education and technology are nicely interweaved nowadays and almost every stakeholder has at least one preferred technology tools, that make doing job and connecting with customers a little bit easier and more fun for all involved. Despite that 69% of interviewed respondents indicating no idea on freely available web tools for Secondary T&L, Writer (2012) has listed at least 50 webs for teachers.

Internet provides access to numerous web-tools for teachers as outlined by Writer (2012), which are reliable and effective technologies useful in increasing student motivation as stated by Osborne and Collins (as cited Khalid, 2009) and facilitate clear thinking as stated by and Newton and Rogers (as cited Khalid, 2009) and development of interpretation skills with data.

From the interview, principals argued that even when they buy ICT resources, they find a few teachers using them reliably, arguing that they need some technical assistance on technology adoption. This shows that the ICT resources for adoption of ICT are low in the secondary schools in Githunguri sub-county, as justified in the reviewed research. The institution-level obstacles include lack of ICT infrastructure; old or unwell maintained H/W; lack of reliable S/W; restricted access to ICTs; inadequate project-related involvement; absence of ICT mainstreaming into institution's strategy. The system level barriers include inflexible structure of traditional assessment and restricted organizational structure.

A survey done by Yildirim (2007) on factors that discourage willing adopters of ICTs, established that most of them use ICT to prepare documentation only. In addition, lack of access, time pressures, lack of mentors and opportunities for training have delayed adopters' use of ICT (Slaouti and Barton, 2007).

4.6.2 ICT Observability Influences Adoption of ICT in Secondary T&L

Observability refers to the level to which the results of an innovation are visible to others (Rogers, 1995). A positive correlation of 0.305 and significance of $p<.001$ was obtained in the relationship between adoption of ICT in T&L and observability of ICT. This indicates a positive linear relationship between ICT adoption in teaching and observability of ICT resources. P-value of $p<.001$ indicates 0% chances of finding a correlation found in the sample of this study. An association between OBL and adoption of ICT in T&L is, $X^2(4) =226.892$, $p<0.001$. This infers that there is an influential relationship between OBL and adoption of ICT in T&L. The study therefore states that, ICT observability influences adoption of ICT in teaching.

ICT observables and image are the greatest substantial issues in predicting willing adopters' intentions to incorporate technology (Rogers, 1995). On the same vein innovations that offer observables will have a more widespread and rapid rate of integration (Dillon and Morris, 1996). This study established that 68.7% of respondents are of the same opinion with Rogers (1995) and (Dillon and Morris, 1996). Hence this study concludes that ICT observeble results

influences adoption of ICT in teaching. ICT observable results mentioned in this study include application of CAT, E-Learning and Distance learning among others.

4.6.3 ICT H/W Architectural Rapid Change Influences Adoption of ICT

A positive correlation of 0.354 and significance of p<.001 was obtained in the relationship between adoption of ICT in teaching and ICT architectural hardware rapid change. This indicates a positive linear relationship between adoption of ICT in teaching and ICT hardware rapid change. P-value of p<.001 indicates 0% chances of finding a correlation found in the sample of this study. An association between HARC and adoption of ICT in T&L is, $X^2(4) =760.723$, $p<0.001$. This infers that there is an influential relationship between HARC and adoption of ICT in T&L. The study therefore established that, the rate of ICT architectural hardware rapid change influences adoption of ICT in teaching.

In the last five years, computers have gone from 1000 CPU to 100,000 CPU. This poses a great need for technical assistance to the adopters of the innovation. The technical support team will help update ICT resources in place and train the adopters on new features in the updated resources. This will ensure effective, efficient and consistence in adoption of ICT in teaching. Some hardware change calls for radical software changes (Al Geist, ORNL and Lucas, 2009).

4.6.4 Perceived Complexity in Adopting ICT in Secondary T&L

Complexity is the level to which an innovation is perceived as relatively difficult to understand and use (Thompson et al., 1991). A positive correlation of 0.359 and significance of p<.001 was obtained in the relationship between adoption of ICT in teaching and perceived ICT complexity. This indicates a positive linear relationship between ICT adoption in teaching and perceived ICT complexity. P-value of p<.001 indicates 0% chances of finding a correlation found in the sample of this study. An association between CPL and adoption of ICT in T&L is, $X^2(4) =320.726$, $p<0.001$. This infers that there is an influential relationship between CPL and adoption of ICT in T&L. The study therefore established that; the perceived complexity of ICT influences adoption of ICT in teaching.

ICT adopters interviewed in this study implied that, they found it difficult to intertwine their activities with the ICT skills they had. Others found it complex to convert their tools of work into ICT based material, from the findings of this study 57% of respondents were of the view

that adopting ICT technology was complex to understand and use, while 34% were of the contrary opinion.

Findings of this study find a support from previously study done by Rogers (2003), who acknowledged 5 technological characteristics influencing the judgment to adopt an innovation. Technology attributes influence the diffusion processes of an innovation and important factors influencing an innovation adoption. Evidence suggests that innovation attributes; complexity influence the rate of adoption of an innovation as in this context (Rogers, 2003).

Similarly, Askar and Bas (2008) adopted structural equation modeling technique to analyse ICT usage in higher education. Usluel, Asar and Bas (2008) investigated underlying relationship between ICT facilities, perceived attributes and ICT usage for high education. Variables studied here include relative advantage, compatibility, ease of use and observables, on innovative educational and administrative uses. They reported that about 64% of variance of ICT use, was explained by ICT resources and computer attributes.

Finally, previous research indicates that relative advantages, complexity, observables and image are the most significant factors in predicting adopter's intention to incorporate ICT (Yi et al., 2006). To end with agreeing with Dillon and Morris (1996, p.6), "innovation offering advantages, compatible with present performs and believes, less complex, prospective Trialability and observables have high rate of adoption and integration"

4.6.5 Relative Advantages of ICT Influences Adoption of ICT in Teaching

Relative Advantages is the level to which an innovation is perceived as better than idea it supersedes (Rogers, 1995). A positive correlation of 0.330 and significance of $p<.001$ was obtained in the relationship between adoption of ICT in teaching and ICT and ICT relative advantages. This indicates a positive linear relationship between ICT adoption in teaching and ICT relative advantages. P-value of $p<.001$ indicates 0% chances of finding a correlation found in the sample of this study. An association between RA and adoption of ICT in T&L is, $X^2(4) =839.786$, $p<0.001$. This infers that there is an influential relationship between RA and adoption of ICT in T&L. The study therefore established that; the rate of ICT relative advantages influences adoption of ICT in teaching.

Respondents interviewed could site some relative advantages; like time saving and quality results, but they explained lack of ICT T.S as a major challenge to their effort to adopt ICT in teaching.

4.6.6 ICT Trialability Influences Adoption of ICT in Teaching

Trialability is the capability to try out innovation on a limited basis, before making a decision on whether to adopt the innovation or not (Rogers, 1983). A positive correlation of 0.413 and significance of $p<.001$ was obtained in the relationship between adoption of ICT in teaching and ICT perceived Trialability. This indicates a positive linear relationship between ICT adoption in teaching and perceived Trialability. P-value of $p<.001$ indicates 0% chances of finding a correlation found in the sample of this study. An association between TBL and adoption of ICT in T&L is, $X^2(3) =383.605$, $p<0.001$. This infers that there is an influential relationship between TBL and adoption of ICT in T&L. The study therefore demonstrated that ICT perceived Trialability influences adoption of ICT in teaching.

This indicates low level of ICT proficiency in Githunguri sub-county, as justified in the reviewed literature on obstacles that disappoint the use of ICT. Some of which are lack of ICT skills lack of confidence: lack of follow up of new and lack of differentiated training programs Balanskat et al., (2007).

Another similar study done in South Africa revealed that inadequate training, as one of factors discouraging adoption of ICT (Chigona and Chigona, 2014). On the same point lack of adopters' time to train on new skills, old ICTs, low number of computers per adopters, lack of T.S and lack of collaboration among adopters were constraints to willing adopters' confidence and competence in the use of ICT (Peralta and Costa, 2007). Understanding the extent to which these barriers influence individuals and institutions helps in deciding how they are to be tackled (Becta, 2004).

4.6.7 Compatibility of ICT Resources Influences Adoption of ICT in T&L

An innovation such as a software application can be compatible or incompatible with earlier introduced ideas, clients' needs for innovations or social cultural values and beliefs (Rogers, 1983). A positive correlation of 0.251 and significance of $p<.001$ was obtained in the relationship between adoption of ICT in teaching and ICT compatibility. This indicates a

positive linear relationship between ICT adoption in teaching and ICT compatibility. P-value of p<.001 indicates 0% chances of finding a correlation found in the sample of this study. An association between CPA and adoption of ICT in T&L is, $X^2(4) = 483.276$, $p<0.001$. This infers that there is an influential relationship between CPA and adoption of ICT in T&L. The study therefore ascertained that, ICT compatibility influences adoption of ICT in teaching.

Findings of this study find a support from previously study done by Rogers (2003) who identified five attributes influencing the decision to adopt an innovation. Technology characteristics influence the diffusion processes of an innovation. They are substantial factors manipulating adoption of an innovation. Evidence indicates that innovation attributes including compatibility influences the rate of adoption (Rogers, 2003).

Similarly, in another study by Usluel, Askar and Bas (2008) adopting structural equation modeling technique to analyze the effects of innovation compatibility on innovative educational and administrative uses in Turkey's universities. They reported about 61% of variance of ICT use explained by ICT resources and computer attributes. Finally, "innovations that offer compatibility with existing practices has a more extensive and faster rate of integration" (Dillon and Morris, 1996, p.6),

4.6.8 Availability of Technical Support in Adoption of ICT in Teaching

Technical support lacks to the adopters when stranded, like in the case of OSS where only a dispersed group of developers who are not necessarily on call when system crashes or a user needs assistance (Dedrick & West, 2004). A positive correlation of 0.399 and significance of p<.001 was obtained in the relationship between adoption of ICT and teaching and ICT compatibility. This shows positive linear relationship between ICT adoption in work place procedures and ICT technical support. P-value of p<.001 indicates 0% chances of finding a correlation found in the sample of this study. An association between TS and adoption of ICT in T&L is, $X^2(4) = 357.136$, $p<0.001$. This infers that there is an influential relationship between TS and adoption of ICT in T&L. This study therefore evidenced that, ICT technical support influences adoption of ICT in teaching.

A study done by Chigona and Chigona (2014) in South Africa revealed that lack of efficient T.S is one of factors, discouraging adopters from implementing ICT into their day to day activities. High percentage of respondents with the perception that the ICT was complex, could

possibly explain the low level of adoption, in Githunguri sub county, Kenya. Just like the study done in Turkish education by Yilmaz (2011), who reported that the technology integration processes in Turkish education system provide school with H/W and internet connections. It is also crucial to provide adopters with T.S for repair and maintenance hence guaranteed sustained use of ICT.

Technical failure of a devices leads to disturbances and if there is lack of T.S, then regular maintenances of the computers will lack hence adopters not using computers (Jones, 2004). The effect is that adopters end up despairing and not adopting computers due to fear of equipment breakdown, since no one will give them T.S in case there is technical problem.

4.6.9 Software Portability and Adaptability

Technological factors in adoption of ICT include software portability and adoptability among other software attributes identified by (ISO/IEC-9126-1, 2001). Analysis of the data on software portability and adaptability, indicates a positive coefficient of 0.424 and a significance of $p<.001$ was obtained in the relationship between adoption of ICT in teaching and ICT SPA. This indicate a positive linear relationship between ICT adoption in teaching and ICT SPA.

P-value of $p<.001$ indicates 0% chances of finding a correlation found in the sample of this study. An association between SPA and adoption of ICT in T&L is, $X^2(4) =374.166$, $p<0.001$. This infers that there is an influential relationship between SPA and adoption of ICT in T&L. The study therefore verified that ICT SPA influences adoption of ICT in teaching.

Rapid change on computer hardware like shifting from using faster CPU, to using multi-cores CPU is as disruptive to scientific software (Al Geist, ORNL and Lucas, 2009). This poses difficulties in making software, which are easy to sustain; in terms of portability, adoptability and technical support. Portable software should be easy to use in different hardware platforms with a few changes if any.

Software sustainability in terms of adaptability, portability and technical support are very important technological factors considered in this study. Technical support is therefore required to support adopters on updating or redesigning software to suit new hardware architecture capabilities. New scientific applications, introduce new debugging issues and huge data, hence high demand for technical support (Al Geist, ORNL and Lucas, 2009).

S/W usability is defined in relation to learnability, understand-ability, attractiveness and operability (ISO/IEC-9126-1, 2001). Empirical outcomes indicate that, improving the usability aspects such as understand ability, learnability, operability and attractiveness has a positive impact on the overall usability (Raza, Capretz, & Ahmed, 2011). The responses obtained from this questionnaire items answers study question [i] "What are the technological factors that influence adoption of ICT in T&L in Kenya?" the technological factors identified are included in the model proposed, developed and tested in this study. See figure 1: Proposed model.

4.7 Model Development and Validation

This study developed and validated a model as informed by technological factors identified. Then classified variables identified in the study as dependent and independent variables. The researcher formulated a model which was empirically tested to assess its applicability in T&L. Validation of the model was done using experts and statistical measures of relationship analysis of variance (ANOVA). In addition, the square of the multiple correlation coefficients and the coefficient of multiple determinations (R-Square) used as recommended by Kothari (2004), to validate the relationship between the variables in the proposed model. ANOVA is one of the best measures of relationship that can be used in a research where several variables are involved (Kothari, 2004). Data collected using questionnaire, interview schedules and observation were analyzed using windows SPSS statistical package. This aligns with objective number [ii] of this study, "To develop a model for adoption of ICT in T&L". The model constitutes of the following significant technological factors: TI, TBL, TS, CPL, RA, CPA, HARC, and SPA, See the model below.

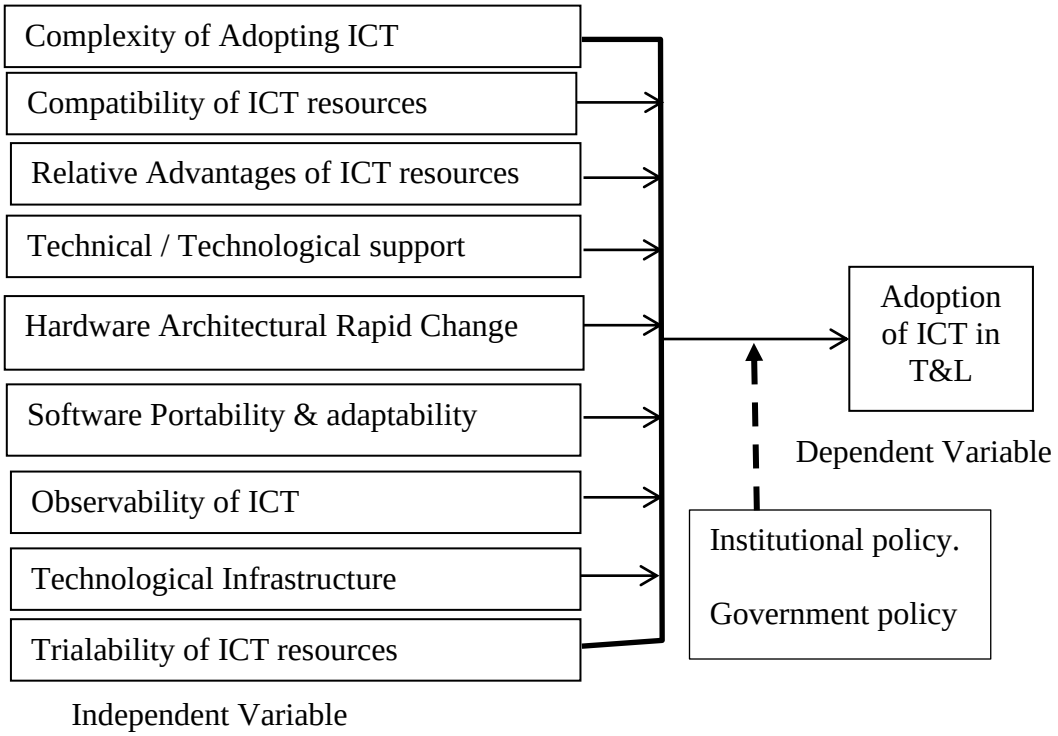

Figure 14: Proposed Technological Model (Researcher, 2018)

4.8 Model Validation

This section aligns with objective number [iv] of this study; "To validate the model for ICT adoption in T&L". The model was validated using ICT experts, statistical measures of relationship analysis of variance (ANOVA) and the coefficient of multiple determinations (R-Square) as suggested by (Kothari, 2004). This was useful in validating the relationship between the variables in the proposed model.

4.9 Expert Opinion Survey for Validating the Model

This section presents a validation of the proposed model. The researcher developed a validation questionnaire for technological adoption model distributed to experts to give their opinion regarding the newly developed model. The respondents were experts' scholars holding at least a master's degree and have been using technology acceptance models to conduct research.

The researcher interviewed the experts in order to gather opinions regarding the newly developed model. The experts interviewed were among those that responded to the expert questionnaire. Validation of the model used a questionnaire in Appendix XIV: presented to 20 experts on ICT adoption.

4.9.1 Analysis Results

4.9.1.1 Respondents Age

A majority of the respondents were between the age of 25 and 35 at 35% while those between the age of 36 and 45 were approximately 27.27%, those between the age of 45-55 at 19% and above 56 years at 18% as presented in Figure 15.

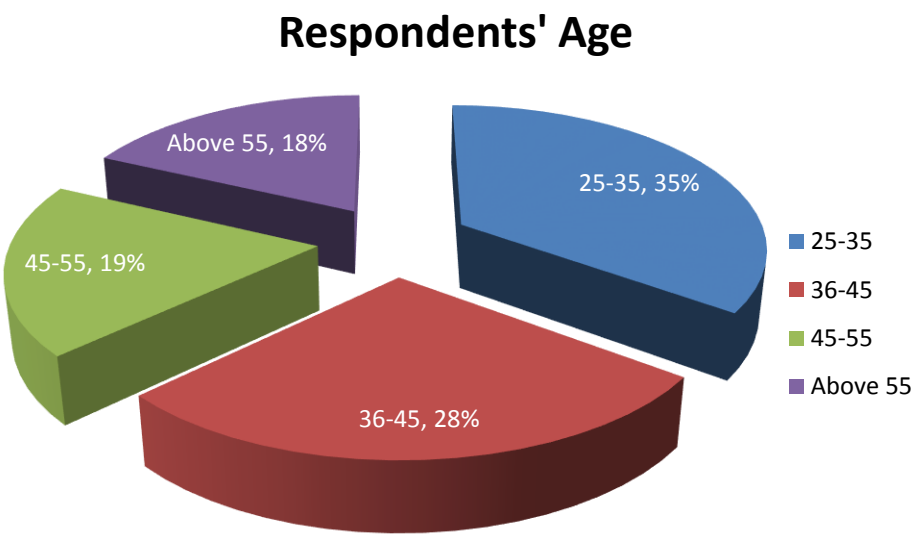

Figure 15: Respondents' Age

4.9.1.2 Respondents Gender

A majority of the respondents were Male at 60% while female respondents were 40% as shown in Figure 16.

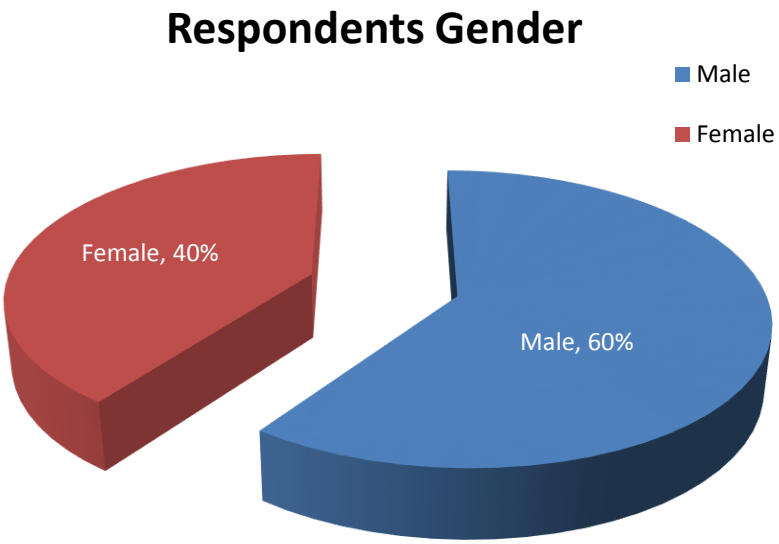

Figure 16: Respondents Gender

4.9.1.3 Respondents Level of Education

Most of the respondents were holders of a master's degree at 90% while PhD holders were 10% as shown in Figure 17.

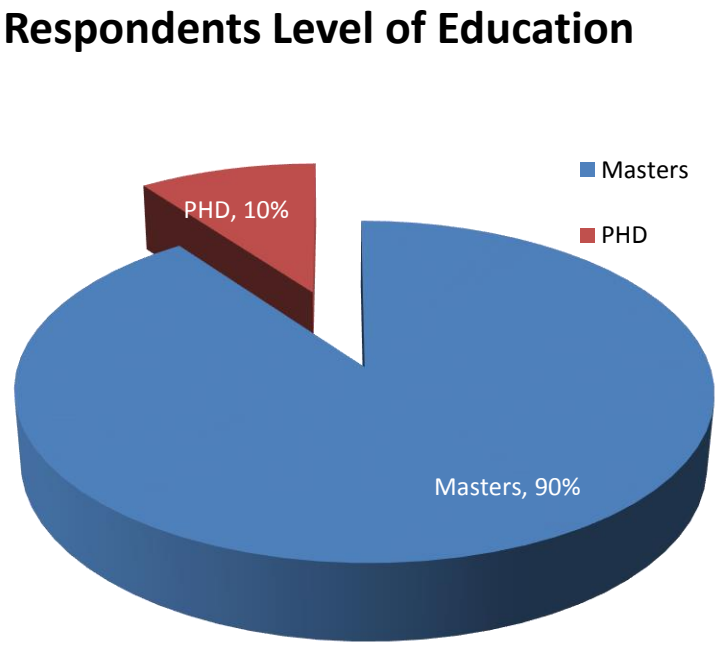

Figure 17: Respondents Level of Education

4.9.1.4 Respondents Experience with Information Technology Adoption

Most of the respondents had experience of between 5-10 years constituting 66% while those above 10 years constituted 34% of the respondents. The least in terms of experience were those with experience of between 1-6 years, as presented in Figure 18.

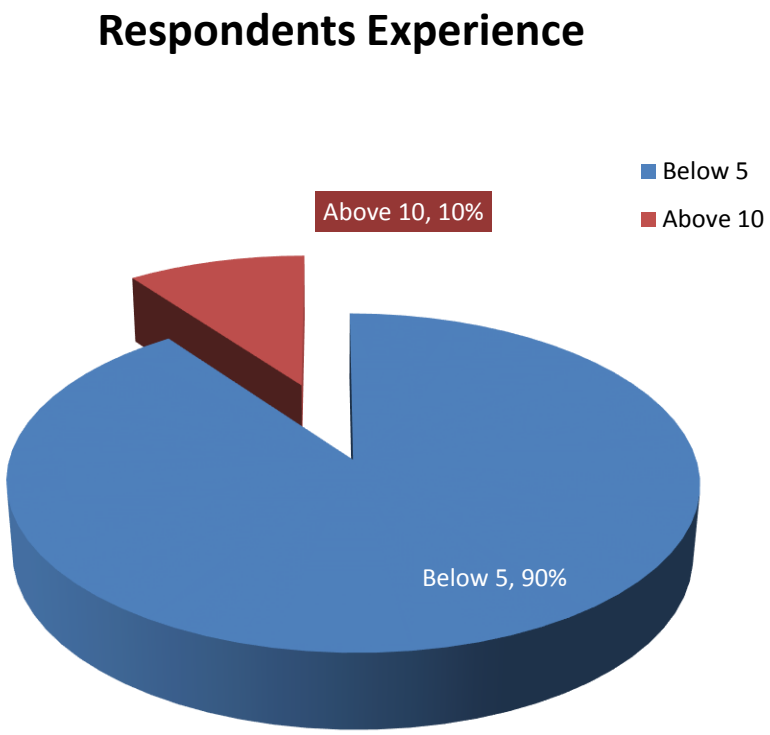

Figure 18: Respondents Experience

4.9.1.5 Influence of TI on Adoption of ICT in T&L

A majority of the experts were in support of the fact that TI has a great influence on adoption ICT in T&L. 41.8% and 36.4% of the respondents fell within the Agree and Strongly Agree respectively with 16.8% of the respondents remaining neutral 4.6% disagree and 0.5% strongly disagreeing. See figure 19 below.

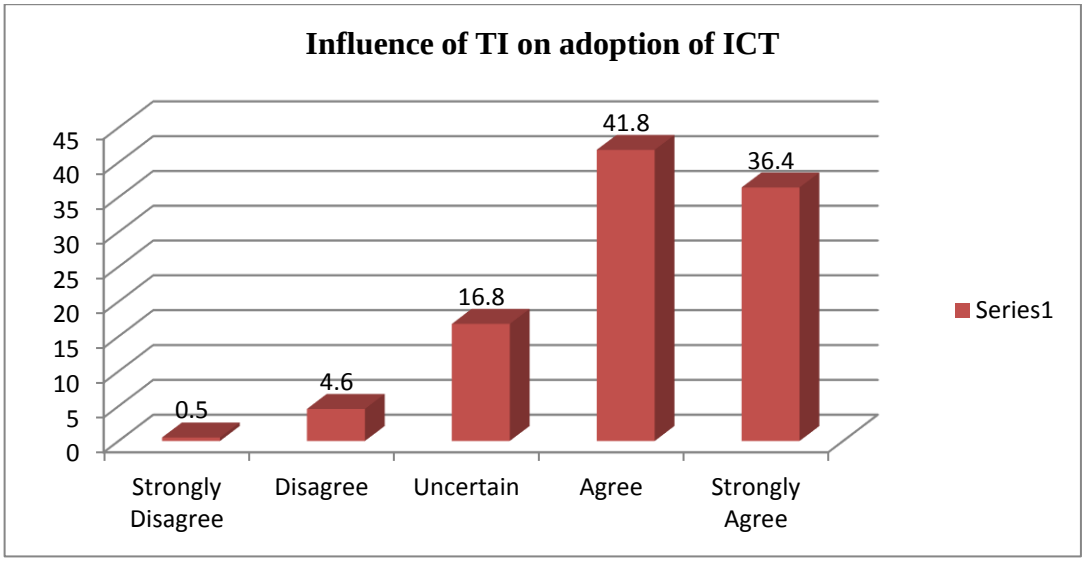

Figure 19: Influence of TI on Adoption of ICT

4.9.1.6 Influence of ICT OBL on Adoption of ICT in Secondary T&L

Majority of the experts were in support of the fact that OBL possess a great influence on the adopt ICT in T&L. 67.3% of the respondents agree with 25% of the respondents remaining neutral 7.7 % disagree. See figure 20 below.

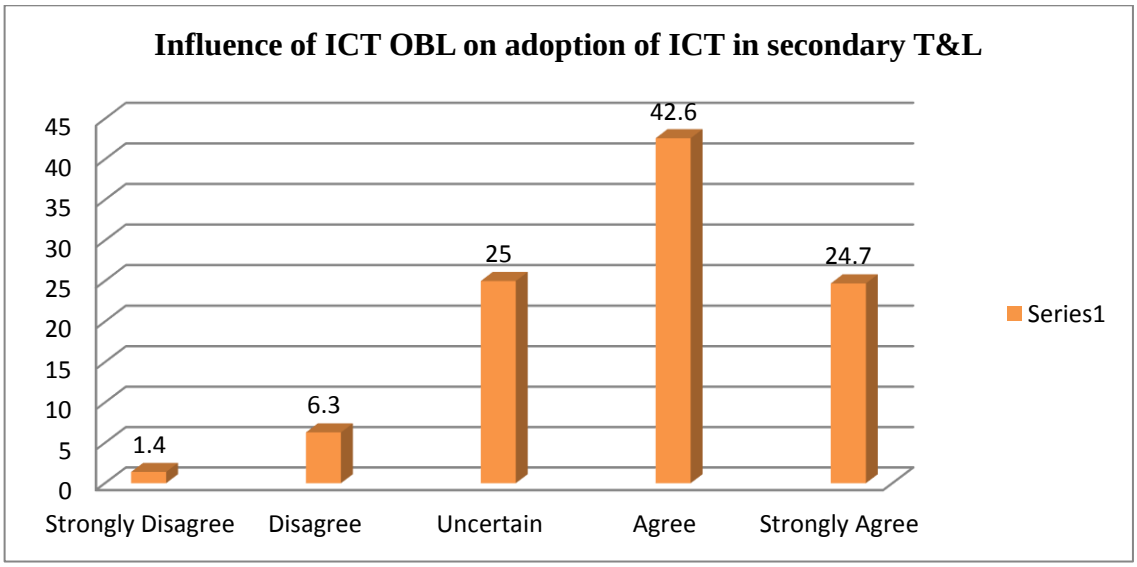

Figure 20: Influence of ICT OBL on Adoption of ICT in T&L

4.9.1.7 Influence of Perceived CPL in adopting ICT in Secondary T&L

Majority of the experts were in support of the fact that CPL has a great influence on the adoption of ICT in T&L. 68.7 % of the respondents agree with 25% of the respondents remaining neutral 6.3 % disagree. See figure 21 below.

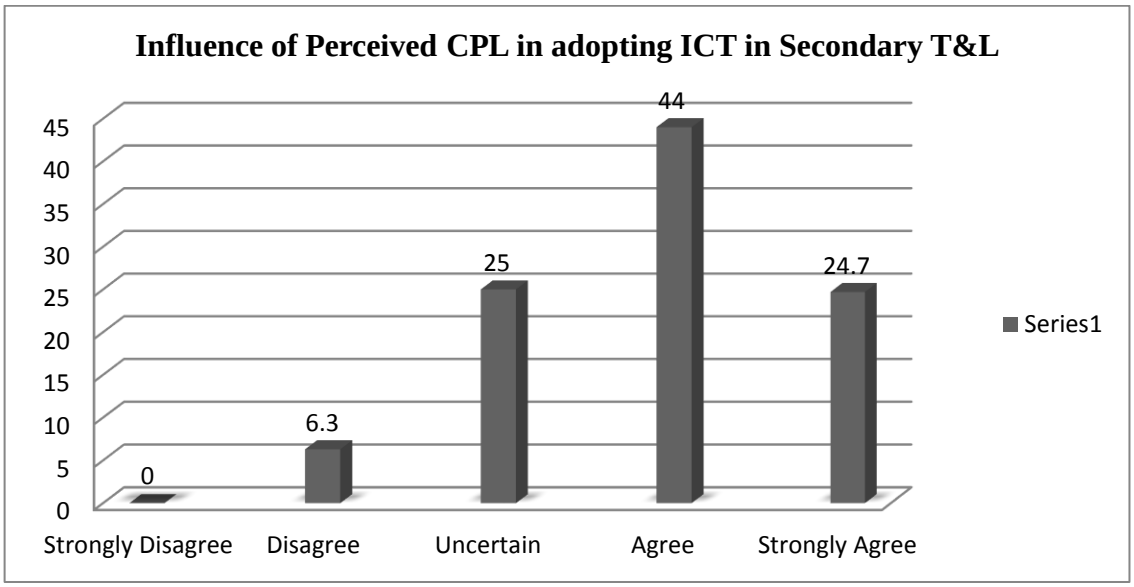

Figure 21: Influence of Perceived CPL in Adopting ICT in T&L

4.9.1.8 Influence of ICT OBL Adoption of ICT in Secondary T&L

A majority of the experts were in support of the fact that OBL has a great influence on the adoption of ICT in T&L. 68.7 % of the respondents agree with 24.6 % of the respondents remaining neutral 6.7 % disagree. See in figure 22 below.

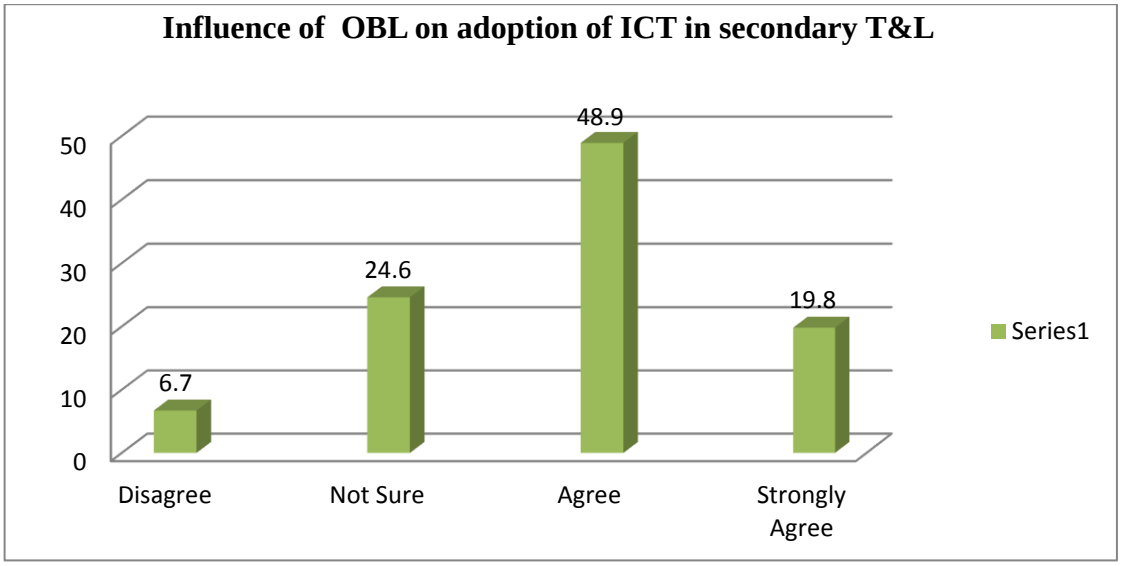

Figure 22: Influence of ICT OBL on Adoption of ICT in T & L

4.9.1.9 Influence of ICT HARC on Adoption of ICT

A majority of the experts were in support of the fact that HARC has a great influence on adoption of ICT in T&L. 88.6 % of the respondents agree with 7.0 % of the respondents remaining neutral 4.4 % disagree. See figure 23 below.

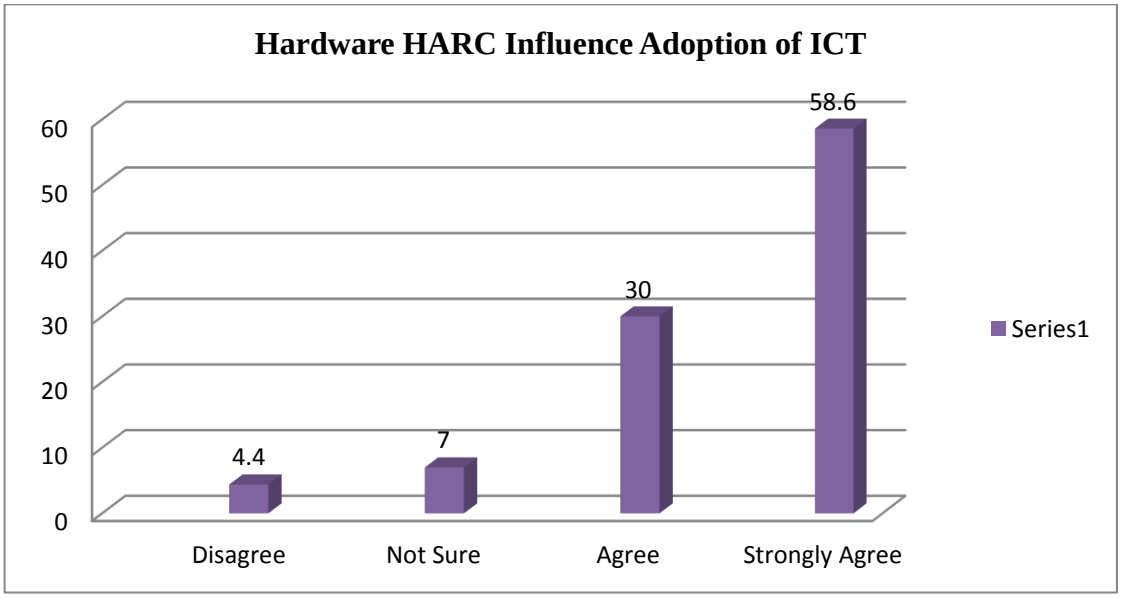

Figure 23: Influence of ICT HARC on Adoption of ICT

4.9.1.10 Influence of ICT RA on Adoption of ICT T & L

A majority of the experts were in support of the fact that RA has a great influence on adoption of ICT in T & L. 96.5 % of the respondents agree with 3.5% of the respondents remaining neutral. See figure 24 below.

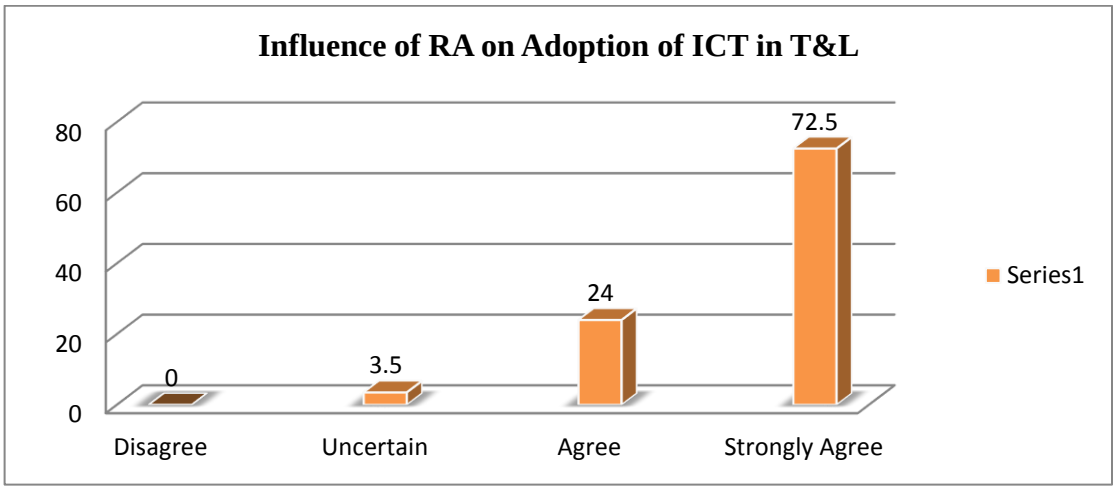

Figure 24: Influence of RA

4.9.1.11 Influence of ICT TBL

A majority of the experts were in support of the fact that TBL has a great influence in adoption of ICT in T & L. 88.9 % of the respondents agree with 9.5% of the respondents remaining neutral and 1.6 disagreed. See figure 25 below.

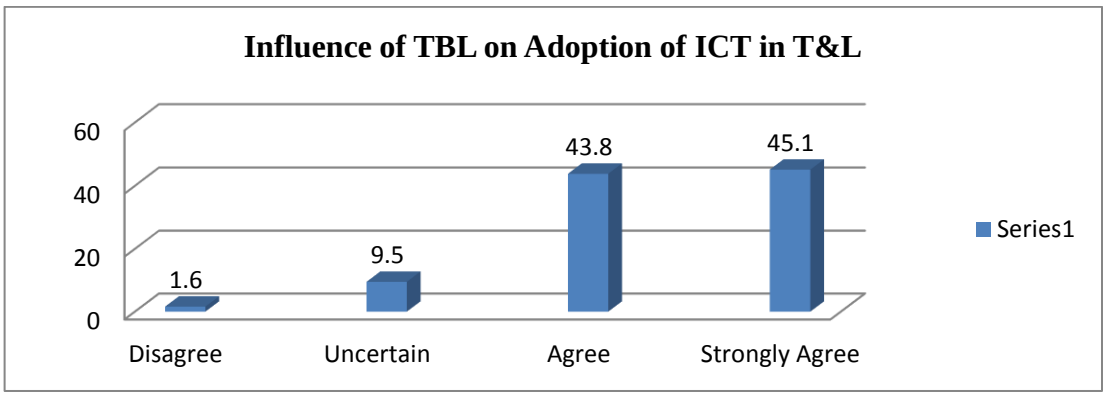

Figure 25: Influence of TBL on Adoption of ICT in T&L

4.9.1.13 Influence of ICT SPA on Adoption of ICT

A majority of the experts were in support of the fact that SPA has a great influence on the adopt ICT in T&L. 68.7 % of the respondents agree with 23% of the respondents remaining neutral and 7.3 disagreed. See figure 26 below.

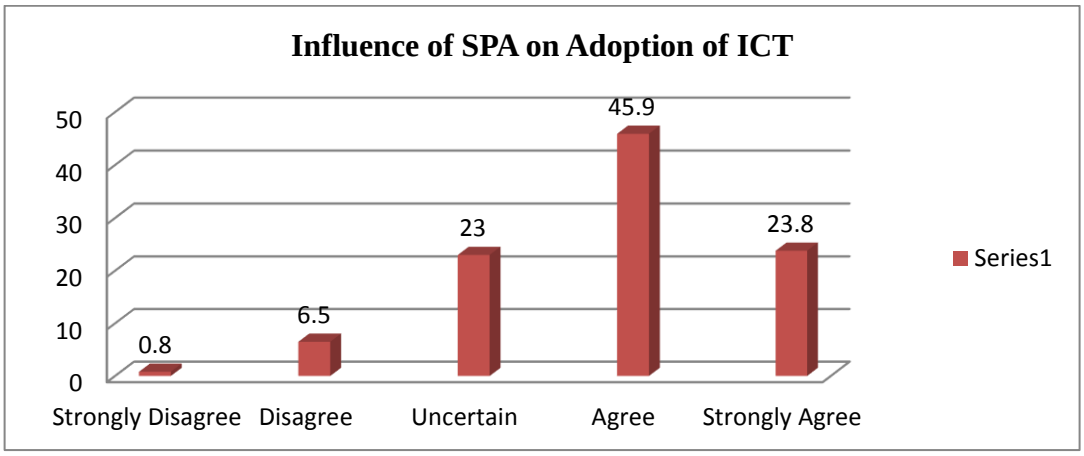

Figure 26: Influence of SPA on Adoption of ICT

4.9.1.13 Influence of ICT CPA on Adoption of ICT in T&L

A majority of the experts were in support of the fact that CPA has a great effect on adoption of ICT in T & L. 80.5 % of the respondents agree with 16.7% of the respondents remaining neutral and 1.8 disagreed. See Figure 27.

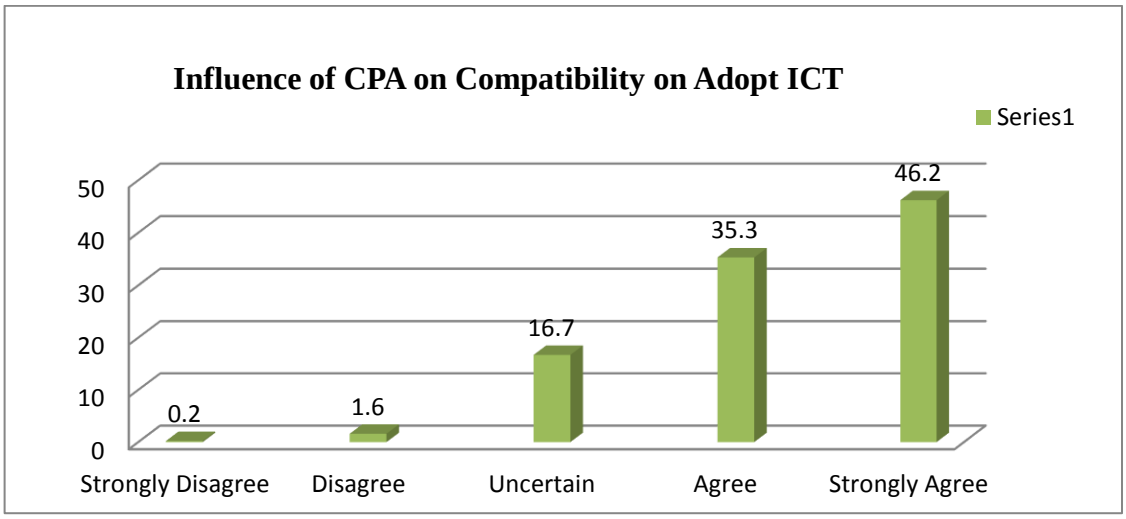

Figure 27: Influence of CPA on Compatibility on Adopt ICT

4.10 Correlation Testing

Bivariate correlation was useful in measuring the strength of relationship between the variables. In interpreting the results, the correlation can take any value between -1, 1. In case of -1 it indicates a negative linear relationship, 0 indicates no relationship while 1 indicates a perfectly positive linear relationship. In the correlation for this study, the values of the correlations for each of the variables are 0.394, 0.338, 0.398, 0.210, 0.307, 0.286, 0.435 and 0.391 respectively. This indicates that each of these indicators has a positive linear relationship with the dependent variable. See Table 42.

Table 42

Correlation Testing

		TI:	TBL:	TS:	CPL:	RA:	CPA:
TI:	Pearson Correlation	1	.394**	.338**	.398**	.210**	.307**
	Sig. (2-tailed)		.000	.000	.000	.000	.000
	N	20	20	20	20	20	20
TBL:	Pearson Correlation	.394**	1	.452**	.555**	.224**	.507**
	Sig. (2-tailed)	.000		.000	.000	.000	.000
	N	20	20	20	20	20	20
TS:	Pearson Correlation	.338**	.452**	1	.373**	.159**	.414**
	Sig. (2-tailed)	.000	.000		.000	.000	.000
	N	20	20	20	20	20	20
CPL:	Pearson Correlation	.398**	.555**	.373**	1	.184**	.483**
	Sig. (2-tailed)	.000	.000	.000		.000	.000
	N	20	20	20	20	20	20
RA:	Pearson Correlation	.210**	.224**	.159**	.184**	1	.190**
	Sig. (2-tailed)	.000	.000	.000	.000		.000
	N	20	20	20	20	20	20
CPA:	Pearson Correlation	.307**	.507**	.414**	.483**	.190**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	
	N	20	20	20	20	20	20
HARC:	Pearson Correlation	.286**	.296**	.192**	.238**	.395**	.220**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000
	N	20	20	20	20	20	20
OBL:	Pearson Correlation	.435**	.335**	.344**	.387**	.165**	.372**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000
	N	20	20	20	20	20	20
SPA:	Pearson Correlation	.391**	.372**	.423**	.365**	.364**	.337**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000
	N	20	20	20	20	20	20

4.11 R-Square Test

R-Square test was statistically useful in measuring successfulness of the fit attained in explanation of the variation of the data (Harnett and Soni, 1991). R-Square is the square of the correlation between the response values and the predicted response value.

Table 43

R-Square Test Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.630[a]	.397	.386	.599

The overall model has predictive accuracy of 0.397. Model R^2 value of 0.75, 0.50, and 0.25 described as substantial, moderate and weak respectively (Hair et al., 2012). Therefore, this model has predictive accuracy useful in predicting technological factors influencing adoption of ICT in T&L.

4.12 Analysis of Variance (ANOVA) Test

ANOVA being one of the best measures of relationship that researcher can use in a research where several variables are involved (Kothari, 2004). ANOVA test was therefore very essential in this study for testing the developed model. The ANOVA test gave the following results, basic in identifying factors influencing our data set (Harnett and Soni, 1991).

Table 44:

Results of ANOVA Test

		Sum of Squares	df	Mean Square	F	Sig.
TI:	Regression	83.443	4	20.861	33.502	.000
	Residual	390.416	627	.623		
	Total	473.859	631			
TBL:	Regression	47.763	4	11.941	27.634	.000
	Residual	266.179	616	.432		
	Total	313.942	620			
TS:	Regression	90.690	4	22.672	30.484	.000
	Residual	467.821	629	.744		
	Total	558.511	633			
CPL:	Regression	68.606	4	17.152	23.413	.000
	Residual	426.358	582	.733		
	Total	494.964	586			

Continuation of Table 22: ANOVA Test Results

		Sum of Squares	df	Mean Square	F	Sig
RA:	Regression	26.283	4	6.571	21.368	.000
	Residual	194.036	631	.308		
	Total	220.319	635			
CPA:	Regression	25.870	4	6.468	10.769	.000
	Residual	345.337	575	.601		
	Total	371.207	579			
HARC	Regression	72.477	4	18.119	29.381	.000
	Residual	389.761	632	.617		
	Total	462.239	636			
OBL:	Regression	39.854	4	9.963	16.077	.000
	Residual	374.948	605	.620		
	Total	414.802	609			
SPA:	Regression	89.214	4	22.304	34.991	.000
	Residual	379.900	596	.637		
	Total	469.115	600			

Now that the p-value is less than 0.05, TI, TBL, TS, CPL, RA, CPA, HARC, OBL, SPA have significant combined effect on adoption of ICT in T&L.

The regression test below is testing for the level of significance of the individual independent variables in this relationship. See table 46 below.

Table 45:

Coefficients

Model	Un standardized Coefficients		Standardised Coefficients		
	B	Std. Error	Beta	t	Sig.
1(Constant)	3.862	.256		15.114	.000
TI: How would you rate availability of ICT resources for teaching in your school?	.156	.037	.176	4.187	.000
SPA: How would you rate Software portability and Adaptability?	.098	.049	.093	1.999	.046
TS: How would you rate the availability of ICT Technical Support in Teaching?	.163	.034	.202	4.848	.000
CPL: How would you rate ICT Complexity?	.091	.038	.109	2.399	.017
RA: How would you rate the Relative Advantages of using ICT in Teaching?	.180	.052	.138	3.465	.001
CPA: How would you rate the ICT Resource Compatibility with tradition resources?	-.091	.041	-.097	-2.256	.025
HARC: How would you rate the influence of ICT; Hardware & Software rate of Change?	.115	.034	.131	3.363	.001
OBL: How would you rate the ICT Observability?	.025	.038	.026	.646	.519
TBL: How would you rate ICT Resources Trialability?	.144	.037	.168	3.900	.000

a. Dependent Variable: Adopted: How would you rate Adoption of ICT in Teaching, in your school?

The coefficient of use of reliable infrastructure in Secondary T&L was positive (0.156), and significant ($p<.001$). This implied that the adoption of ICT in Secondary T & L related to the

availability of reliable ICT infrastructure. The coefficient of the perceived complexity of adopting ICT in teaching was positive (0.091), and significant (p=0.017). This implied that the adoption of ICT in Secondary T&L related to the complexity of adopting ICT in teaching. The coefficient of perceived Compatibility of the ICT facilities necessary for ICT adoption was negative (-0.91), and significant (p=0.025). This implied that ICT adoption negatively related to the perceived Compatibility of the facilities necessary for ICT adoption in T&L. This means that the schools that perceived the Compatibility of the facilities necessary for ICT adoption to be incompatible are less likely to adopt ICT than the schools that perceived the compatibility of the facilities necessary for adoption of ICT.

The positive (0.163) and significant (p<.001) coefficient of T.S implied that the adoption of ICT in Secondary T&L is highly dependent on TS on its adoption in Secondary T&L. It means the schools where the T.S is provided the likelihood of ICT adoption is higher than in the schools where the T.S is lacking The coefficient of ICT hardware rapid change on adoption of ICT in Secondary T&L was positive (0.115), and significant (p<.001). This implied that the adoption of ICT in Secondary T&L is highly dependent on ICT hardware rapid change for its adoption in Secondary T&L.

In reference to the predictor variables tested in the regression test in this chapter, it was noted that absence of one predictor reduced the level of adoption of ICT in secondary education and hence the need to provide for all predictors, to achieve the great level of adoption of ICT in secondary education.

The coefficient for ICT Trialability was (0.144) and a significant (p<.001). This implied that the level of adoption of ICT in Secondary T&L related to the Trialability of ICT resources. Finally, the coefficient Relative Advantage of ICT gave a positive coefficient of (0.180), and significant (p =p<.001). This implied that the level of adoption of ICT in Secondary T&L related to the Relative Advantage of ICTs, technical support and skills in Secondary T&L.

From the regression results discussed above the researcher concluded that, TI, TBL, TS, CPL, RA, CPA, HARC, and SPA have significant individual influence on adoption of ICT at 10% level of significance. OBL have significance 0.519. This means that in the overall model OBL have negligible influence on adoption of ICT in T&L. This finding helps us answer the question number [ii] of this study “To what extent do ICT technological factors influence adoption of

ICT in T&L in Kenya?" as empirical test resulted to: Y= 0.156 * TI + 0.144* TBL + 0.163 * TS + 0.091* CPL + 0.180 * RA - 0.091 * CPA + 0.115 * HARC + 0.098 * SPA+ 0.025 * OBL. To answer research question number [iii] "Do theories and models cater for ICT technological factors influencing adoption of ICT?" This study established that reviewed theories and models lacked on important technological factors. Reviewed model could not take care of critical technological factors established in this study. This was established following the identification of technological factors influencing adoption of ICT in Kenyan secondary T&L; using questionnaire, interview and observation methods alongside review of literature.

4.13 Automated Tool for Assessing Status of Technological factors in Adoption of ICT

Based on the theoretical model developed in this study, the researcher developed an automated tool useful in assessing status of technological factors in adoption of ICT as discussed below.

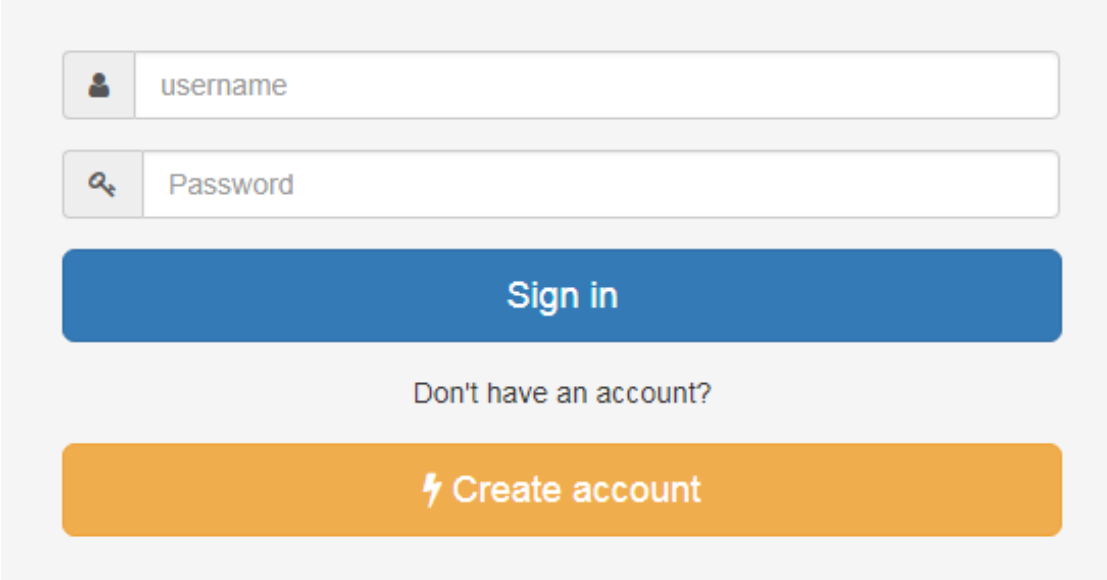

Figure 28: Login Screen

User Login Screen: The user logs screen allows for log in by authorized user.

4.13.1 Technological Infrastructures TI,

The application tool captures indicators of technological factors (Technological Infrastructure) influencing adoption of ICT as follows.

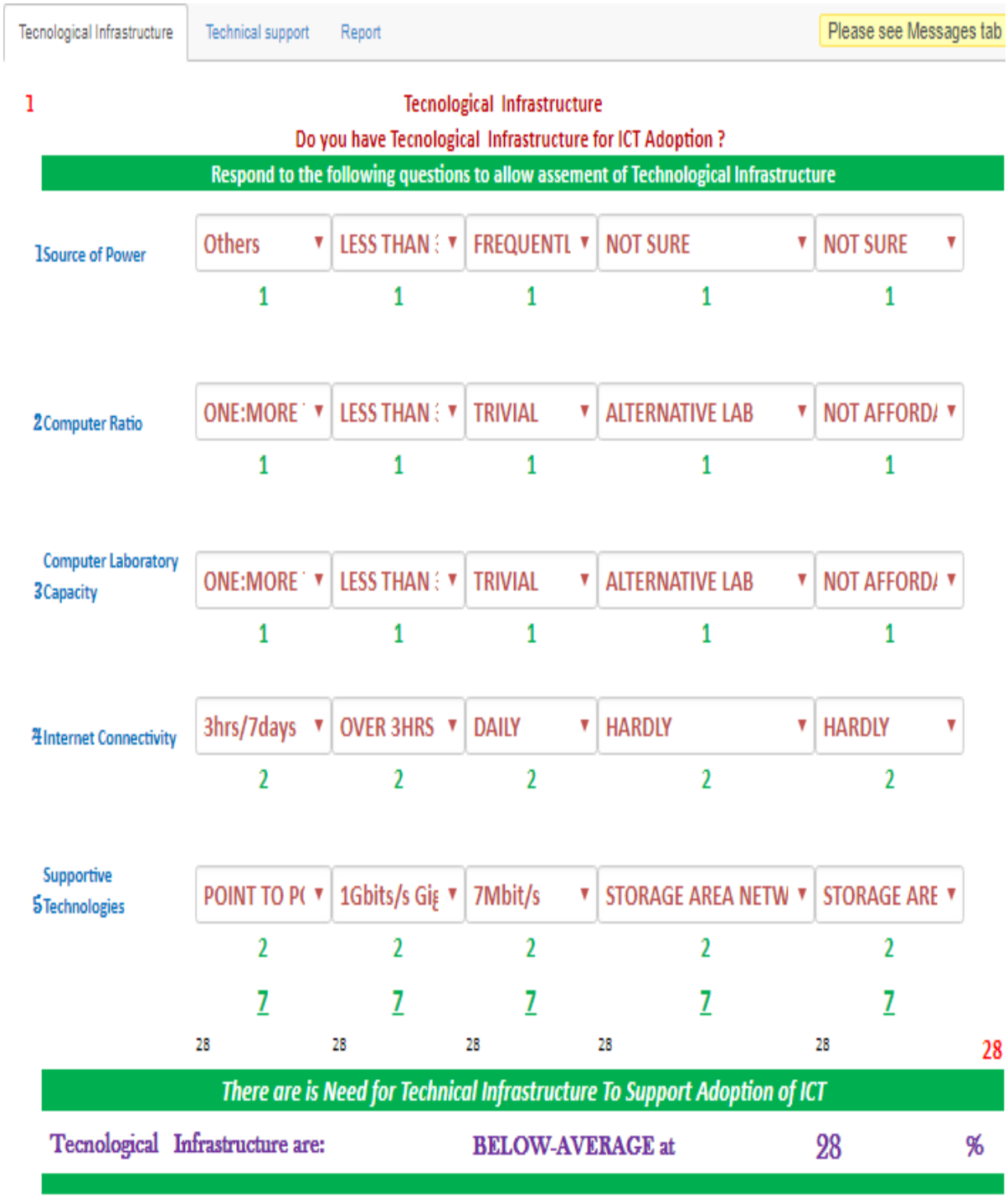

Figure 29: Technical Infrastructure

4.13.2 Technical Support TS Among Others

The application tool captures indicators of other technological factors influencing adoption of ICT (CPA, CPY, SPA, TBL, OBS, CPL, RA and TS) as follows.

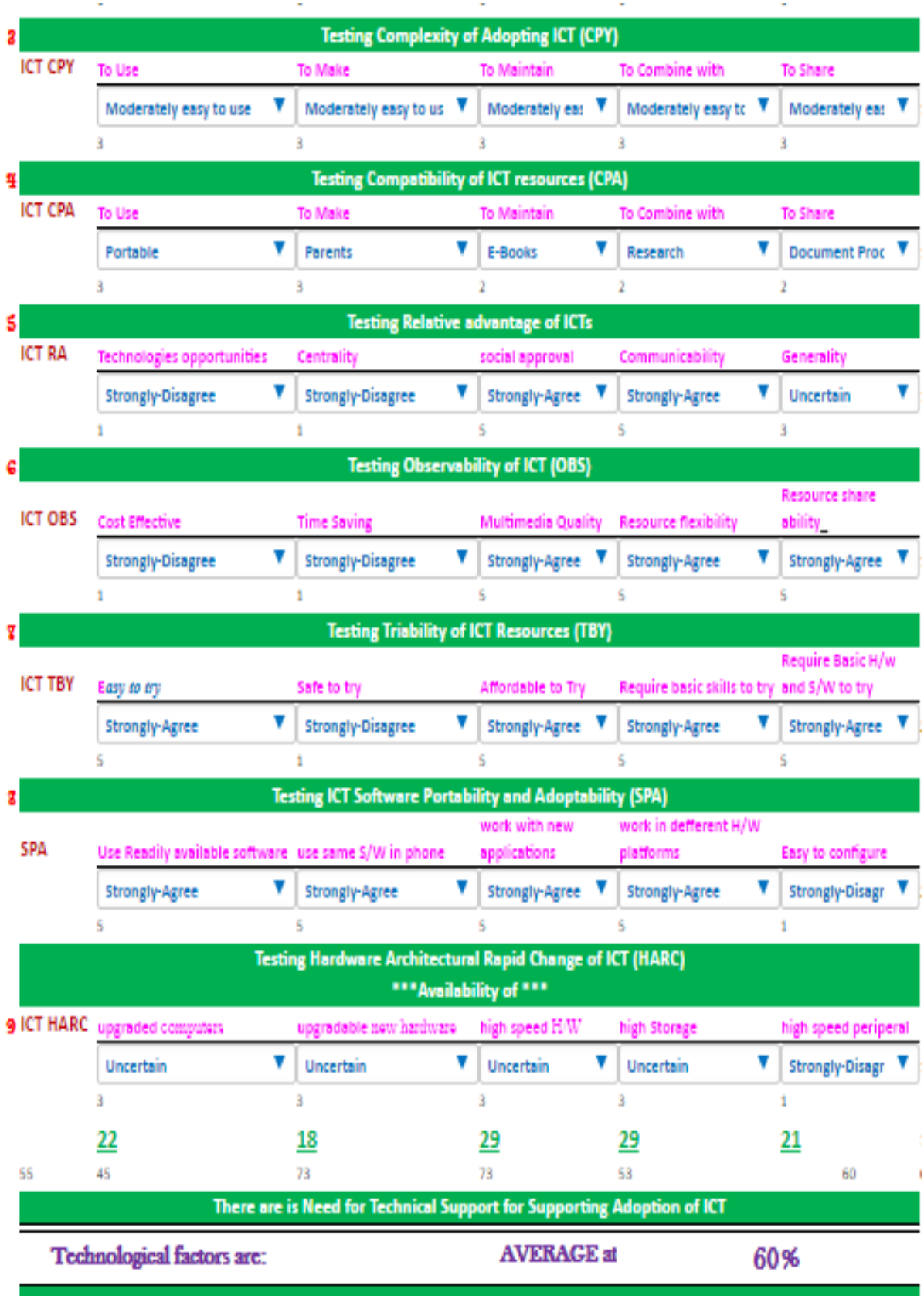

Figure 30: Capturing TS, CPA, CPY, SPA, TBL, OBS, CPL, RA and HARC

4.13.3 Resulting Output

The application tool analyzes and produces results showing levels of technological factors attained as follows.

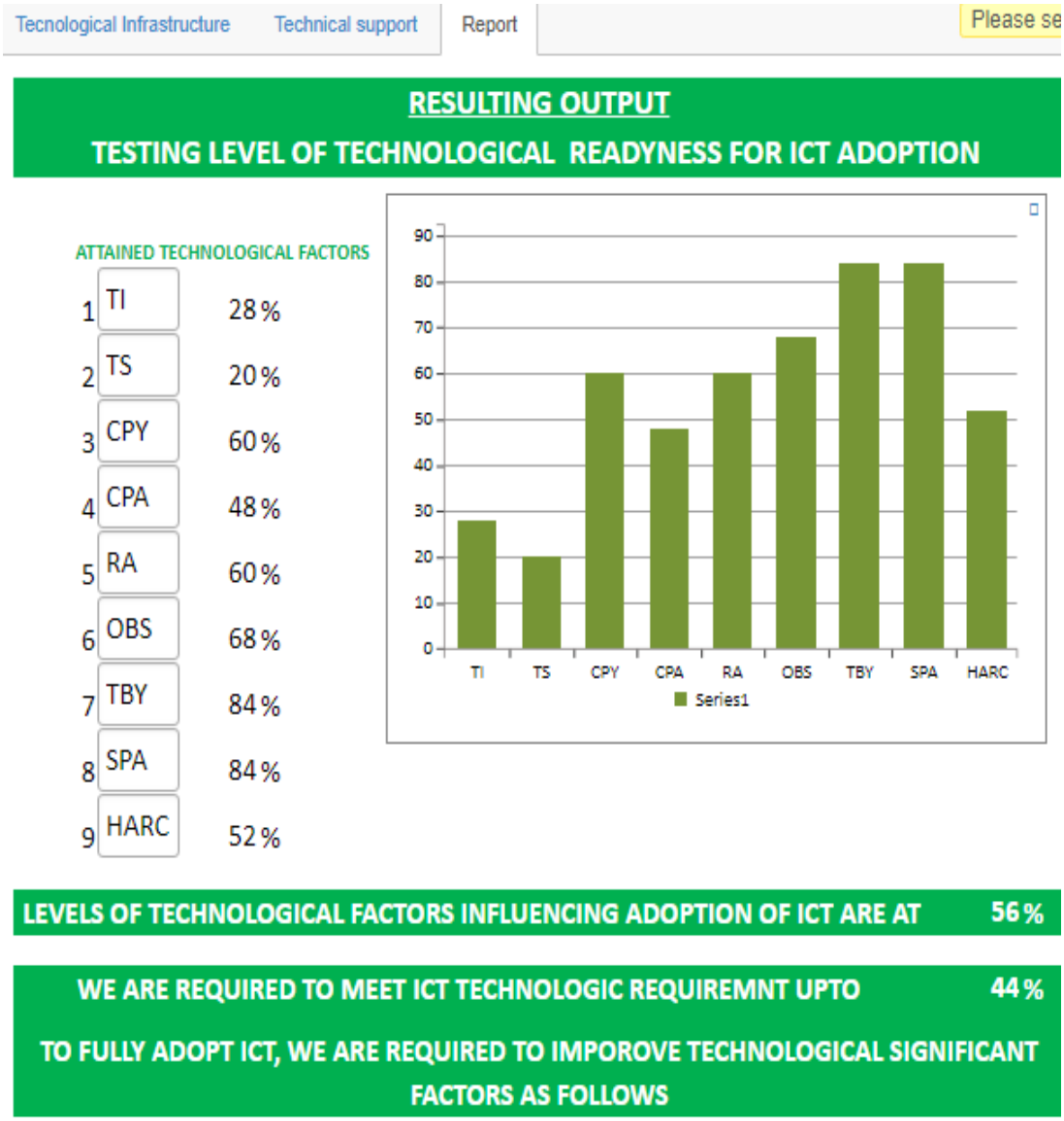

Figure 31: Resulting Output

4.13.4 Implication of Results

The application tool provides the user with summarized implications of the assessed technological factors. This shows the technological gaps for improvement in adoption of ICT

LEVELS OF TECHNOLOGICAL FACTORS INFLUENCING ADOPTION OF ICT ARE AT	56%

WE ARE REQUIRED TO MEET ICT TECHNOLOGIC REQUIREMNT UPTO	44%

TO FULLY ADOPT ICT, WE ARE REQUIRED TO IMPOROVE TECHNOLOGICAL SIGNIFICANT FACTORS AS FOLLOWS

	TECHNOLOGICAL FACTORS TO BE ATTAINE	
1	TI	72%
2	TS	80%
3	CPY	40%
4	CPA	52%
5	RA	40%
6	OBS	32%
7	TBY	16%
8	SPA	16%
9	HARC	48%

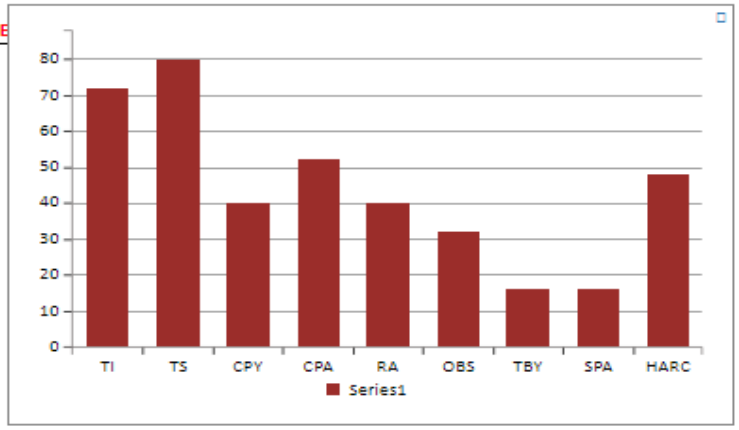

Figure 32: Implications

4.13.5 Interpretation of Results

The application tool provides the user with a short interpretation of the results as follows.

INTERPRATATION OF RESULTS

WE ARE REQURED TO IMPROVE ICT TECHNOLOGICAL FACTORS BY	44%
1 TI	BASIC MENTAINCE ONLY
2 TS	NEED TO ESTABLISH TECH SUPPORT
3 CPY	NEED TO OUTOSOURCE
4 CPA	NEED TO OUTOSOURCE
5 RA	NEED TO OUTOSOURCE
6 OBS	NEED TO BENCH MARK
7 TBY	NEED TO BUDGET FOR IMPROVEMENT OF IT
8 SPA	NEED TO BUDGET FOR IMPROVEMENT OF IT
9 HARC	NEED TO OUTOSOURCE

Figure 33: Interpretation of Results

4.13.6 Submission of Results to the Experts

Submitted results helps the consultants make decisions useful in facilitating adoption of ICT more effectively. See figure below.

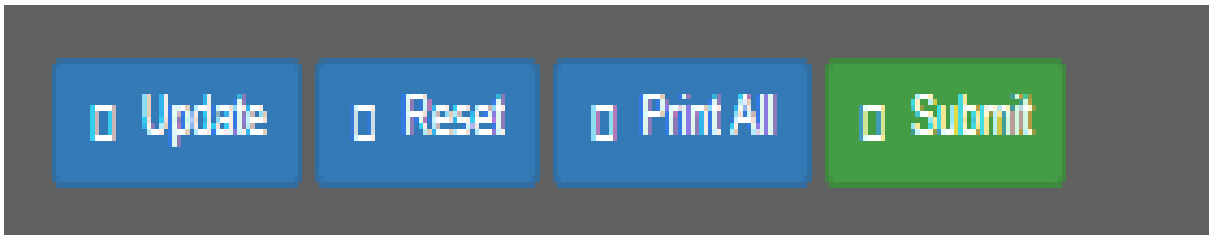

Figure 34: Submission of Results to the Experts

As seen from the figure above the first button is used to update; make permanent the edited values on assessment done. Reset button; is used to clear the content and allow fresh entry of values for analysis. Print All button; allow the use to print a hard copy or to pdf format for offline use. Finally, the Submit Button is used to start online transmission to the experts.

4.14 Summary: Data Analysis, Presentation and Interpretation

In this chapter, research design and method identified in chapter three were useful in giving the results; analyzed, presented and discussed in this chapter. Data collected using questionnaire, interview schedules and observation were analyzed using windows SPSS statistical package. Descriptive and inferential analysis results discussed, in the view of this study objectives and research questions. In the chapter the proposed model was developed, tested and validated using ANOVA and R-Square as suggested by (Kothari, 2004).

Review on empirical research and statistical analysis of data helped in establishing technological factors in adoption of ICT. This was helpful in meeting objective number one of this study. Data collected were analyzed statistically to establish the extent of influence by technological factors on adoption of ICT. To meet objective number two of this study, identified technological factors were statistically analyzed and tested to establish their interdependence and level of influence on adoption of ICT. Chi Square Independence Test was undertaken. The findings used to conclude reliable associations between variables used in the model, see 4.3.2.

To form an ICT technological adoption model the researcher integrated established technological factors. The researcher statistically tested for fitness and validated the developed model for adoption. R-Square test used to statistically, measure how successful the fit is in explaining the variation of the data (Harnett and Soni, 1991). See section 4.11. The researcher used correlation and regression analysis to test the model and ANOVA test used to examine the relationship between variables. Thus, ANOVA test was essential in testing the developed model, See 4.3.5.

A theoretical framework by Rogers (1995) helped to guide the research on development of a suitable conceptual framework, representing the relationship graphically. Triangulation method usefully helped to capitalize on strength of both quantitative and qualitative methods of data collection (Yeasmin and Rahman, 2012). In this chapter the research objectives were met; answering the research question, developing the proposed model and validated the model. In the next chapter, the researcher provides summary, Conclusions and Recommendations of this study.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

In this chapter the researcher concludes the findings of the study on ICT technological factors in adoption of ICT in secondary school T&L. The study further assessed the appropriateness of the existing technology adoption models in this scenario. The study developed and validated an appropriate model that is more suitable in predicting ICT technological factors in adoption of ICT in work place procedures.

This chapter contains indicators to key areas of knowledge contribution made by this study. The chapter further point out on the areas requiring further investigation in future. In the same manner, this chapter shows theoretical academic contributions, methodological contributions, and practical uses of the study recommendations, limitations and delimitations of the research.

5.2. Summary of Key Findings

5.2.3 ICT in Education

Focused empirical literature review done in this study revealed that, ICT is recognized as a key drive of economic development and social change worldwide (Komza, 2005). ICT plays a major role in: economic, political, social and cultural development, and has rapidly transformed the manner in which individuals carry out economic activities, access information, services and share information among each other (Kelles-Viitanen, 2003). Therefore, this interprets ICT as a universal economic language.

5.2.4 Emerging Technologies Useful in Education

In education, information communication technologies have played a major role in ensuring accessible quality education anywhere anytime. Some of the most resent achievement in using technologies in education includes use of robot teachers; cloud computing, powerful software supporting; e learning and simulations. These resources expand beyond hardware and software to great ideas applied in social media. These ICTs include web 2.0 among others. This explains the positive influence ICT as an innovation, has on human activities.

5.2.5 Technological Factors in ICT

Adopters have not identified and agreed on one common factor influencing adoption of ICT (Alimazighi and Bouchbou, 2009). This study studied common technological factors of ICT discussed in various studies comprising: Tornatzky and Klein (1982) who debated 10 attributes listed in 23rd paragraph of section 1.1 of this study. Premkumar et al., (1994) as a result used this list to study EDI diffusion and discussed 4 technological factors listed in section 1.1 paragraph 23 of this study. While Hai (1998) used a different set of six attributes listed in section 1.1. In the same manner technical support and internet connectivity, identified by (Waithaka et al., 2013). Nevertheless as explained in section 2.5.7 (Computer hardware architectural rapid change); the ICT rapid growth brings up new technological factors (Al Geist, ORNL and Lucas, 2009).

5.3 Achievements on Objectives of this study

This study had four research objectives as presented in chapter 1.4. The first objective sought to establish the technological factors influencing adoption of ICT in T&L. This study established nine technological factors; Relative Advantage [RA], Perceived Compatibility [CPA] and Perceived Complexity [CPL], Perceived Trialability [TBL], Perceived Observability [OBS], and hardware architectural rapid change [HARC], software portability with adaptability [SPA], technological infrastructure [TI] and technical support [TS].

The second objective sought to investigate the extent of impact of identified ICT technological factors in T&L. Analysis of this study established that: 95.6% of respondents indicated that ICT Relative Advantage influences their choice to adopt ICT in T&L. 16.7% of respondents indicated that ICT Compatibility influences their choice to adopt ICT. 68.3% of respondents indicated that ICT Complexity influences their choice to adopt ICT. 88.9% of respondents indicated that ICT Trialability influence their choice to adopt ICT. 68.7% of respondents indicated that ICT Observability influences their choice to adopt ICT. 83.3% of respondents indicated that ICT Technical Support influences their choice to adopt ICT. 78.2% of respondents indicated that lack of ICT Infrastructure influences their choice to adopt ICT. 88.6% of respondents indicated that ICT Hardware Technological Rapid Change influences their choice to adopt ICT in T&L. 69.7% of respondents indicated that Software Portability and Adaptability influences their choice to adopt ICT in T&L.

The technological variables established in this study find support in previous studies as illustrated in table 46 (Technological factors gaps in analyzed studies). The study discussed five of them as used to develop a model by Rogers as shown in section 2.7.4 and the other four discussed as technological factors but not incorporated in any model in the past. This study established the gap and incorporated these four technological factors as shown in Figure 2.

Newly incorporated technological factors in ICT Technological Adoption Model are Technical Infrastructure, Technical Support, Hardware architectural Rapid Change and Software Portability & Adaptability as shown in table 11. Each of these constructs tested with four sub-variables as follows.

i. Technical infrastructure constituted of; access to working computer system, availability of functional computer laboratory, availability of local area network and availability of stable internet.
ii. Technical Support constituted of; access to technical support, office for technical support staff and technical support training.
iii. Hardware architectural Rapid Change constituted of; upgradable hardware, up to date hardware, high-speed processor and high storage media.
iv. Software Portability & Adaptability constituted of; software availability, use diverse h/w platform, modern software and sharing of software.

The third objective was to develop a practitioner's model for adoption of ICT in T&L. This study developed a model useful in adoption of ICT in T&L as in Figure 14: Proposed model. The model includes technological factors identified in objective one of this study.

The fourth objective was to test the model for ICT adoption in T&L. This study validated the model as shown in section 4.12, using statistical measures of relationship analysis of variance (ANOVA) as suggested by (Kothari, 2004). Again, the coefficient of multiple determinations (R- Square) used as shown in section 4.6.1 to statistically measure how effectively the fit is in explanation of variation of the data as suggested by (Kothari, 2004; Harnett and Soni, 1991). Other tests and validations achieved include Cronbach's test of research instrument internal consistency as shown in section 3.8.5.2. Methodological triangulation test of credibility and validity of research tools results, Chi-Square test to determine the association between the categorical variables used as shown in section 4.3.1.

5.4 Academic Contributions

This study further noted that the reviewed models lack important constructs that are important in the prediction of technology adoption in a developing country. In this study, the proposed model introduced the newly identified technological factors enhancing the DIO model for better adoption of ICT in T&L.

5.5 Methodological Contributions

The methodological approach carried out in this study delivers a guideline to future studies and researchers who wish to undertake a related research. Such studies and researchers will be able to get guidance on the design of the questionnaire, interview schedule useful as research instruments in their studies. Future researchers will also get guidance on how to examine reliability and validity of the instrument and the overall methodological approach applied in this study. Finally, this study also provides guidance on statistical quantitative and qualitative data analysis to future researchers on similar studies.

5.6 Practical Implications of this Study

This study established that the adoption of ICT is lagging behind in Kenyan public secondary T&L. Existing literature revealed that some developing countries like Korea are doing plenty well as seen in section 2.4.2 of this study. They have reliable infrastructures with well-established broadband Internet connectivity (UNESCO, 2014). They have established Help Desk at the Metropolitan Provincial Offices of Education (MPOE) level, real-time T.S can only be effective with T.S desk at institution level (Hwang, Yang and Kim, 2010). Furthermore, there is need for additional T.S staff and training at institutional level (Hwang, Yang and Kim, 2010).

From the studies reviewed, Kenyan schools do not offer any form of T.S required for ICT adoption in T&L. There lacks well-established and maintained ICT infrastructures for ICT adoption in secondary T&L. Learners do not use any communication device like mobile phones as part of ICTs. However currently, electricity connectivity is in progress.

Adoption of the technological model developed in this study would ease adoption of ICT in T&L. The model provides the ICT experts with a guide on technological factors, to consider when developing S/W and H/W resources. This will help maximise on the positive influence of

the technological factors and reduce on the negative influence. The experts will be able to develop ICTs which suit specific adopters, lowering technical complexity of generalized ICTs.

Adoption of the technological model provides the policy makers with elementary technological factors, guiding on development of relevant ICT adoption policy for achieving national goals as stipulated in vision 2030. Use of the automated tool (in section 4.13) for assessing status of technological factors in adoption of ICT will ensure availability of updated database on ICT adoption. Updated database is useful in making timely decisions and policies.

Technological factors established in this study are key, in developing effective ICT adoption roadmap. In that this study established the extent to which each factor contributes in influencing adoption of ICT as shown in section 4.12. This study guides on importance for establishment of TS center, where real time technical assistance can be offered to adopters so as bridge the adoption gap. This will help register great success in adoption of ICT in T&L like Korea, which is termed as an educational powerhouse.

5.7 Limitations of the Research

This study referred to technological factors affecting current technology, with no regard to any advancement of technology while the study was in progress. The study covered schools in Githunguri sub-county Kenya. Therefore, generalizability of these results to other populations in Kenya and other developing countries in Africa may not be ascertained.

5.8 Delimitations

Respondents were approachable with 89% of them responding to the research questions as expected. Data were successfully collected using predesigned data collection tools, analyzed and conclusions drawn within the schedule. Data analysis tool used was effective and gave satisfying results.

5.9 Conclusions

In the quest to find a reliable model for adoption of ICT in T&L, this study identified and critically reviewed the following ICT adoption models; the Technology Acceptance Model (TAM) by Davis and Venkatesh, the Theory of Planned Behaviour (TPB) by Ajzen and the

Diffusion of Innovation Model by Rogers. In the same following, the researcher derived a conceptual model as shown in section 4.7.

In conclusion, this study established technological factors influencing adoption of ICT. The identified technological factors were used as constructs for developing a technological adoption model. The adoption of technological model is useful in overcoming technological challenges in adoption of ICT. Using the model engineers and experts are able to develop hardware, software and systems with minimal or no technological limitations. Developed resources should be highly portable, compatible, adoptable, easy to use, and easy to try, with observable relative advantages and coping with hardware architectural rapid changes. Policy makers guided by technological model should develop policies to establish reliable technological infrastructure, and ICT technical support centers with dynamic technical support team, to ensure maximum benefit of adopting ICT.

5.10 Recommendations

This study recommends the following

5.10.1 Recommendations for practice to

i. The Government of Kenya to establish policies and strategies for technical support to all adopters of ICT both online and offline,
ii. Donors and G.O.K to fund for establishment of centralized place where adopters can get technical advice, technical assistance and ICT resources,
iii. Stakeholders to provide for technical support workshops and supporting staff in the place of adopters work place,
iv. ICT experts to consider technological factors in ICT technological adoption model when developing S/W and H/W resources as they influence adoption of ICT,
v. ICT experts should develop ICTs which suit specific adopters to lower technical complexity of generalized ICTs,
vi. Institutions of Higher Learning in partnership with various industries to establish ICT Mentorship Project on ICT adoption to reduce perception that ICT adoption is Complex,
vii. The ministry of communication and technology among other partners to adopt this model to quicken the rate of ICT adoption in the country to better our economy,

viii. The government to facilitate adopters to attend ICT adoption workshops, as it is in line with the ICT policy in place to attain vision 2030 as stipulated.
ix. The GOK to establish an ICT adoption model, useful for benchmarking by adopters.
x. The governments of developing countries such as Kenya need to make deliberate efforts to promote adoption of ICTs. This will save money in terms of underutilized ICT resources. The same money channeled to facilitate adoption of ICT further among other economic projects.

5.10.2 Recommendations for Service users / beneficiaries

i. Investors to use the technological model in development of ICT business models capable of overcoming technological facts when providing services at highly affordable cost,
ii. Ministry of Education to adopt the technical model developed in this study to help mitigate impact of technological factors hindering adoption of ICT in T&L.
iii. Ministry of Education to adopt Automated Tool for Assessing Status of Technological factors in Adoption of ICT

5.10.3 Recommendations For other Stakeholders

i. Donor to fund for establishment of ICT support center useful in providing technical support to ICT adopters for better economy
ii. Sponsors to facilitate for technical training and seminars where adopters can learn how to cope with technological factors in adoption of ICT.
iii. MOEST to take initiative of benchmarking with countries with established ICT policies and structures like Korea, which has good laid down structure for T.S, aiming at achieving real-time help and T.S at institution level.

5.12 Suggestions for Further Research

The researcher focused on the adoption of ICT in Kenyan secondary T&L and therefore recommends for;

i. Extending the research to other levels of T&L in Kenya and abroad.
ii. More research to be done to investigate and further validate the model developed in this study,
iii. Scholars to critic on the ICT Technological Adoption Model designed in this study,

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APPENDICES

Appendix I: Administrators Permission and Introduction

Administrator Permission and Introduction

February 01 / 2015

Dear,

My name is Bernard G. Gakenga, a graduate student at Mount Kenya University Main Campus Thika. Part of my graduate work is conducting a study project in attempt to solve a problem or shed light on technological factors in adoption of ICT in Teaching. Therefore, with your permission, I request to supply questionnaires and conduct interviews with teachers in your schools. I would also like access to your technology plan and or resources in the school if you have any. For confirmation of my mission, I can provide my research proposal that was submitted to the University postgraduate committee upon request.

This study phase will be short only lasting 1 week as to minimize classroom and teacher disruptions. Please respond to this request at your earliest convenience to enable me to seek participation from teachers soon. Participation is voluntary with a promise to take great lengths to assure all information is kept confidential, and there will be no names attached to the project. All raw data collected in this study will be kept secure, and destroyed six months after this study is complete. If you have any concerns or questions regarding this study, please contact my academic advisor, Mr. John Kamau and or Dr. Joyce Gikandi.

Agreement

Kindly Tick Appropriately

☐ Permitted to undertake the research activity in our school

☐ Not permitted to undertake the research activity in our School

☐ Day ☐ Day/Boarding ☐ Boarding ☐ Boys ☐ Girls ☐ Mixed School

Comments if any ……

School Name ……..……

Participant Signature

Date _____

Researcher's Signature

Date _____

Appendix II: Informed Consent

Teacher's Informed Consent

February 01th 2015

My name is Bernard G. Gakenga, and I am currently a graduate student at Mount Kenya University. Part of my graduate work is conducting a study project where i attempt to solve a problem or shed light on technological problems in adoption of ICT in teaching.

I would like to ask for your participation in my research. The research will consist of one questionnaire, an interview and a possible observation. Your participation in this study is voluntary and you can withdraw at any time without penalty or restrictions. All information obtained during the study will be kept confidential and your identity will be protected at all times. Raw data will be kept secure, and will be destroyed six months after the completion of the research.

If you have any concerns or questions regarding this study, please contact my academic advisor, Dr. John Kamau and or Dr. Joyce Gikandi.

For any concerns regarding your rights as participants, please contact The Chair, School of Pure and applied Sciences Committee, Mount Kenya University.

Agreement

I ……. ……., consent to complete participation in Bernard G. Gakenga's research: on technological factors in adoption of ICT in teaching. I understand confidentiality will be maintained in any reports of this study, and all raw data will be kept secure, and will be destroyed six months after the completion of the research.

_____Participant Signature Date_____

_____Research's Signature Date_____

Appendix III: Questionnaire

Survey on Technological factors in Adoption of ICT in Education

Preamble: A survey on: Technological Factors in Adoption of IT in Secondary Education secondary School in Githunguri -Sub County, Kiambu county Kenya.

The purpose of this questionnaire is to gather information from class room teachers, on the technological factors influencing the adoption of ICT, in public secondary schools Githunguri sub-county, Kiambu County, Kindly respond to the listed questions and statements by stating the answer or circling the appropriate number to indicate the level of your agreement or disagreement with the statements listed. The information provided will be used with utmost confidentiality and only used for the purpose of this study. Please respond to the three sections and do not indicate your name on this questionnaire.

Thanks, as you participate.

Appendix III: Section A

Participant Information

The intent of this section is to obtain some information about individuals who respond to this survey. Information gathered about participants will be treated confidentially, and only group data will be reported as an outcome of this study.

A. Specify your subject of specialization……. …….

B. Gender: __Female __Male

C. Age: _____

D. How long have you used ICT? __0-1 year __1-5 year(s), __More than 2 Semesters

E. How much training did you receive in using ICT as a teaching and learning tool?

__None __1-5 Hours __More than 5 Hours

F. Is there any kind of pressure or force from your employer to use ICT as a teaching tool in your classes? __Yes __No

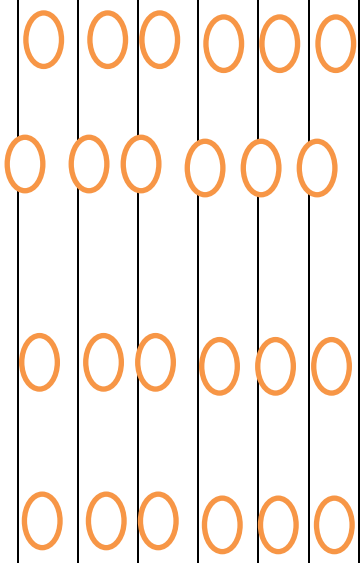
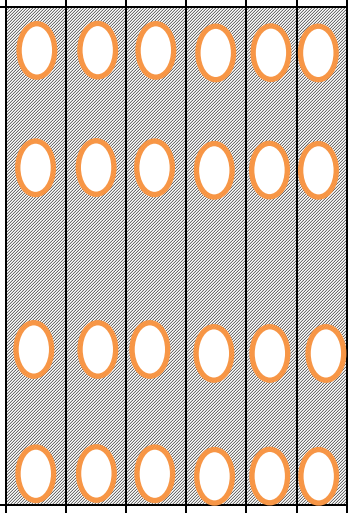
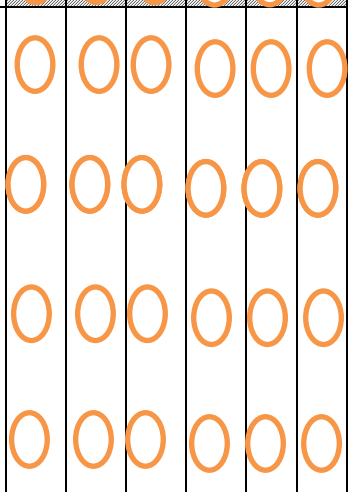
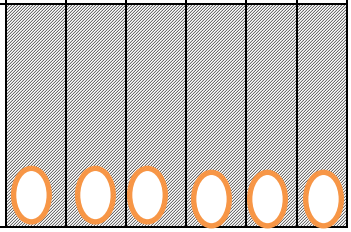
G. What is your level of professionalism: Diploma__ Bachelor Degree ___ Masters __ any other specify _____

Appendix III: Section B:

Table 46: Questionnaire for Teachers Section B

Kindly tick the appropriate cell to indicate the level of your agreement or disagreement with the following statements.		Strongly Dis agree	Dis agree	Uncertain	Agree	Strongly Agree	No Opinion
1	ICT Observability influences adoption of ICT in T&L [Do you observe any advantage from use of ICT in your day to day activities] ICT resource share ability influences adoption of ICT in T&L [Easy to share resource] ICT Computer Speed influences adoption of ICT in T&L [Computer work at a high speed suitable for T&L] ICT Multimedia Quality influences adoption of ICT in T&L [ICT produces Quality Multimedia Resources] ICT Resource flexibility influences adoption of ICT in T&L [Information are easy to edit, format and update]						
2	ICT Technological Infrastructure influences adoption of ICT in T&L, [I/We use reliable Computer hardware and connectivity] Access to working computer system influences adoption of ICT in T&L [functional computer systems] Availability of LAN influences adoption of ICT in T&L [Interconnection of computers in school]						

	Availability of stable internet influences adoption of ICT in T&L [Able to access internet services comfortably] Availability of functional computer laboratory influences adoption of ICT in T&L [room with suitable ICT resources]	
3	Hardware Architectural Rapid Change influences adoption of ICT in My / Our T&L Availability of up-to-date computers influences adoption of ICT in T&L Availability of upgraded to use with new hardware & S/W, influences adoption of ICT in T&L Availability of high-speed influences adoption of ICT in T&L Availability of high Storage capacity computers, influences adoption of ICT in T&L	
4	Complexity of adopting ICT in T & L influences My / Our adoption of ICT in T&L Relative ease of understand and use ICT in T&L influences adoption of ICT in T&L Availability of basic technical knowledge and skills to use ICT in teaching, influences adoption of ICT in T&L Ease of converting traditional teaching resources into digital content influences adoption of ICT in T&L Availability of ICT basic skills influences adoption of ICT in T&L	
5	Trialability of ICT in teaching influences My / Our adoption of ICT in T&L	

	Easy to try different ICT applications in Teaching process, influences adoption of ICT in T&L. ICT resources are safe to try and user even without prior experience. This influences adoption of ICT in T&L I find cost of trying use of ICT in teaching being manageable. Hence influences adoption of ICT in T&L Available basic skills for trying ICT in T&L, influences adoption of ICT in T&L	
6	Availability of ICT Technical Support influences my / our adoption of ICT in T&L. ICT Technical Staff give clear guidelines on adoption of ICT in T & L. ICT Technical Staff in place gives technical support for adoption of ICT in T& L. ICT Technical Staff trains us on technical skills in adoption of ICT in teaching. ICT technical staff is posted in our institution.	
7	ICT Compatibility influences Our / My adoption of ICT [T&L] I / We use ICT resource for lesson's presentations Teachers share ICT resources to present their different lessons regular. I find it easy to combine traditional teaching AIDs with E-Content. Teachers with little or no technical skills get Technical assistance.	
8	Software Adaptability and Portability influences My / Our adoption of ICT in T&L I do use readily available software in school computers to present my work.	

	I do use my phone to update my work in school's computer I am able to use modern ICT applications with our old Pentium ii computers. School management software in our school is useable in my phone.	
9	ICT Relative Advantage influences My / Our adoption of ICT in T&L Using ICT, I enjoy Technologies opportunities; newer and better ways. Use of ICT ensures Centrality; all resources seem to come from one source. Use of ICT in teaching improves my social approval; Learners enjoy and prefer lesson presented using ICTs. Use of ICT ensure Communicability; easy to express.	

Section C

<u>Kindly respond to the following question with a brief explanation</u>

A. Are there some technology devices [Eg Computer, projector, Modem etc.] available for your use at school? …… If yes, which are they? …… Do you regularly use the technology tools like; [Evernote, Twitter, Google Education, Drop box etc.] for teaching and learning purposes during lessons? …… if yes kindly give examples of how you use them.

……..……
…… Do you regularly use the technology tools like: [Teachers Pay Teachers, Plan board, Timetoast, Capzles] for lesson planning and designing? …… if yes kindly give examples of how you use them.

……..……

B. Do the schools realize any benefit from use of these technologies? if yes, in what ways?……

If no explain ……..

C. Do you consider using technology tools during lessons, to be of a positive impact on student in any way? ……if yes in what ways? ……..If no explain……

D. Do you experience problems in accessing internet in your school? ….. If yes describe to what extent……

……Who pays for the cost of internet incurred? ..……..

E. Do you think it is suitable to use mobile phone in teaching and learning in schools? ……

Explain ……

Are there set of mobile phones H/W & S/W belonging to the school, which are on a private network, and locked to that network only? …… if yes describe it ……

Are there training programs, on use of mobile phones & or ICT in teaching? ……if yes explain briefly the nature of training and to what extent or how do you find them ……Do you think the technical support in place is adequate and why? ……
……

F. Are there challenges and or complications you find in using ICT in teaching?…… explain you answer

……

G. In your own view, does use of ICT in teaching require too much knowledge in ICT? ……explain……

H. Briefly describe how teachers use web technologies in teaching in you school. ……
…….....

I. Briefly describe state of your internet connectivity in your school. …….....

J. Briefly describe your view on use of mobile technology in teaching. …….....**.....** Is it correct to state that it's complex to adopt ICT in teaching? ….. if yes explain briefly …….....

Appendix IV: Interview Schedule and Questions

Interview took place in the month of November, December and January 2014-2015. The interviewees' availability determined the date and time for the interview.

1. Technological Infrastructure: The purpose of this section was to get opinions from the users regarding the level of investment on ICT infrastructure, like computer laboratories and internet, useful in T&L process. Below are the exact questions before further probing;

i. Do you access working computer system in your school for teaching?
ii. Do you have a Local Area Network (LAN) for ICT resource sharing?
iii. Do you access internet for sharing teaching resources?
iv. Do you learners have working and spacious computer laboratory for learning?

2. ICT Observability: The purpose of this section was to get opinions from the users regarding the observability of ICT. The respondents asked whether ICT observability influences their decision to adopt ICT in teaching. Below are the exact questions before further probing;

i. Does use of ICT in T&L makes it easy for teachers to share resources?
ii. Does use of ICT influence speed of teaching and timely coverage?
iii. Does use of ICT in teaching facilitate use of Quality Multimedia for T&L?
iv. Does Sharing of Multimedia lowers Cost of preparing AIDs?

3. H/W Architectural Rapid Change influences adoption of ICT: The purpose of this section was to get opinions from the users regarding the influence of ICT hardware Architectural Rapid Change on adoption of ICT. Below are the exact questions before further probing;

i. Do you have computers that are termed as outdated not repairable for your use?
ii. Do you have computers that are not upgradable for modern uses?
iii. Do you think it is correct to say; modern computers are faster than older ones?
iv. Is it true that modern computers store more data and support newer S/W e.g. office

4. ICT Software Portability and Adaptability: Here we get explanation from the users on the influence of SPA in adoption of ICT in T&L. Below are the exact questions before further probing;

i. Do you use readily available software in school computers for T&L?
ii. Who owns the ICT resources you use to prepare or update T&L materials?
iii. Are you able to use modern ICT applications computers available?
iv. Do you use school management software in your mobile computers / phone?

5. Relative Advantages of ICT: The purpose of this section was to get explanation from the users regarding the influence of relative advantage of ICT on adoption of ICT in T&L. Below are the exact questions before further probing:

i. By using ICT do you enjoy Technologies opportunities; newer and better ways?
ii. Does use of ICT ensure Centrality; all resources seem to come from one source?
iii. Does use of ICT ensure Communicability; ease communication in T&L?
iv. Does use of ICT in teaching improves your social approval; Learners enjoy and

6. ICT Trialability: The purpose of this section was to substantiate how Trialability influences adoption of ICT in T&L. The respondents were asked whether, they have ever tried or witness a colleague try use of ICT resource such as teaching and learning software, projectors, screens and internet in teaching. 90% respondents in this study have tried or witness use of ICT resource in teaching. Among the used ICT resources are computers, projectors and smartphones.

On further probing it was established that some users had used laptops, modems to connect to internet. Projectors for illustrations and smartphones for Google search and you tube. The study noted that the main reason why adopter have tried and used these resources is that they are; affordable, readily availability, ease to try and reuse. Below are the exact questions before further probing;

i. Do you find it easy to try different ICT applications in T&L?
ii. Are ICT resources safe to try and user even without prior experience?
iii. Do you find cost of trying use of ICT in teaching being manageable?
iv. Do fail to try use of ICT in T&L due to fear of technology failure?

7. ICT compatibility with other methods - The purpose of this section was to get explanation from the users regarding the level of compatibility of ICT with other T&L methods. A pattern analysis on the responses is shown below.

i. Do you comfortably use ICT resource in presenting your lesson?
ii. Does Teachers share ICT resources to present their different lessons regular?
iii. Do you find it easy to combine traditional teaching AIDs with E-Content?
iv. Does Teachers with little or no technical skills get Technical assistance?

8. Availability of ICT Technical Support: The purpose of this section was to investigate the users regarding the level of influence by availability of technical support in T&L. Below are the exact questions before further probing;

More Questions

A. What is the total number of staff and students in your school?
B. How many teachers for computer do you have in your school?
C. Is there any computer laboratory in your school?
D. What is the total number of Computers in your school?
E. How adequate are the available computers to the teachers and student population?
F. Which fraction of the school computers are connected to the internet?
G. What is the cost of your internet subscription per year?
H. Is your school in possession of digital content and or digital library?
I. What are the resources of the digital library if any is available?
J. What are your views on adoption of IT in teaching and learning?

Appendix V: Observation Schedule

Observation was carried out alongside face-to-face interview. The researcher could request the interviewees to allow for observation and possibly take a photo or video clip where possible. The observation took place on the following areas of interest, to provide qualitative data useful in clarifying some claims.

Observation Availability of ICT Technical Support:

The purpose of this section was to establish availability of technical support for T&L.

i. An observation was made on availability of technical support necessary for adoption of ICT in T&L.
ii. Ability of adopters to handle technical issues in adoption of ICT in T&L
iii. Activities involving use of ICT in T&L processes

Observation on Availability of ICT Infrastructure:

The purpose of this section was to ascertain availability of ICT Infrastructure for T&L.

An observation was done on availability of internet connectivity and functional computer laboratory.

Observation on S/W Portability and Share-ability:

The purpose of this section was to ascertain the claims on software portability and share-ability availability of ICT Infrastructure for T&L.

A. An observation was done on the ICT hardware platforms and the software used in them.
B. Investigated use of ICT resources for teaching and compatibility of the software used in the available platforms.

Appendix VI: Schools That Participated

	School name	Boarding	Day / Boarding	Day
1	William Ngiru Gitau Sec			X
2	St. Joseph Githunguri Boys	X		
3	Githiga Boys High school	X		
4	Kambui Girls high school	X		
5	J.G Kiereini Boys High School	X		
6	Gitwe Girls High School	X		
7	Githunguri Technical Mixed School			X
8	Gathiruini Boys	X		
9	Nyaga Mixed Secondary		X	
10	Komothai Girls	X		
11	Gathirimu Girls	X		
12	Gathugu sec			X
13	Kiambururu Sec			X
14	Kanjai sec			X
15	St Vincent Lioki	X		
16	Kamondo Sec			X
17	Kahunira Sec			X
18	Kiairia sec			X
19	Mukuyu			X
20	Kagumo sec			X
21	Gathanji Sec			X
22	Gitiha			X
23	Gikanga Kageche Sec			X
24	Miguta sec			X
25	Githima sec			X
26	Gathaithi sec			X
27	Thuita Sec			X
28	Mukua sec			X
29	Kagema Sec			X
30	Ndireti Sec			X
31	Komothai Boys	X		
32	PCEA Kambui Secondary for H.I		X	

Appendix VII: Letter of Introduction from Mount Kenya University

Mount Kenya University

SCHOOL OF POSTGRADUATE STUDIES

REF: MIT/2014/62583

27th March, 2015

To whom it may Concern

Dear Sir/Madam,

RE: BERNARD G. GAKENGA - REGISTRATION NO. MIT/2014/62583:

The purpose of this letter is to introduce the above named student who is pursuing a **MIT** in the Department of **Information Technology** in the School of **Pure and Applied Sciences.**

The title of his research project is *"Technological Factors in Adoption of Information Technology in Secondary Education: A Case of Githunguri Sub- County, Kenya".*

He now has to proceed to the field to collect data for his research project in the course of this semester (**March, 2015 – May, 2015).**

Any assistance accorded to him will be highly appreciated.

Thank you.

Mount Kenya University
School of Postgraduate Studies
P.O. Box 342 - 01000 Thika

Prof. Mbaruk Suleiman.
Dean, School of Postgraduate Studies

Appendix VIII: NACOSTI Research Authorization

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Telephone: +254-20-2213471,
2241349, 310571, 2219420
Fax: +254-20-318245, 318249
Email: secretary@nacosti.go.ke
Website: www.nacosti.go.ke
When replying please quote

9th Floor, Utalii House
Uhuru Highway
P.O. Box 30623-00100
NAIROBI-KENYA

Ref: No.

Date:
6th May, 2015

NACOSTI/P/15/0445/5622

Bernard Gathogo Gakenga
Mount Kenya University
P.O Box 342-01000
THIKA.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Technological factors in adoption of Information Technology in secondary education: A case study of Githunguri Sub-County, Kenya"*** I am pleased to inform you that you have been authorized to undertake research in **Kiambu County** for a period ending **16th October, 2015.**

You are advised to report to **the County Commissioner and the County Director of Education, Kiambu County** before embarking on the research project.

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

DR. S. K. LANGAT, OGW
FOR: DIRECTOR-GENERAL/CEO

Copy to:

The County Commissioner
Kiambu County.

The County Director of Education
Kiambu County.

Appendix IX: NACOSTI Research Permit

THIS IS TO CERTIFY THAT:
MR. BERNARD GATHOGO GAKENGA
of MKU, 0-32 RUIRU,has been permitted to conduct research in *Kiambu County*

on the topic: *TECHNOLOGICAL FACTORS IN ADOPTION OF INFORMATION TECHNOLOGY IN SECONDARY EDUCATION: A CASE STUDY OF GITHUNGURI SUB-COUNTY, KENYA*

for the period ending:
16th October,2015

.....
Applicant's Signature

Permit No : NACOSTI/P/15/0445/5622
Date Of Issue : 6th May,2015
Fee Recieved :Ksh 1,000

.....
for Director General
National Commission for Science, Technology & Innovation

CONDITIONS

1. You must report to the County Commissioner and the County Education Officer of the area before embarking on your research. Failure to do that may lead to the cancellation of your permit
2. Government Officers will not be interviewed without prior appointment.
3. No questionnaire will be used unless it has been approved.
4. Excavation, filming and collection of biological specimens are subject to further permission from the relevant Government Ministries.
5. You are required to submit at least two(2) hard copies and one(1) soft copy of your final report.
6. The Government of Kenya reserves the right to modify the conditions of this permit including its cancellation without notice

REPUBLIC OF KENYA

NACOSTI

National Commission for Science, Technology and Innovation

RESEARCH CLEARANCE PERMIT

Serial No. A 5057

CONDITIONS: see back page

Figure 35: Learning physics using ICT

Figure 38: Projector, Learning Math

Figure 36: Simulation, Learning chemistry

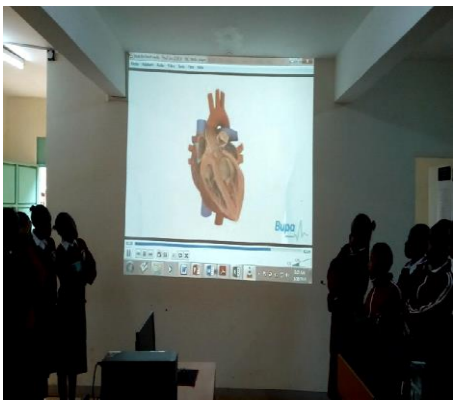


Figure 39: Animations, Learning Biology

Figure 37: Desktops, Taking an Examination

Figure 40: Video Clip, Learning ICT

Appendix X: Kenya Rural Electrification Program

FACILITY	No. OF FACILITIES ELECTRIFIED FROM 1973- 2003/04	NO OF FACILITIES ELETRIFIED 2003/04 -10/11	TOTAL ELECTRIFIED	TO BE ELECTRIFIED 2010/11- 2012/13	TOTAL
Trading Centres	1,096	5,783	6,879	3,371	10,250
Public Secondary Schools	285	4,163	4,448	2,478	6,926
Health Centres	348	2,082	2,430	1,516	3,946
TOTAL	1,729	12,028	13,757	7,365	21,122
Level of Electrification	4%	10%	18%	22%	
Access level	15%		70%		100%
Funds required to electrify the remaining facilities: Kshs.25billion (US$250M)					
Funds committed Kshs.17billion (US $170M) . Balance Kshs.8Billion (US$80M)					

Appendix XI: Expert opinion survey for validating the Model

Dear Sir/madam,

I am Bernard G. Gakenga, a student from Mount Kenya University Pursuing a Master of Science Degree in Information Technology. As part of my thesis, I have proposed and developed a Technological Adoption Model for which I am seeking your opinion as an expert in ICT adoption so that I can validate. The purpose of the questionnaire is solely for use in this study and not for any other purpose. Your opinion and personality will remain anonymous in the study. Thank you in advance.

Yours Faithfully

Bernard G. Gakenga

Expert Qualifications/Requirements

For one to be considered an expert, they require to hold a post graduate degree and a scholarly publication in adoption of innovation or a scholarly publication in adoption IT / ICT.

SECTION A

1. Expert age:
   20-29 ☐ 30-39 ☐ 40-49 ☐ Above 49 years ☐
2. Gender
   FEMALE ☐ MALE ☐
3. Education Level
   Masters ☐ PhD ☐
4. Experience with information technology adoption.
   2-6 years ☐ 7-10 years ☐ 11 years and above ☐

SECTION B

5. In your opinion, do you rate the following identified technological factors as critically required in Technological Adoption Model.

	Technological Factor	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
1	TI,					
2	TS,					
3	TBL,					
4	CPL,					
5	RA,					
6	CPA,					
7	HARC,					
8	OBL					
9	SPA					

THANK YOU.

Appendix XII: Automated Tool Sample Code

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×

Scan this QR code to open Live Preview tab on your phone/tablet

Live Preview

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var el_banner = document.getElementById("lp-banner");

var el_slider_panel = document.getElementById("lp-slider-panel");

el_slider_panel.setAttribute("style","display:block;height:43px;position:absolute;padding-left:8px;padding-top:8px;");

el_slider_head.setAttribute("style","width:0px;display:none");

el_banner.setAttribute("style","width:113px");

windowResized();}function onmouseleaveslider(e){

var el_slider_head = document.getElementById("lp-slider-head");

var el_banner = document.getElementById("lp-banner");

var el_slider_panel = document.getElementById("lp-slider-panel");

el_slider_head.setAttribute("style","display:block;height:50px;width:15px;float:left;");

el_banner.setAttribute("style","width:92px");

el_slider_panel.setAttribute("style","display:none"); windowResized();}

var msg = {

lp_prepare:"Live Preview is preparing the web page. Please wait..",

lp_diconnect:"Live Preview has been turned off.",

lp_notaskstop:"There is no on-going conversion to stop.",

```
lp_taskstop:"The on-going conversion was stopped."};
function iframe_onload_handle() {
const el_iframe = document.getElementById('iframe-main'),
el_iframedoc = el_iframe.contentDocument || el_iframe.contentWindow.document;
document.title = el_iframedoc.title;
adjustBanner();
if(el_iframedoc.getElementById('formc')) {
var el_toast = document.getElementById('lp-toast');
el_toast.style.display = 'none';}} function change_favicon(img) {
var favicon = document.querySelector('link[rel="shortcut icon"]');
if (!favicon) {
favicon = document.createElement('link'); favicon.setAttribute('rel', 'shortcut icon');
var head = document.querySelector('head');
head.appendChild(favicon);} favicon.setAttribute('type', 'image/ico');
favicon.setAttribute('href', img);} function displayQrDialog() {
var localip = document.getElementById("localip").value;
const localurl = window.location.protocol + "//" + localip + ":" + window.location.port +
window.decodeURIComponent(window.location.pathname);
const el_qrimage = document.getElementById("qr-image");
var el_qrimage_canvases = el_qrimage.getElementsByTagName("canvas");
var el_qrimage_imgs = el_qrimage.getElementsByTagName("img");
for (var i = 0; el_qrimage_canvases.length; i++) {
el_qrimage.removeChild(el_qrimage_canvases[0]);}
for (var j = 0; el_qrimage_imgs.length; j++) {
el_qrimage.removeChild(el_qrimage_imgs[j]);}
new QRCode(document.getElementById("qr-image"), localurl);
document.getElementById("dlg-qr").style.display = 'block';};
function debounce(func, wait, immediate) {
```

```
var timeout; return function ()
{
var context = this, args = arguments; var later = function() { timeout = null;
if (!immediate) func.apply(context, args);}; var callNow = immediate && !timeout;
clearTimeout(timeout); timeout = setTimeout(later, wait);
if (callNow) func.apply(context, args);};}; function adjustBanner() {
try{var el_iframe = document.getElementById('iframe-main'),
iframeDocWidth = el_iframe.contentDocument.documentElement.clientWidth || el_iframe.contentDocument.scrollingElement.clientWidth,
el_lp_banner = document.getElementById("lp-banner");
var lp_banner_width = iframeDocWidth - (el_lp_banner.clientWidth);
el_lp_banner.style.left = lp_banner_width + "px";
}catch(e){}}
function stopLivepreview() {
ws.send(JSON.stringify({'type': 'killprocess'}));
toast(msg.lp_taskstop);}
function updateProgressBar(val) {
var el_bar = document.getElementById('lp-progress-bar'),
r = el_bar.getAttribute('r'),
c = Math.PI*(r*2);
if (val < 0) { val = 0;}
if (val > 100) { val = 100;}
var pct = ((100-val)/100)*c;
el_bar.style.strokeDashoffset= pct;
if((val > 0 && val < 100)) {
document.getElementById('lp-progress-stop').style.fill = "#FF9F1E";
document.getElementById('lp-progress-button').setAttribute("status","enable");}
else{ document.getElementById('lp-progress-stop').style.fill = "#666";
```

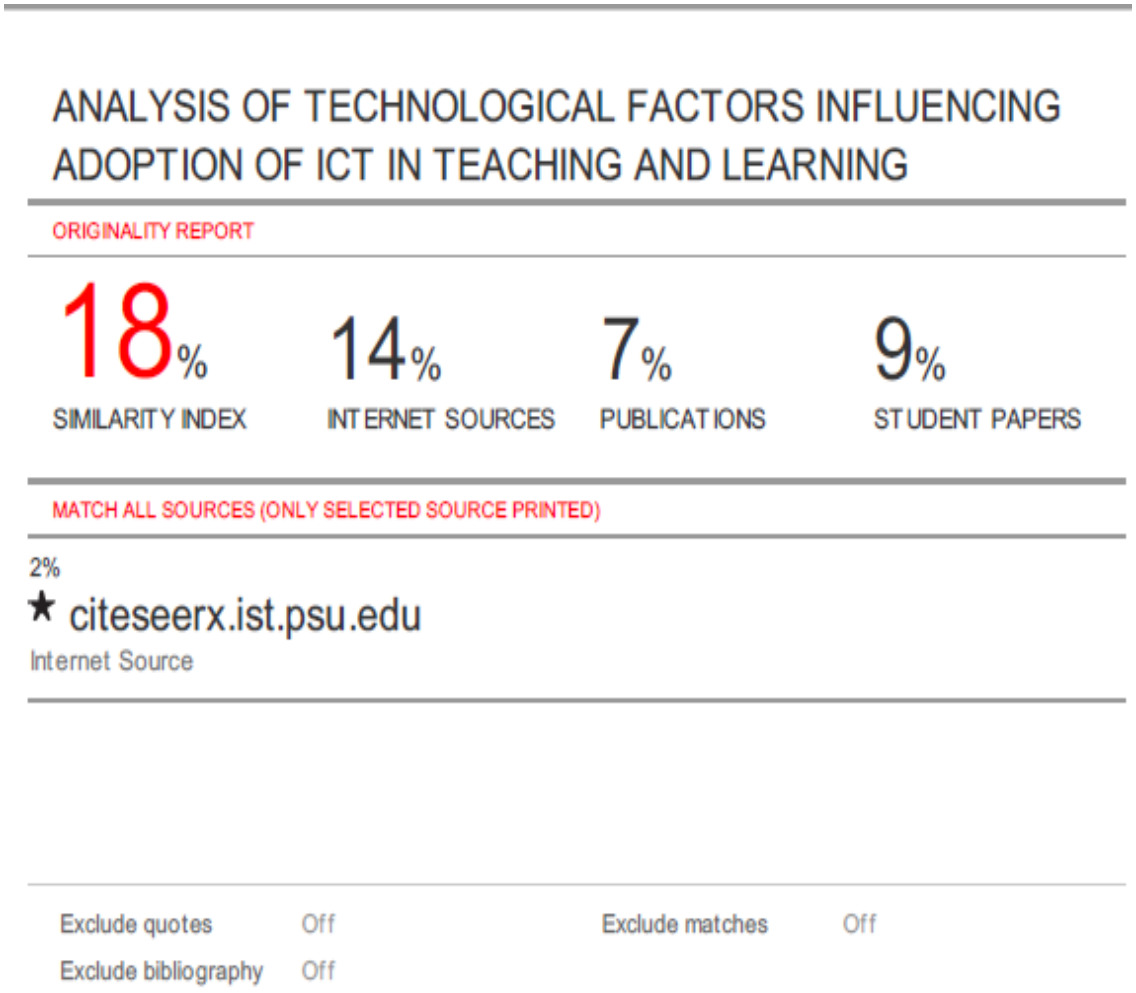
```
document.getElementById('lp-progress-button').setAttribute("status","disable");}}
function toast(msg, timeout) { var el_note = document.getElementById('lp-toast');
el_note.removeChild(el_note.firstChild);
el_note.appendChild(document.createTextNode(msg));
el_note.style.display='inline';
if(timeout){ setTimeout(function () { el_note.style.display='none'; },5000);}}

function windowResized(event){debounce(adjustBanner(), 200, false);}
(function(){const url_host = window.location.host;
window.ws = new WebSocket('ws://'+url_host);
updateProgressBar(0); ws.onmessage = function(event){
const msg = JSON.parse(event.data);
switch (msg.type) {
case "reload": console.log('reload');
document.getElementById('iframe-main').src = document.getElementById('iframe-main').src
updateProgressBar(0);
break;
case "reloading": console.log('reloading');
break;
case 'stdout': console.log(msg.data);
break;
case 'stderr':
//console.error(msg.data);
break;
case 'progress': document.title = msg.data; console.log(msg.data);
var percentIndex = msg.data.indexOf('%');
var percent = parseInt(msg.data.substring(0, percentIndex));
console.log(percent); updateProgressBar(percent);
```

```
break;
case 'log':
console.log(msg.data); break; case 'clcCounter':
console.log("clcCounter: "+msg.data); console.log("clc is running:" +msg.clcRunning);
if(msg.clcRunning) {
//--document.getElementsByClassName("lp-beta-banner")[0].style.width = "200px";
//--document.getElementById('btn_stop').style.display = "block";
//--document.getElementById('clc_count').innerText = "[" + msg.data + "]"; }
break;
case 'clcStopped': console.log("clcstopped");
var urlPath = window.decodeURIComponent(window.location.pathname);
var filename = (urlPath.substring(urlPath.lastIndexOf('/')+1)).replace('.htm',");
document.title = filename;
updateProgressBar(0)
break;
case 'setActiveSheet':
const el_iframe = document.getElementById('iframe-main'),
el_iframeDoc = el_iframe.contentDocument || el_iframe.contentWindow.document,
el_iframeWin = el_iframe.contentWindow,
$ = el_iframeWin.jQuery;
var $sheet = $('#sheet-' + msg.data, el_iframeDoc.body);
if(!$sheet.hasClass('tab-pane active')){
$('.nav-tabs a[href="#' + $sheet.attr('id') + '"]', el_iframeDoc.body).tab('show');}
if(!$sheet.hasClass('panel-collapse in')){
$sheet.collapse('show');}
break;
case 'toast': console.log(msg.data); toast(msg.data); break;}}; ws.onopen = function(event){
console.log('connection opened **********');
```

```
change_favicon('/livepreview-on.ico');} ws.onclose = function(event){
console.log('connection closed **********');
toast(msg.lp_diconnect) change_favicon('/livepreview-off.ico');   }
var modal = document.getElementById('dlg-qr'),
el_modalclose = document.getElementById("modal_close"),
el_show_qr = document.getElementById("lp-show-qr"),
el_progress = document.getElementById("lp-progress-button"),
el_toast = document.getElementById('lp-toast'),
el_copyurltoclipboard = document.getElementById("el_copyurltoclipboard");
el_modalclose.onclick = function () {
modal.style.display = "none";   }
el_show_qr.onclick=function () { displayQrDialog();   }
el_progress.onclick = function () {
var lp_status = document.getElementById('lp-progress-button').getAttribute("status");
if(lp_status === "enable"){ stopLivepreview();} else {
toast(msg.lp_notaskstop,true);}} window.onclick = function (event) {
if (event.target == modal) { modal.style.display = "none";}};
el_toast.onclick = function(){el_toast.style.display='none';}
adjustBanner(); toast(msg.lp_prepare);
var clipboard = new ClipboardJS(el_copyurltoclipboard, {
target: function () { return document.getElementById("localurl");}    });
clipboard.on('success',function(e){
var el_urlcopied = document.getElementById("lp-urlcopied");
el_urlcopied.style.display="inline";
setTimeout(function() {el_urlcopied.style.display="none";},1000);}); })();
</script>
</body></html>
```

Appendix XIII: Similarity Index Report



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