NATIONAL INNOVATION SYSTEM FACTORS, INCENTIVES, CULTURE AND INSTITUTIONAL LINKAGES IN KENYAN ICT INNOVATION FIRMS

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A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR AWARD OF THE DEGREE OF DOCTOR OF PHILOSOPHY IN BUSINESS ADMINISTRATION, SCHOOL OF BUSINESS, UNIVERSITY OF NAIROBI

2019

DECLARATION

This research thesis is my original work and has not been submitted for a degree qualification or examination to any other University or institution of learning.

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DEDICATION

This thesis is dedicated to my dear wife Vivian, lovely sons Ryan and Ethan, Mum Zipporah Wachinga and all my sisters. The inspiration and incredible support you rendered to me during this research study is unspeakable.

ACKNOWLEDGEMENT

I thank God for all now and in the future. I owe Him all and all the time I am aware I cannot thank Him enough.

My appreciation for the contribution of my supervisors Prof. Muranga Njihia and Dr. X.N Iraki into account the rigour and commitment with which they did their work in assisting me finalize this dissertation. Despite his busy schedule, Professor Njihia was always available for consultation and mentored me throughout my study period. Special thanks to Dr. Agnes Wausi for your encouragement and mentorship along this insightful journey. Many thanks to Dr. George Njenga, the Executive Dean of Strathmore University, for mentoring me for half my life. My appreciation also goes to all staff members in the sampled institutions for availing data that made this study a success.

I express my sincere appreciation to my colleagues at the University of Nairobi who I turned to many times when in doubt as to where the journey was heading to and for the interpretation of the many turns and twists only them could clarify.

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ABSTRACT

National Innovation System (NIS) is the set of institutions and their institutional institutional linkages that allow movement of information and technology among organizations and persons which is vital to the innovative undertakings on the national scale. It is based on assumption that encourages interconnectedness among the parties participating in innovation which is necessary for increasing economic growth and technological performance. The study aimed at exploring the understanding of NIS and competitiveness, both at sectoral and national level. The study attempted to address the question: what is the effect of innovation incentives and innovation culture on the relationship between NIS factors on the institutional linkages of the NIS in Kenya. The study was thus set to investigate the influence of innovation incentives and innovation culture on the NIS factors and institutional institutional linkages in Kenyan NIS. Specifically the study was set to establish the effect between NIS factors and institutional linkages in the NIS in Kenya, to investigate the influence of innovation incentives on the relationship between NIS factors and institutional linkages in the NIS in Kenya, to determine the influence of innovation culture on the relationship between NIS factors and institutional linkages in the NIS in Kenya and to determine the joint influence of NIS factors, innovation incentives and innovation culture on institutional linkages in the NIS in Kenya. This research study adopted cross-sectional survey design. The study targeted 112 Kenyan ICT innovation institutions via census whose outcome was 73 institutions responding within the study timeframe. The research study used semi-structured questionnaire with both closed and open-ended questions as well as path analysis with multiple regression analysis. The study established that there exists a positive influence of NIS factors on institutional linkages in the NIS in Kenya. Innovation incentives had a moderating influence on the relationship between NIS factors and institutional linkages in the NIS in Kenya. Innovation culture had an intervening influence on the relationship between NIS factors and institutional linkages in the NIS in Kenya. Also it was found out that there exists joint effects of NIS factors, innovation incentives and innovation culture on the institutional linkages in the NIS in the Kenyan ICT innovation institutions. All the effects of NIS factors, innovation incentives and innovation culture on institutional linkages in the NIS in Kenya were significant. There was presence of reverse causality among the NIS factors and their institutional linkages in NIS in Kenya hence a lot of different results can be extracted based on these variables. The study results indicate that more communication, investment in infrastructure and teamwork has to be focused by these institutions to enhance innovation. Thus NIS factors, innovation incentives and innovation culture are key elements that influence the institutional linkages in the NIS in Kenyan ICT innovation institutions. For more innovation to be realized through NIS, then partnership with other stakeholders should be encouraged in these institutions especially universities that deals mainly with sharing knowledge and not necesarily transmission of skills. Left to itself, the market will produce less innovation and lower productivity based on societal needs. For policy-making in NIS, most focus has been put on practice than theory. The study used a combined theory approach to ascertain the joint effect of the RBV, SNT and DIT theories on institutional linkages in NIS in Kenya. This points out to the need of pairing the theories as opposed to individual focus to better inform the institutional linkages in NIS.

ABBREVIATIONS AND ACRONYMS

ANOVA: Analysis of Variance

ASTII: African Science, Technology and Innovation Indicators

BPO: Business Process Outsourcing

CUE: Commission for University Education

DFID: Department for International Development

DIT: Diffusion of Innovation Theory

FDI: Foreign Direct Investment

GDP: Gross Domestic Product

GII: Global Innovation Index

MoEST Ministry of Education and Science and Technology

MoICT Ministry of Information Communication Technology

NIS: National Innovation System

OECD: Organization for Economic Co-operation and Development

R&D: Research and Development

RBV: Resource Based View

SEM: Structural Equation Modeling

SNT: Social Network Theory

UNCTAD: United Nations Conference on Trade and Development

VIF Variance Inflation Factor

WIPO: World Intellectual Property Organization

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

National Innovation System (NIS) is the set of institutions and their institutional linkages that allow movement of information and technology among organizations and persons which is vital to the innovative undertakings on the national scale (Altenburg, 2013; Koh & Wong, 2014). NIS is based on the assumption that interconnectedness among the parties participating in innovation is necessary for altering economic growth and technological performance. These parties include the people, public research enterprises, private firms and universities (OECD, 2013).

Institutional linkages within national innovation systems are influenced by such factors as interconnectedness, systems to generate, carry and disseminate knowledge and capacity, among others (Murray et al., 2010). Proper incentives including fiscal, monetary and regulatory policy measures strengthen linkage dynamics between institutions, technologies and knowledge generation by connecting economic and non-economic actors (Altenburg, 2013). A culture supporting innovation (termed as a pro-innovation culture) stimulates trust and respect in employees, values collaboration and is illustrated by quick decision-making and search for solutions (Cassiolato et al., 2011).

The study uses three theories, namely: Social Network Theory (SNT), Resource-Based View (RBV) and the Diffusion of Innovation Theory (DIT). As observed by Pearce and Robinson (2007), RBV's fundamental principle is that an organization varies in major aspects since each organization has a "unique" set of tangible and intangible resources as well as skills to utilize those resources. SNT is based on the importance of institutional

linkages among interacting nodes or units. The relations described by institutional linkages among units/nodes are a key component of SNT (Klerkx & Leeuwis, 2013). Diffusion study concentrates on circumstances that escalate or diminish probability that new idea, process or product will be uptaken by constituents of a certain culture (Pijpers et al.,2008). By studying how innovation takes place using DIT, Kumar(2014) concludes that media and personal exchanges affect belief and judgment.

It is widely acknowledged that innovation propels economic growth. It is therefore important to undertake regular and systematic innovation measurements to better understand the dynamics of economic growth (Schramm et al., 2008). Institutionalizing the measurement of innovation provides reliable indicators to inform review of harmful policies and enact innovation-supportive policies. OECD (2005) opines that information requirements of both policymakers and analysts should be considered while coming up with constructs of innovation.

To accurately ascertain impact of innovation on the economy, the government should create a coordinated emphasis on innovation measures that involve the business community and academia. This is because innovation is influenced by a wide array of elements such as those domiciled at the industrial, sectoral, regional and country basis. For instance, at company-level, factors can include R&D and other complementary elements such as intangible assets that can include software, labour and new company structures.

Thus, it is prudent to look past conventional ST&I indicators and take into consideration wider innovation drivers like education, entrepreneurship and access to labour market. Innovation surveys provide evidence on innovation at each level and give knowledge on strategies on innovation, types of innovation and justification for undertaking innovations. Innovation surveys were therefore developed to increase knowledge about innovation at

firm level with a view to developing effective innovation policies. There is thus need to evaluate policy actions for innovation at regional and national levels to gain better undertanding of their relevance in diverse contexts of innovation. Issues to be addressed are for example, where innovation is dominated by business firms versus where innovation is controlled by public firms.

In addition, innovation involves technologies developed through interdisciplinary research and often used across a broad range of industries. On the other hand, interactions across actors, locations, and technologies also need to be tracked as part of the innovation measurement framework. The impact of innovation on socio-economic performance needs to be regularly monitored. Currently, formal innovation is widely measured using innovation surveys based on the guidelines documented in the Oslo Manual (Arunde et al.,2013). The Oslo Manual provides a framework for countries to develop internationally comparable innovation indicators. In Africa, the African Science, Technology and Innovation Indicators (ASTII) initiative of the African Union (AU) adopted the Oslo Manual as a guide for the implementation of innovation surveys. The surveys are therefore designed to measure and provide a breadth of information on the innovation process at each level. They can identify motives and obstacles to innovation, changes in the way firms operate, the kinds of innovation activities that they engage in and the types of innovations they implement. In relation to the innovation process as a system, innovation surveys can provide information on firms' institutional linkages with other actors in the economy and on the methods they use to protect their innovations (Arunde et al.,2013). Specifically, innovation measurement focuses on: Inputs to innovation: role of R&D and non-R&D inputs into the innovation process and how R&D interrelates with other

innovation inputs, institutional linkages and the role of diffusion: technological change and productivity growth, Incentives and obstacles to innovation. The impact of innovation: the effect of innovation on output, productivity and employment at national level and in various sectors. Role of human capital in innovation: knowledge and skills, quality of the education system and how it matches industry needs.

The Kenyan government formulated and adopted Vision 2030 to transform the country into an industrialized and middle-income nation from 2008 to 2030 based on social, economic and political pillars. ST&I is seen as a basis to support the Vision 2030 as well as overall development of the country through various plans and flagship developments. New incentive structure and an ST&I policy will be created to assist in the application of ST&I in universities, research centres and business firms (Kenya Vision 2030, 2015).

Tagged as Africa's 'Silicon Savannah', Kenya's Information Communication and Technology (ICT) sector presents the biggest employment and entrepreneurial growth potential in key subsectors including: Business Process Outsourcing (BPO), mobile telephone application development, internet website design, telecommunications, network administration, mobile-based agriculture support, electronic-procurement and market research (Juma, 2006; Moraa & Gathege, 2013).

1.1.1 National Innovation System Factors

The National Innovation System (NIS) concept first appeared in the mid-1980s in the context debates over industrial policy in Europe. Remarkably, this concept has been rapidly diffused and widely used in both academic circles and policymaking content, both in developed and developing countries.

The term ‘national system of innovation’ (NSI) is used to exhibit a country’s joint initiative towards boosting technological innovation. The term was first used by Freeman, in an unpublished paper that he prepared for the OECD expert group on Science, Technology and Competitiveness in 1982. In the paper, Freeman used the term to emphasise government’s key function in developing a country’s technological infrastructure. Lundvall used the term ten years later to relate the interdependence between technical and institutional change after conducting comprehensive studies of institutions and states in North America and Europe. Thus, Lundvall’s understanding of NSI concept is mainly informed by the uniquenesses of the developed world context, where he undertook his initial studies.

Manzini (2012) avers that the application of the term NIS in context of developing world is a key point for research. Innovation in any nation is best understood as being embedded in a national innovation system (NIS). Atkinson (2014) observes that an innovation system includes all economic, political and other social institutions affecting innovation (e.g. a nation’s financial system, organization of private firms, the pre-university educational system, labour markets, culture, regulatory policies and institutions).

NIS projects the systems methods for the actor entities, innovation process and the knowledge across these systems (Nicholls & Murdock, 2012). NIS consists of all the interconnected actor entities participating in discovering, creating, disseminating and exploiting technology and innovations. Schiller and Leifner (2012) notes that over several decades, NIS has been attaining both academic and practical soundness, having early strong approval by Organization for Economic Co-operation and Development (OECD) and developed nations, and lately being the centre of increased focus as a way to solve significant issues for developing countries.

Research of NIS centres on the key elements of the system, such as private and public firms, and examines their common institutional linkages as well as their interactions with the institutional and social platform in which the system is entrenched. Various studies have been conducted on NIS, both in developing and developed countries to show the development of NIS and the interactions between various actors.

A number of national innovation systems factors can be identified in the literature. According to Mapila et al. (2011), product factors such as the creation of new products, diffusion of products and creation of technological opportunities can affect the institutional linkages in the national innovation system. Mulgan et al. (2011) avers that institutional linkages in NIS can also be influenced by communication factors such as knowledge transfer, information diffusion and stakeholders' engagement; educational factors such as interactive learning, technology and creation of human capital (Schiller & Leifner, 2012).

McDonald (2011) notes that for developed and developing countries, growth in productivity and wealth rely more on a nation’s capacity to create new technological knowledge and to share it into marketable inventions than on the country’s natural resources. Due to the scarcity of natural resources, transformational leaders around the world have embraced this changing process informed by the fact that fact that successful creation of new knowledge will sustain the economic competitiveness of nations (Fier, 2013).

Sustainable competitiveness is a key consideration in enhancing the economic suitability of a nation and value of the life of its residents. Over the years, nations have used various means of achieving sustainable competitiveness while at the same time blocking others with mixed success rates. Those who remain on top commonly have high incidences of innovations.

The measurement and assessment of national innovation systems has centred on four types of knowledge or information flows: interactions among enterprises constituting of primarily joint research activities and other technical collaborations; interactions among enterprises, universities and public research institutes including joint research, co-patenting, co-publications and more informal institutional linkages; diffusion of knowledge and technology to enterprises including industry adoption rates for new technologies and diffusion through machinery and equipment; and personnel mobility focusing on the movement of technical personnel within and between the public and private sectors. Attempts to link these flows to firm performance show that high levels of technical collaboration, technology diffusion and personnel mobility contribute to the improved innovative capacity of enterprises in terms of products, patents and productivity.

The value of innovation has not remained inconspicuous. With developing economies such as sub-Sahara Africa, the topic of innovative economy and NIS is especially current. These nations are aiming at translating into “innovative economies” by breaking their overreliance on raw materials. Today, however, many scholars (Altenburg, 2013; Intarakumnerd, 2013) agree that innovation in the developing world certainly occurs, although its nature and origins are still obscure and misunderstood (Pansera, 2013). Over time, the field has widened and is now cited that innovation encompasses both technical and non-technical attributes and may happen more incrementally, which is particularly relevant in a developing country context where innovation is taking place in broad ways that are often ignored by the mainstream literature because of their unconventional nature (Pansera, 2013).

1.1.2 Innovation Incentives

Brogan et al. (2010) define incentive as any stimuli (monetary or non-monetary) that encourages a certain action or decision. innovation incentives can thus be deemed to as both financial and nonfinancial enablers to the innovative process.

A nation's innovative capability mainly relies on how actors interact amongst themselves as items of a common practice of knowledge generation, application and the technologies they utilize (Nicholls & Murdock, 2012). For example, public research firms, universities and corporates serve as research initiators undertaking research and development tasks. Conversely, governments conduct the role of coordinator among research initiators regarding their visions, perspectives and policy instruments for the future (Klerkx & Leeuwis, 2013). Also, to enhance innovation, different innovative actors must have strong connections with each other leveled against a strong level of trust with governments boosting and activating trust among these actors. The institutional linkages can be in the way of staff exchanges, collaborative research, acquisition of equipment and cross-licensing (Kirkman, 2012). Finally, NIS are defined by unique socio-cultural features of nationwide communities. Therefore, there are national trends of innovativeness, technology flow and learning, that ends up in each country, regardless of the level of development, owning some form of NIS, whether working well or not (Nicholls & Murdock, 2012).

Nations inject incentives such as tariffs, resourcing and subsidies to boost interest in certain invention. These incentives encourage further investment in exploration, exchange of knowledge and growth in innovation which is the process establish a new market for the innovation. To attract additional investment in innovation process, funds and market growth for innovations, research firms and the industry can lobby government for more incentives and change of policy direction towards innovation (Hekkert & Negro, 2009).

There is a need for various actors within national innovation system to be incentivized to promote funding for innovation, engaging in R&D and strengthening collaborative institutional linkages (Mofor et al., 2014). Adekunle et al. (2013) avers that African incentives regimes are not as impactful compared to non-African nations leading to the slow pace of development of technology in the continent. Among others, fiscal and monetary incentives can include tax breaks, subsidized loans, donor funds, government-backed venture capital, favorable regulation and government procurement policy (Bartels & Koria, 2012).

1.1.3 Innovative Culture

Innovation culture can be defined as a multi-faceted construct involving four pillars, namely: intent to innovate, infrastructure to back innovation, the norms vital to shape a market and value direction, and the foundation to undertake innovation (Dobni, 2008). Feinson (2013) on the other hand looks at an innovation culture as a multi-dimensional construct consisting of the goal to be innovative, the infrastructure to back innovation, operational level norms vital to sway a market and value alignment as well as the atmosphere to apply innovation. Innovation culture can be affected by several factors such as strategy, structure, support mechanisms, behavior and open communication (Cozzens & Kaplinsky, 2012). Majid (2011) posits that embedding a culture of innovation is key to ensuring a firm has necessary resources to innovate.

Organisations located in a country develop a culture compatible with their national culture to sustain operations and function effectively. Theorists such as Geert Hofstede and Fons Trompenaars have identified different dimensions that can be used to evaluate differences in national cultures. Often the cultural divide results in great differences that can cause problems for the management of the international organisations. Consequently, a corporate culture can be made to override different values of cultural backgrounds to generate a

unified organisational culture founded on its practices (Werbner, 2011). Values and practices, therefore, exist alongside each other. Needs are determined from attitudes and values formed from the experiences of daily life. By using services and technology, an individual seeks solutions when these needs are not met (Ling et al., 2014). The values and attitudes an individual has and the reaction he or she expects from the larger group play an important role in the innovation process. Naturally, there will be variation in individual needs as well as in individual teams and organisational behaviour within any given national culture.

Gilford et al. (2014) theory of reasoned action explains a procedure for how culture can influence individual behaviour. The theory states that attitudes lead to the intention to perform certain behaviour which eventually leads to actual behaviour. This subjective intention to perform arises from a perceived social support for certain behaviour as well as the expectations or approval of certain behaviour. In this way, therefore, culture can influence actual behaviour through attitudes and subjective norms.

In terms of the institutional linkages of Kenyan ICT innovation institutions, culture may provide important barriers for its use by inhibiting individual innovation. From this we can, therefore, hypothesize that cultural factors may be able to explain the differences in the adoption rate of institutional linkages of Kenyan Innovation institutions between organisations. Among the many theories and models proposed, Rimal et al. (2015) suggests three approaches to underpin a successful institutional linkages of Kenyan Innovation institutions, namely: “the adoption approach, the domestication approach and the diffusion approach”. This kind of finding can help the service provider when trying to implement a new innovation in a new locality, organisation or entity.

A nation's culture is a major component in advancing its innovative power. According to Dunphy and Herbig (2014), 30% to 50% of a society's innovative ability is affected by the national culture. Innovation and creativity are being fronted as basic drivers of productivity, wellbeing and economic advancement (Panfilo, 2010). Many scholars perceive the function of innovation as vital to the economic advancement (Kusiak, 2014; Panfilo, 2010). Lundvall et al. (2013) avers that innovation culture is key in economic development, enhancement of sustainable competitiveness and boosting the value of life. Alemdar (2014) concurs that innovation gives important basis by which global economies participate in the international arena. While describing the value of innovation, Mulgan (2012) avers even further that "innovation-machine" is the centre of capitalism. For this study, innovation culture was operationalized through organizational learning, customer focus, empowerment and team orientation. This concurs with earlier work by Dobni (2008) who measured innovation culture quantitively using seven dimensions, namely: organizational learning; organizational constituency; implementation perspective; market orientation; creativity and empowerment; innovation propensity and value orientation.

1.1.4 Institutional linkages in National Innovation Systems

An innovation system is a web of actors and firms that are connected by a shared premise aimed at creating innovative skills, approaches and types of a firm for uptake by the knowledge consumers to solve known challenges (World Bank, 2016). Fagerberg and Sapprasert (2011) note that an innovation system is regulated by the current firms and rules affecting the actors' performance and laws on the advanced technologies. National innovation systems are therefore exploratory frameworks aimed at solving economic development challenges (Cozzens & Kaplinsky, 2012).

Institutional linkages can be in the form of joint research, personnel exchanges, cross patenting, and purchase of equipment (OECD, 2017). Most NIS scholars focussed on institutional linkages between three main actors: universities, government and inventive firms. In an NIS, shared knowledge between knowledge generators and end-users assume a key part. According to McDonald (2011), these institutional linkages can either be strong or weak. As such, in the present study, the information pertinent to institutional linkages will be sourced from innovation -based government ministries and parastatals, public research institutes, academia and industry.

The role and importance of institutional linkages in the science and innovation system emerges in the context of the global knowledge economy. The growth in the knowledge intensity of all goods and services and business processes, and the commodification of knowledge itself, has placed a premium on generating, accessing and extracting economic value from knowledge.

Globalisation of trade, finance and competition has made the need to access this knowledge more urgent, technically easier, but as a result of this competition, more challenging. One consequence is that innovation is becoming increasingly distributed, and in this way more complex (Gupta, 2015). As a result, organisations are adopting many of the well-established practices of the scientific community, such as identifying important new knowledge and finding more about it through direct contact, based on an accepted canon of knowledge sharing. Firms search for institutional linkages to access knowledge from outside organisations and networks, be they other firms, universities or research institutions, with the intent of extracting economic value from it.

Innovation is thus the result of numerous interactions by a community of actors and institutions, which together form national innovation systems. Essentially they consist of the flows and relationships which exist among industry, government and academia in the development of science and technology. The interactions within this system influence the innovative performance of firms and economies (OECD, 2017). One consequence is to place considerable emphasis on knowledge management, both within and outside organisations, be they private or public. Ability in acquiring, assimilating, sharing and creating knowledge is the ultimate organisational capability, a meta-competence which allows an organisation to consistently outperform its rivals (OECD, 2017).

A related consequence, important from both a business development and a policy perspective, is that the performance of an innovation system now depends crucially on the intensity and effectiveness of the interactions between knowledge generators and knowledge users. This emphasis on institutional linkages is not just 'business as usual'. That is, that oft-repeated objective of getting a better return on all the public funds invested in research in the universities and government research agencies through more effective commercialisation. Rather, the emphasis is on the establishment of mechanisms that can most effectively shape knowledge production to align with economic objectives, and can provide the commercial sector with relevant knowledge, where, how and when required. The latter has been referred to as the 'knowledge distribution power' of a science and innovation system.

Therefore, institutional linkages in an NIS are not simply transactions that mirror a clear-cut division of labour in the production of knowledge. They represent an institutionalised form of learning that provides a specific contribution to the stock of economically useful knowledge. They act not only as knowledge transfer mechanisms but also in other capacities such as building networks of innovative agents or increasing the scope of multidisciplinary experiments (OECD, 2017).

There is an emphasis on institutional linkages in NIS in the current analysis and policy literature, also treated under the labels of networks, interaction, and collaboration and to some extent clusters. (Romero et al., 2017) aver that in the context of mapping, the focus is on identifying and counting relationships (for instance, the number of business-university institutional linkages or agreements); identifying resources crossing organisational boundaries (such as university R&D funded by business and students employed by industry); and in some cases identifying measurable outputs (such as the number of co-publications, patents and licenses).

Just like on a roadmap, the implicit assumption is that all roads are equal, and that the more roads established between points, the better the outcome. No consideration is given, among other things, to the state of the roads (i.e. how fast traffic can move), the volume of traffic they carry, their carrying capacity, and whether some roads are used to carry more or less valuable goods. Indeed, the metaphor itself may be quite inadequate. The components and the processes within the science and innovation system are so heterogeneous that a very different model may be more appropriate (Johnston et al., 2013).

The complex and multi-dimensional nature of interaction between various components and processes in an innovation system (Johnston et al., 2013) inform basics of institutional linkages in a system of scientific innovation. For many of these components, there is little or no data available. For some, they may be so abstract that they are unlikely ever to be directly measurable. Nevertheless some attempts have been made to go beyond the simple counting of institutional linkages, resource flows and bibliometric outputs. These include: mapping of knowledge flows embodied in capital equipment, publications and human mobility, analyses of private and social returns from investment in knowledge generation and application through R&D as well as measurement of knowledge networks through innovation surveys (OCED, 2016).

1.1.5 Innovation Institutions in Kenya

Innovation takes place as a result of institutional linkages among various actors in the innovation system and is not limited to a single actor (OCED, 2012). The main components of the National Innovation System in Kenya include demand for ST&I, education and research system, the business system and intermediate organizations (Jowi & Obamba, 2013; Republic of Kenya, 2012). With leading technologies especially in the financial services such as MPESA and several technology hubs and incubation centers, Kenya is currently enjoying an ICT boom (Moraa & Gathege, 2013), which is steering economic growth across multiple industrial sectors. ICT sector in Kenya contributes up to 5% to GDP towards the growth and advancement of the country (Fiscal Year 2011-2012) which was among the factors contributing to rebasing the country's economy in 2014. As noted by World Bank (2015), the same sector recorded improvement by contributing an average of 3.7% to the GDP. This growth is due to robust telecommunications infrastructure, rise of innovations hubs and high capacity international gateways.

The Science, Technology and Innovation (ST&I) Act was adopted in 2013 with the aim of re-orienting ST&I programs to market needs and national objectives as well as make the ST&I bodies more impactful and supportful to the national system of innovation (Lacave & Vullings, 2014). Earlier, Ministry of Higher Education Science and Technology (MoeST) was founded in 2009 by the National Government under the Office of the President with the aim of funding, formulating policy and planning of the ST&I sector. In 2004, the government set up the Ministry of Information Communications, and Technology (MoICT) with the aim of formulation, administration and management of Information, Broadcasting and Communication policies (Republic of Kenya, 2013).

Universities and academic entities are key indicators of systems of innovation in ensuing advances in ST&I as well as the adoption of knowledge. Also, the shift from an agrarian economy in Kenya needs value addition and application of innovation to enhance value chain interconnectedness (Cozzens & Kaplinsky, 2012; Bartels & Koria, 2012). Development activities of various universities in Kenya are coordinated via University Division that falls under Ministry of Education Science and Technology (MoEst). However, the Commission for University Education (CUE) offers quality control on higher education which includes, among other institutions, the universities (Republic of Kenya, 2013a). The number of universities has seen gone up to 71 registered by Commission of University Education for the year 2016. Universities are charged with assisting the country to attain its development objectives via knowledge generation, research and innovation (Commission of University Education, 2013).

Within an efficient National Systems of Innovation (NIS) framework, innovation does not occur in isolation but collectively through interaction between various government agencies, universities, research institutes, innovation hubs and other actors. The Ministry of Education, Science and Technology is responsible for national policies and programmes that help Kenyans access quality and affordable, school education, post-school, higher education and academic research.

1.2 Research Problem

Whereas it is agreed that an effective innovation system is needed for a nation to strengthen capability provided by latest science and technology, previous studies have explored the underpinning concepts, that is innovation system factors (Feinson, 2013; Fagerberg & Sapprasert, 2011;), incentives (Cassiolato & Lastres, 2011; Durongkaveroj,

2010), culture (House et al. 2012;) and institutional linkages (Cozzens & Kaplinsky, 2012; Bartels & Koria, 2012) separately. This study sought to determine any interrelationship that exists among the foregoing concepts and how the same translates into an effective NIS.

Traditional National Innovation Systems were majorly guided by independent theories such as orthodox economic theory that deals with technical changes in innovation (Dosi et al, 1988), Resource Based View (RBV) that gave insight to individual firms unique set of resources that enabled innovation for competitive advantage (Pearce & Robinson, 2013) at organization-level as well Social Network Theory (SNT) that examined the interconnectedness of various actors within various nodes of the innovation systems (RIPC,2014). For policy-making, more emphasis has been given to practice than theory (Sharif, 2016). For instance, the OECD member countries are less interested in theory behind national innovation systems than are the academics (Lacave & Vullings, 2014). In addition, there exists scanty documentation on how a combination of more than one theory informs institutional linkages of NIS. This study used a combined theory approach to national innovation systems based on RBV, SNT and DIT.

Kenya's current system of innovation lacks synchronization among the actors, is linear and disjointed, has weak connections between academia, industry and government; the academic curricula and graduate skill sets are not well-aligned to industrial demands and, has insufficient funding and support for innovations (Moraa & Gathege, 2013). In addition, DFID in 2014 observed that the National Innovation Policy in Kenya is fragmented and the linkage between ministries and government agencies is weak (Lacave & Vullings, 2014).

This has occasioned the country with challenges in the diffusion of innovations as outlined in Government of Kenya in Sessional Paper of 2012. DFID (2014) identified the country's need for improved institutional linkages between the industry and intermediate firms that develop and transmit knowledge. This contrasts with South Korean NIS, that according to Feinson (2003) and Shulin (1999) exhibits active learning, controlled foreign direct investment (FDI), heavy investment in human resources, promotes exports as well as uptake of R&D. This study assessed how the interrelationships among various NIS factors, incentives and culture present opportunities for institutional linkages in the country for NIS.

A vast majority of related studies have taken qualitative desktop review designs, which have been largely inadequate as they have failed to get first-hand perspectives from stakeholders within the NIS on pertinent variables underpinning the present study. For instance, Kerlin (2013) uses qualitative case study evidence to suggest that national-level institutional variables in the United States (that is, innovative culture, economy type and governance) determine the occurrence (that is, size) and characteristics (that is, shape) of social enterprise organizations within a country. While undertaking comparative meta-analysis of innovation systems in China, Kirkman (2012) endorsed five key activities of NIS as the basis of a framework that can be viewed as “nation-specific”. These include: linkage, research, implementation, education and end-use. In another comparative meta-analysis of National Innovation Systems between OECD and developing countries, Fagerberg and Sapprasert (2011) found that the NIS-approach gives a practical outlook of development processes as it perceives innovation efforts as closely connected to wider macroeconomic and academic policies.

Further, what this study set to address is that Kenyan literature on the same is scanty, presenting a knowledge gap that the study intended to fill. This may be due to inadequate cooperation between Kenyan universities and the industry (Gechaga et al., 2005). Critical issues such as national innovation system factors, incentives, innovative culture and NIS institutional linkages, have largely been explored in developed economies and for the developing economies, only countries outside of Africa have been studied. Literature on the same is thus scanty, in Sub-Sahara Africa and Kenya in particular. For instance, in Finland, Haukka (2005) argues that largely attributed to government support of networking as an NIS management, the linkage between science and industry is so advanced that in the mid-1990, 40% of all innovative organizations stated that they collaborated with public research firms or universities.

In a study to measure innovation incentives in catching-up-economies with reference to Thailand, Intarakumnerd (2013) found that nations impact innovation process by funding and coordinating public enterprises that are linked to creation and dissemination of knowledge as well as by availing to all actors in innovation system with both fiscal and regulatory incentives. From their research on the transforming role of technology in the fiscal policy of Singapore, Koh and Wong (2014) conclude that technological innovation process is enhanced with the interaction of public and private institutions and the coordination of relevant policies, incentives, and initiatives. This augments earlier studies by Hekkert and Negro (2009) on the effect of goverment funding on clean energy technology in Germany. Effective performance was recorded when government intervened by offering better resources, subsidies and tarriffs pointing out to the need for nations in injecting incentives to attract additional investment in innovation, boost exchange of

knowledge and establishment of newer markets for innovation. These observations present a gap in literature that the present study endeavors to address. To this end, this study attempted to address the question: what is the effect of innovation incentives and innovation culture on the relationship between NIS factors and the institutional linkages of the NIS in Kenya.

1.3 Objectives of the Study

The general objective of this research was to investigate the influence of innovation incentives and innovation culture on the influence of NIS factors on institutional linkages between various actors within the Kenyan NIS.

The specific objectives were to:

i. Establish the effect between NIS factors and institutional linkages in the NIS in Kenya.
ii. Investigate the influence of innovation incentives on the relationship between NIS factors and institutional linkages in the NIS in Kenya.
iii. Determine the influence of innovation culture on the relationship between NIS factors and institutional linkages in the NIS in Kenya.
iv. Determine the joint effect of NIS factors, innovation incentives and innovation culture on the institutional linkages in NIS in Kenya.
v. Establish the reverse causality effect amongst NIS factors and institutional linkages in the NIS in Kenya.

1.4 Value of the Study

The study will be useful to both researchers and scholars since it will enable them to add to their understanding of NIS and competitiveness, at national and sectoral levels. This study will also inform future research on NIS concept. Learning institutions will know their contribution to the NIS and any inadequacies in skills and competencies needed in the ICT sector. This would also encourage these institutions to align their curriculum to the sectoral needs since universities are broadly recognized as vital institutional players in NIS as noted by Cozzens and Kaplinsky (2012). Further, universities undertake commercial activities such as selling knowledge and developing enterprises even as organizations assume intellectual approaches, distributing knowledge among themselves and learning at high level of skills. In modern "knowledge-based" economies and industrialized nations, universities provide "knowledge workers" and ensure flow of ideas via increased applied research undertakings (Abidin et al., 2012).

In addition, the research was expected to be of value to the policy makers, for instance, the Ministry of ICT in the formulation of better policies to address the shortfalls identified in the NIS in Kenya. The government will also identify the weak actors and give the essential support and incentives. Government policies on technology have been centered on incentifying or assisting R&D expenditure by the industry via channels such as R&D tax credits, direct funding and essential subsidies. New kinds of policies are required to solve systemic failures, especially policies geared towards connecting and enhancing absorptive capacities of organizations. Generally, these policies are geared towards enhancing innovation networks and designing these flows, institutional connectedness and relationships efficiently. As highlighted by OECD (2012), these policies should concentrate on improving the skills of each organization and boosting the relationships as well as innovative works of clusters of organizations and sectors.

Innovation hubs, clusters and innovations companies will gain from the study since they will know their role to the Kenyan NIS and its competitiveness. This may enlighten and encourage them to formulate strategies that may enhance growth and competitiveness of the sector. This research study may also have implications to ICT innovators who may wish to design innovative solutions that are easy to adopt regardless of the existing culture in an organisation.

1.5 Ethical Considerations

Before the start of the research, participants were notified of their right to choose to participate in the survey. The importance of participation in this study was also emphasised and participants were informed about how their responses were to supplement the outcome of the research study. Some participants were fearful of disclosing information due to the uncertainty of possible consequences. Reassurance was made that data received would be treated with maximum privacy and that the identity of all participants was to be kept secret or disguised with using pseudonyms.

1.6 Organisation of the thesis

This study thesis has five chapters. First chapter introduces the research by giving the primary background, context, objectives and value of the study. The chapter also highlights conceptual analysis and direction of the study.

Second chapter reviews and evaluates the existing literature in the area of NIS factors, innovation incentives, innovation culture and institutional linkages of Kenyan ICT innovation institutions as well as the selected literature supporting the study concepts. The chapter also discusses theories informing the study, selected research study gaps, conceptual model and the research hypotheses.

Chapter three of the thesis details the research methodology employed in the research delving into the study's research philosophy, research design, population, sampling and data collection methods. The chapter also discussed operationalization of the study variables and techniques used in analyzing the data gathered in the field to address the study objectives.

Chapter four delves on preliminary observations of the research study. This includes the study responses rate, the tests for normality, Reliability, validity and multicollinearity as well the results on each of the study variables. The chapter also highlights test for all hypotheses aimed at confirming the study objectives. Further, discussions on the outcomes of these tests together with theoretical and past empirical studies are also conducted. This chapter concludes with a newly proposed conceptual framework informed by the outcomes of the study.

Chapter five gives summary and suppositions of the research as well as the theoretical, policy and practical inferences of the study. Limitations of the study and suggestions for further studies are also highlighted in this chapter.

1.7 Summary of Chapter One

This introductory chapter provided context of the research study by offering brief discussion of the study constructs. These include NIS factors, innovation incentives, innovation culture and institutional linkages in the NIS in Kenya. Kenyan contextual aspect of the study is also discussed. The research gaps that the research study intended to bridge were elaborated upon conceptually, contextually and methodologically. The main objective of this research was to investigate the influence of innovation incentives and

innovation culture on the NIS factors on institutional linkages between various actors within the Kenyan NIS. This was established together with five specific research objectives that informed formulation of the study hypotheses in chapter two. The chapter also discussed the value of the study in its contribution to theory, policy and managerial practice of National Innovation Systems as well as the ethical considerations guiding the study and outline of this thesis. The review of the literature on the conceptual, theoretical and empirical aspects of the study based in hypothesized relationships among and between variables were presented in the following chapter.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter discusses theoretical review where concepts guiding the research study are being discussed. Chapter also highlights other authors works and findings under the empirical review section which is followed by critique of the existing literature relevant to the study. The chapter ends with the identified study gaps that were addressed in the research and conceptual framework explaining the relationship amongst study variables.

2.2 Theoretical Review

This part of the study delves into the theories that guided the research study. They include: Resource Based View Theory, Social Network Theory and Diffusion of Innovation Theory. It also presents the key principles of the theories, their relevance to the study and a detailed critique of the theories.

2.2.1 Resource-Based View (RBV)

RBV is a method of evaluating and detecting company's tactical gains focused on assessing its distinct combination of resources, intangibles, competencies and abilities.

It is widely perceived that RBV theory, also called Resource Based Theory (RBT) and Resource-Advantage Theory(RAT), was founded by Birge Wenefeldt in 1984. However, the principles of the theory may have been in existence for decades. Mahoney (2015) observes that some researchers identified knowledge with resource-based perspective as early as 1930s with Barney being significantly impacted by Wernerfelt's earlier studies that initiated the notion of resource position hurdles being slightly similar to entry hurdles in

the positioning school of 1980s. In addition, 1959 book of Theory of Growth of the Firm by Edith Penrose is perceived by some researchers of strategy to contain many concepts that influence modern RBV, though this is at times debatable (Naumanen & Hymen, 2015). It was in 1990s when RBV became central in strategic planning. RBV responded to the gap in the positioning school that revolved around managerial attention on exterior concerns such as the structure of the industry. RBV argued that sustainable advantage is derived from doing things in a superior manner supported by developing superior capabilities and resources (Priem et al.,2014). On the other hand, some scholars perceive RBV as a totally new approach although with basis in Ricardian and Penrosian economic theories. In this school of thought, companies can attain sustainable supranormal profits on condition that they have exceptional resources that are safeguarded by totally excluding them from being accessed by any other player in the respective industry (Lewis et al., 2012).

Pearce and Robinson (2012) notes that RBV's basic principle is that a firm varies in major tactics since individual organizations own a "unique" set of tangible and intangible resources and corporate skills to apply those resources. Individual enterprises create aptitudes from these assets, that when utilized, result into a firm's competitive gain. According to Su et al. (2014), the distinct abilities cannot be acquisitioned but must be developed over time. When mixed with outside relationships, these inner competencies may be viewed as an adaptable system of innovation. The capabilities may include strategies, structures, and business models that encourage innovation and economic growth, particularly in these times of high market and technological turbulence. In linkage

to the present study, it is argued that government, research institution and industry-level capabilities all play a role in effective innovation and economic development. A national innovation system may therefore be effectively developed within a country's own resources which may include physical, fiscal, human and corporate resources.

RBV is an interdisciplinary method that denotes a significant paradigm shift in thinking (Fahy et al., 2011). The theory was developed within the principles of economics, ethics, law, management, marketing, supply chain management and general business (Hunt et al., 2013). RBV centres around firm's internal resources as a way of managing processes and attaining competitive gain. Barney(2013) avers that for resources to hold potential as sources of sustainable competitive advantage, they should be valuable, rare, imperfectly imitable and not substitutable (now generally known as VRIN criteria). This is further supported by Priem et al. (2011) who avers that RBV suggests that firms must develop distinct, company-specific core-competencies that will enable them to outdo rivals by doing things uniquely. This view is furthered by Ross (2011) who notes that although the literature denotes diverse aspects of the resource-advantage perspective, the common notion is that the enterprise's resources are fiscal, legal, human, corporate, informational and relational. And that resources are heterogeneous and imperfectly mobile as well as management's key task being understanding and organizing resources for sustainable competitive gain.

Fahy et al.(2012) opines that attaining sustainable competitive advantage is anchored in most of the literature in strategic management and strategic marketing disciplines. RBV thus gives strategists a way of examining potential resources necessary for competitive edge although not all resources are of equal importance, nor possess the potential to

become a single source of sustainable competitive advantage. As Barney (2013) opines, the sustainability of any competitive gain depends on the extent to which resources can be imitated or substituted. Barney et al. (2013) point out that understanding the causal relationship between the sources of advantage and successful strategies can be very difficult in practice. Thus, a great deal of managerial effort must be invested in identifying, understanding and classifying core competencies. In addition, management must invest in organisational learning to develop, nurture and retain key resources and competencies.

In the resource-based view, strategists select the strategy or competitive position that best exploits the internal resources and capabilities relative to external opportunities. Given that strategic resources represent a complex network of inter-related assets and capabilities, organisations can adopt many possible competitive positions.

Although scholars debate the precise categories of competitive positions that are used, there is general agreement, within the literature, that the resource-based view is much more flexible than Porter's prescriptive approach to strategy formulation (Hooley et al., 2017).

Firms in possession of a resource, or mix of resources that are rare among competitors, are said to have a comparative advantage. This comparative advantage enables firms to produce goods and services that are either perceived as having superior value or can be produced at lower costs. Therefore, a comparative advantage in resources can lead to a competitive advantage in market position (Lev, 2011). In the RBV, proponents choose the strategy or competitive position that best exploits the internal resources and capabilities relative to external opportunities. Given that strategic resources represent a complex network of inter-related assets and capabilities, firms can adopt many possible competitive positions. Hooley et al.(2017) suggests six types of competitive positions, namely:

innovation positioning, price positioning, quality positioning, benefit positioning, service positioning and tailored positioning. In addition, RBV portends gains in formulating conditions such as value, inimitability, non-substitutability and uniqueness (Grant, 2010). Resources that possess these qualities would strengthen the institutional linkages in NIS in the Kenya.

2.2.1.1 Critique of Resource-Based View (RBV)

The resource-based view (RBV) of the firm has been around for decades during which time it has been both widely taken up and also subjected to considerable criticism. The theory reviews and assesses the principal critiques evident in the literature, arguing that they fall into eight categories. They conclude that the RBV's core message can withstand criticism from five of these quite well provided the RBV's variables, boundaries, and applicability are adequately specified. Three critiques that cannot be readily dismissed call for further theorizing and research. They arise from the indeterminate nature of two of the RBV's basic concepts for resource and value and the narrow conceptualization of a firm's competitive advantage. As their suggestions for this work indicate, the theory feel the RBV community has clung onto an inappropriately narrow neoclassical economic rationality, thereby diminishing its opportunities for progress especially during innovations. Hence RBV theory needs to be developed into a more viable theory of competitive advantage, especially if it is shifted into an openly dynamic framework. This theory has the following limitations as far as this study is concerned. To begin with, the RBV theory is based on the incapacity to do an empirical study on measuring the performance of a firm. Because of the heterogeneity of firms, composing a homogeneous sample is hard or even impossible (Locket et. al, 2001). Secondly, the RBV is focused on

the internal organization of a firm and it does not consider the external factors like the demand side of the market. This means that even if a firm has the resources and the capabilities to gain a competitive advantage, it might be that there is no demand, because the model does not consider the "customer".

Also the Resource-Based View theory has a limited ability to make reliable predictive innovations (Priem & Butler, 2012). However, Tywoniak (2016) states that "the usefulness of RBV appears to be greater in terms of generating understanding and providing a structure for strategizing." Barney (2013) states "resource-based logic can help managers more completely understand the kinds of resources that help generate sustained strategic advantages, help them use this understanding to evaluate the full range of resources their firm may possess, and then exploit those resources that have the potential to generate sustained strategic advantage. The three main problems of RBV are the Tautology Problem in the verification of resources, the Value Conundrum and the absence of a chain of causality which relate to the RBV's and VRIO (Value, Rarity, Imitability, Organization) failure to offer sufficient conceptual backdrop for pointing out unique resources. The theory also has other fundamental weaknesses such as The Uniqueness Dilemma, the Cognitive Impossibility Dilemma, and an Asymmetry in Assumptions about resource factor markets that lead to inability of the VRIO framework to assist in identification of resources that can be sources of sustained competitive advantage. The VRIO principle is argued to result directly in the Epistemological Impossibility Problem that precludes use of the scientific method in RBV research (Sanchez, 2011).

While conducting research on income generated from an alliance of firms, Lavie (2006) noted that RBV fails to give accurate status of the performance of a firm due to its underfocus on the cost of attainment of its resources. He posits that the nature of resources in interconnected environs is even more important than their uniqueness, inimitability and immobility. This is especially in cases where there is movement of resources between interlinked actors in a business environment. Increasing number of players in a ccomplex mesh of business partners can increase cost of managing the networks which can in turn derail the targeted intrisic value from the resource exchanges (Burt, 1992). Lavie (2006) further notes that RBV cannot work in isolation and needs to be enhanced by fusing it with social network theory that guides the exchanges of resources between firms. Further, RBV's core assumptions should be enhanced by ascertaining constructs such as relative absoptive capacity, opportunistic behavour and barganing power (Inkpen & Beamish, 1997; Lane et al., 2001; Parkhe, 1993) that may also significantly influence performance of firm beyond the competitiveness gained from its unique resources.

2.2.2 Social Network Theory (SNT)

Borgatti and Halgin (2011) cites increasing application of the social networks for research purposes in diverse fields. Key to this study is the use of social networks in organizational studies as a way of gaining indepth into performance of firms, teams and individuals as well as in optimization of firm-wide innovation, inter-company exchanges, reward system and ethical practices as noted by Borgatti and Foster (2003), Brass et al.(2004) and, Kilduff and Brass (2010).

SNT interprets social interactions in terms of nodes and links. Nodes are the specific actors within the networks while links are the connections between the individual actors. Social network is a diagram of all relevant connections between the nodes being studied. The network can also be applied to establish the social capital of specific actors. These notions are often shown in a social network illustration, where nodes are the dots and links are the lines (Borgatti et al., 2012).

The power of SNT comes from its variance from conventional sociological studies, which presuppose that it is the qualities of specific actors that count. SNT creates an alternate view, where the qualities of entities are less significant than their interactions with other actors on the web. This method has been useful for interpreting many real-world phenomena, but gives little attention single agency, the ability for persons to determine their success which relies heavily on the structure of their network (Burkhardt, 2013).

Kadushin (2014) opines that SNT is a concept of social science that denotes the relationships in a social structure. This view is further supported by Brass (2015) who indicate that a social network is a set of nodes or actors are connected by a set of social relationships, ties or a specified type of ties. A "network" is general term applied for structure of ties amongst actors in a social system (Nohria & Eccles, 2011) where actors could be individuals, roles, firms, industries, or even countries. Their linkages may be founded on exchanges of personal information or economic assets, mutual friendship, relationship, authority or anything else that informs the nature in the interaction. In a network, flows between objects, actors and exchanges, can lead to strong ties (Kadushin, 2014).

To benefit from a social network, entrepreneurs resort to network relationships. Benghozi et al. (2015) observes that the use of SNT in entrepreneurship started in the 1980s. Their study concludes that entrepreneurs used their own informal business and personal networks to establish new firms. For example, social network contacts are the most needed by new and small businesses to overcome their difficulties in getting suppliers and customers in formative stages of their businesses. This is further endorsed by Audrestech et al. (2016) who defines network relationship as an approach that centres around generating and sustaining a permanent connection amongst entrepreneurs and their social network.

Strong ties can be defined as the interaction amongst a person, his kinship and acquaintances (Layden et al., 2015). Exchanges with strong linkages offers such an individual improved interaction with others. Strong ties reflect some key characteristics between the parties of the relationship, such as frequent interaction, extended history, intimacy and sharing, reciprocity in exchanges that allow for mutual confiding and trust-based interactions. Strong ties facilitate the flow of richer, detailed, redundant information and knowledge resources between individuals and their respective groups. In contrast, the weak ties offer a satisfying approach to the study of integration in networks of face-to-face interaction consisting of multiple sub-groups (Noah, 1980). In many cases, weak ties have a special role in a person's opportunity for mobility; there is a structural tendency for those to whom one is only weakly tied to have better access to job information one does not already have (Layden et al., 2015).

Weak ties refer to acquaintances and friends who, as compared to close friends, are more likely to move in different circles than one himself. Layden et al. (2015) argue that weak ties are crucial whenever information is diffused through social interaction because these ties provide bridges between densely knit clusters of social structure.

Further, it is now virtually undisputed in the entrepreneurship literature that culture bears a profound impact on all facets of entrepreneurship in societies. Culture refers to a set of shared values and beliefs (Nepelski & Piroli, 2016). Particularly relevant in this regard are cultural values that emphasize change or certain time-preferences. It is therefore possible for Chinese and other entrepreneurs coming from Confucian-influenced societies to succeed in a highly collectivist environment while drawing legitimacy for their conduct from a cultural emphasis on active change (Nepelski et al., 2016). Entrepreneurs often seek outside resource providers who share a common cultural bond. These cultural bonds are a major step towards building shared systems of fealty and honest business conduct. Salaff et al. (2013) note that ethnic entrepreneurs need to develop socially meaningful relationships with the ethnic community inorder to start a business.

To start a business, ethnic entrepreneurs draw on co-ethnics to help them and to activate their networks for them to access social capital and shared cultural indicators including language and religion. Entrepreneurs from the same ethnic group will get easier access to business networks in the enclave than outsiders. They will be in an advantageous position to exploit ethnic networks. Those that are established in ethnic networks can do best.

Trust can be defined as the willingness of a party to be vulnerable to the actions of another party based on the expectation that the other will perform a particular action important to the trustee and irrespective of the ability of the trustee to monitor or control that other party (Roy et al., 2017). Thus, trust becomes important because the transaction is embedded in a personal relation and structure that generates trust and discourages malfeasance. Social relations are therefore mainly responsible for the production of trust in economic life (Layden et al., 2015). The trust develops dependability in a network of personal relationship because of the transaction that occurs (Welter & Kautonen, 2015).

The actor will be more confident as best as they can from the existing relationship that has been built. At this time, whenever the actor wants to do business again, he does not need to read the legalistic contract clauses again. To maintain the trust, the actor needs to develop it by long-term interdependent role relationship and sacrifice new occupants for these roles. Layden et al.(2015) observes that trust arises in a social interaction, and social norms give meaning and dependability to exchanges. Process-based trust is rooted in reciprocity of social ties, characteristic-based trust is built on social similarity, and institutional-based trust comes from the individual's confidence in the institutional environment (Baharain, 2014).

2.2.2.1 Critique of Social Network Theory (SNT)

Although SNT has been in existence for decades, various researchers have picked areas that need to be improved on the design and application of the theory.

Mejias (2006) avers that the design of the Social Network Theory lays little focus on the space between nodes. Actually, nodes only recognize other nodes within the network and only in moneterized interactions. This implies that the space between is ignored resulting into a *black box* where the internodal space is discrimated against and distance between actors becomes irrelevant (Wellman, 2002). Thus, the networks are nodocentric contrary to the unselfish commitments of actors ideal for sustainability of the network. As such, the networks destroy the closely-knit society and promote scattered communities via what Wellman (2002) calls "Glocalized"networks. The social fabric based on proximity and common culture of actors within a certain location has been replaced by preference of connecting to distant communities through technology. That is, the "far" is more preferable than the "near" with the "near" drifting to oblivion. This has resulted in Networked Individualism in attempt to bridge the physical gap between network nodes (Mejias, 2005).

Vandenberghe (2002) observes that the realization of social interactions in networks via technological automations have eroded the social wealth and reduced to relationships to self-interests based on economic interchanges. Little difference between humans and non-humans exists in interactions within the modern networks. In other words, the social networks have lost the human touch in their intermodal exchanges which are mainly driven by expectations of own financial gains (Mejias, 2006). This has led Vandenberghe (2002) to state that "the economy is no longer embedded in the society. Society is embedded in the economy".

Borgatti, Brass and Halgin (2015) posit that little emphasis has been put on the context in which the social networks occur. This may determine the behavior of the networks due to different factors such as culture at national level (Xiao & Tsui, 2007) and competitiveness or cooperativeness thereof (Kilduff & Brass, 2010). Limited instances exist where the context of existence of networks have been studied (Bian & Zhang, 2014; Lazega, 2014) which is deemed as an area of improvement in the current study. In addition, a large number of social network research studies have not gathered flow of data within the networks which is targeted to be key development in network analysis in future supported by upcoming conceptual analytical approaches (Borgatti & Halgin, 2010).

Actors within social networks may be limited by their network or even encouraged to personally change their network (Gulati & Srivastava, 2014). There is no interrelationship between own challenges and network limitation resulting in "constrained agency" pointing out to disjointment in similarities in capabilities and drivers of the network actors. In network research studies, network actors are treated equally despite their dynamisms in culture, preferences and economic capabilities, among others (Watts, 2003). However, recent studies by Sasovova et al. (2010) indicate differences in network actors are being taken into consideration.

Further, emphasis is laid on the actions of the attributes of the network as opposed to how they came into being while data in the network is cross-sectional instead of being longitudinal. Focussing on actions of attributes of a network ignores the fact that network actors have agency and ever altering their relationships and locations. Presence of co-evolution is ignored (Borgatti, Brass & Halgin, 2014). Based on this, SNT may not well explain presence or absence of reverse causality between independent and dependent variables in the current study.

2.2.3 Diffusion of Innovation Theory

The original diffusion study was conducted as early as 1903 by the French sociologist Gabriel Tarde who drew the original S-shaped diffusion curve. The study is of current significance since "most innovations have an S-shaped rate of adoption" (Wintjes, 2016). Diffusion research focusses on the conditions which increase or decrease the likelihood that a new idea, process or product will be used by members of a given culture. DIT predicts innovations that media, as well as inter-personal contacts, provide information and influence opinion and judgment. Studying how innovation occurs, Wintjes (2016) argues that innovation consists of four stages: diffusion (or communication) through the social system, invention, consequences and time. The information permeates through institutional linkages. However, diffusion of an innovation is dependent on several factors, key among them being characteristics of the innovation, how the innovation is shared, duration and nature of innovation and the type of social system the innovation is pioneered on (Rodgers, 1995).

The nature of interactions and the roles opinion leaders play in them determine the likelihood that the innovation will be uptaken. Innovation diffusion research has tried to explain the factors that affect how and why users apply a new information mode, such as the Internet. The process of diffusion involves opinion gurus who shape audience behavior through their personal exchanges and mediators called “change agents and gatekeepers”. Five adopter classes include: "innovators", "early adopters", "early majority", "late majority" and "laggards". These categories follow a standard deviation-curve, very little innovators adopt the innovation in the beginning (2,5%), early adopters making up for 13,5% a short time later, the early majority 34%, the late majority 34%and after some time finally the laggards make up for 16%.

The present study asserts that in Kenya, diffusion of innovation is moderate as evidenced by research conducted by Muturi et al. (2014) that noted a 28% adoption of mobile banking technology among clients of Kenya Commercial Bank in Limuru. The transfer of skills and networking capabilities of personnel are key to institutional linkages in the National Innovation Systems. The knowledge flows in NIS are characterized by tacit knowledge and informal exchanges of between the actors in the system. There are no formalized knowledge transfer systems.

Wintjes (2016) points out that Diffusion of Innovation Theory (DIT) explains how new ideas or innovations are adopted. From the study of DIT, there are five attributes of an innovation that dictate how the innovation is adopted, namely: relative advantage, compatibility, complexity, trialability and observability. Relative advantage is the degree to which an innovation is perceived as being better than the idea it supersedes. Rogers' theory suggests that innovations with a clear, unambiguous advantage over the previous

approach will be more easily implemented. Wintjes (2016) further states that, “diffusion of innovation theory involves the process by which an innovation is communicated through certain channels over time among the members of a social system”. Here, the characteristics of the innovation, as perceived by the members of a social system, determine its rate of adoption. This theory comprises four elements: innovation, communication channels, time and the social system.

Complexity is the degree to which an innovation is perceived as difficult to understand and use (Marez, Evens & Stragier, 2011). Wintjes (2016) further suggests that new innovations may be categorised on a complexity-simplicity continuum with the qualification that the meaning of the innovation may not be clearly understood by potential adopters. When key players perceive innovations as being simple to use, the innovations will be more easily adopted (Baharain, 2014). ‘Trialability’, therefore, is the degree to which an innovation may be experimented with for on a limited timeframe. As new innovations require investing time, energy and resources, innovations that can enhance performance are more easily accepted (Arjoon & Rambocas, 2011). The characteristics that determine how quickly an innovation is adopted are: relative advantage over existing products, compatibility, complexity, trialability, and observability to the people within the social system.

The main communication channels for information to travel are mass media channels and interpersonal channels useful in generating knowledge about innovation and application of the innovation respectively. These two channels facilitate decisions to adopt or reject any new idea. The social system’s structure also affects the diffusion in terms of a boundary.

The time dimension could also be implicated in the diffusion process in three other ways: innovation decision process, innovativeness and rate of adoption. The first, is the mental process through which an individual passes from first knowledge of an innovation to confirmation of its decision. Secondly, innovativeness is the degree to which an individual is earlier in adopting new ideas relative to others. Thirdly, the rate of adoption refers to the number of members of the system that adopt innovation at a given time. There is strong direct research evidence suggesting that the more compatible the innovation is, the greater the likelihood of adoption (Greenhalgh et al., 2014).

2.2.3.1 Critique of Diffusion of Innovation Theory

In the adopters' categories of this theory, it is noted that the category of a set of adopters is omitted. Rogers didn't realize that some adopters may have the features of innovators or may be early adopters that may not quickly adopt an innovation. For example, a lady may not adopt a new innovation that has to do with jewelleries, not because she is a laggard but because of a belief about jewelleries probably because of religion. The researcher is of the opinion that an adopter may be young, venturesome, financially okay (these are some of the features of early adopters/innovator), and yet delay in adopting an innovation. Rogers never cared about this category; as such no name was given for them. After serious academic discourse with a fellow researcher, Babatunde (2011), the researcher concluded that zero tolerance should be incorporated into the adopters' categories. This will take care of people who are innovators in feature but may not readily adopt some new innovations.

One of the least understood areas of innovation diffusion is the non-adoption of new technology (Pesole, 2015). In some cases, individuals or groups eschew the functionality of technology, regardless of when it was developed. In others, existing technology users do not choose to purchase categorically similar (price, function, availability) newer products

when they become available. Further, some who have used a new technology may later become non-users, given their dissatisfaction with the experience; also known as discontinuance (Pesole & Nepelski, 2016). Thus, majority of research on this topic to date has assumed that for rational or utility maximising consumers, eventually new technology will replace the old (Renda, 2016). But market history has shown that it does not do so easily, automatically or even completely. Pesole (2015) notes that in the maritime industry, some market segments did not replace sailing ships (the old technology) even after the emergence of steam ships (the new technology) in the nineteenth century, and diesel in the twentieth century. Actually, generators of the old technology continued commercialisation and accelerated innovation in response to the threat of the new technology. This phenomenon the "sailing ship effect" (Gilfillan, 1935).

Accepting that diffusion of innovation is neither uniform (Pesole & Nepelski, 2016) nor inevitable, the aim of this study is to investigate limits to adoption that new technological innovations are likely to find from competition with non-use of technology and notionally older technology. To do so the study begins with a cross-disciplinary literature review, exposing the perspectives of researchers in the fields of marketing, new product development and sociology. This provides a two-part framework for the examination of innovation diffusion and exposes three levels of analysis for each framework. Thus it is possible to categorise innovation diffusion as affected by technological, social and learning "conditions" (Schiavone & MacVaugh, 2012) while operating in the contextual "domain" of the individual,community, market or industry.

The conditions and domains that emerge from the review of innovation diffusion are next contrasted with historical examples of contextual technological non-adoption. This evidence provides a lens through which potential drivers of non-adoption become clearer. Using Rogers' (2012) Diffusion of Innovation Theory as an organising framework, an integrative model of factors limiting adoption of new technological innovations is posited to explain the possible effect of interactions between conditions and domains during the process of introduction of a new product. Pesole (2015) examines how much ICT contributes to innovation output by analysing the ICT component in the innovation output indicator.

2.2.4 Theories Informing this Study

A combination of Social Network Theory (SNT), Resource-Based View (RBV) and Diffusion of Innovation Theory (DIT) are the major theories used to inform institutional linkages in NIS in this study. Social networks have been applied to analyze how companies relate to each other, characterizing the many informal networks that bring executives together, as well as associations and institutional linkages between individual staff at different companies. Resource-based theory looks at firms in terms of their unique bundle of resources. It underlines the importance of competencies and resources of an organization in making its business and institutional plans employed to attain sustainable competitive edge. Diffusion of Innovation Theory, on the other hand, articulates how various innovations get integrated and therefore linked within the larger NIS (Gehani, 2017). Contribution of the three theories is informed by the notion that several aspects in organizational theories such as RBV and DIT have either embedded or individually revamped major components of the network theory (Borgatti, Brass & Halgin, 2014).

2.3 NIS Factors and Institutional linkages in NIS

A review of the literature establishes that a large part of empirical literature has focused on the process of international knowledge diffusion and examined the set of factors that affect the extent to which a national system can grow and catch up with the technological frontier. Another gap is established in a study by Jowi and Obamba (2013) where they found out that the uniformity amongst the current firms, programs and policies in Kenya, Ghana and Uganda remain relatively weak. This implies that the frameworks are based on imitation and not on the countries absorptive capacity.

The concept of innovation is used in connection with the processes of technological change. Traditionally, the process of technological change was viewed as consisting of three different stages: invention, innovation and diffusion. Invention is the stage of the production of new knowledge, innovation is the stage of the first application of that knowledge within production and diffusion means the broad use of the new technology (Lacave &Vullings, 2013). This innovation model, which is called trickle-down or cascade model, assumes that the quantum of fundamental research substantially influences the opportunities for technological innovation within a territory, which in turn determines the growth rate of its output. It also assumes that an adequate level of the distribution of resources in basic scientific research makes it possible to initiate an economic growth process.

This cascade model has often been criticized because technological changes do not take place according to the linear logic of this model. On the contrary, technological change must be conceptualized as a process, the outcome of which is not determined before it starts but is subject to new influences along the process. It is not possible to discern a

sequence of clearly delimited stages that have to be passed one after the other. Instead, we have to be aware of the fact that particular innovative activities can be the cause and the effect, the prerequisite and the consequence (Gehani, 2014).

Therefore, a typically used, modern, broader definition of innovation includes all activities of the process of technological change – problems of awareness and definition, the development of new ideas and new solutions for existing problems, the realization of new solutions and technological options, and the broader diffusion of new technologies. Innovation is seen as increasing the competitiveness of a nation. It should be considered as a system that can be classified along a variety of dimensions.

The first dimension focuses on selection of process and product innovation. Process innovations aim to reduce the costs of producing and delivering a given product or service, while product innovations improve the qualities of existing products or provide new products to consumers. The second dimension focuses on selection of radical and incremental innovation. Radical innovations lead to fundamental changes in processes or products, while incremental innovations involve adaptations of a core innovation in particular applications. The third dimension is the selection of technological and organizational innovations. Technological innovations are generally embodied in equipment used by labour, while organizational innovations involve the organization and reorganization of groups of people into effective teams in the production and delivery of goods and services. The fourth dimension deals with selection of S&T push on innovation policy and customer pull on innovation policy. S&T push-driven innovations are an outcome of S&T research in the public and private sectors, while customer pull- driven innovation is built upon market research and user interaction (Schiavone & MacVaugh, 2012)

Lacave and Vullings (2013) observe that plausibility for national ST&I programs, consisting of its enterprises, activities and processes, is enhanced by countrywide assimilated support platform for ST&I. This policy strategy aims at fostering dialogue between researchers, different users and beneficiaries of ST&I. Promoting ST&I acceptance and support of its national activities requires communication between stakeholders.

Exchange of information through print and electronic media is of significant importance since it increases knowledge and understanding of adoption and utilization of technologies. These findings inform the following hypothesis, which is consistent with the study's objective.

Lundvall (2012) posits that although there are a number of historical antecedents to the NIS concept, "its main background should be found in the needs of policy makers and students of innovation", representing an evolutionary process incorporating observation with economic theory. Freeman (2012) notes that following World War II, "a linear model of science and technology 'push' was often dominant in the new science councils that advised governments. It seemed so obvious that the Atom Bomb was the outcome of a chain reaction: basic physics => large-scale development in big labs => applications and innovations (whether military or civil)". While this linear perspective loomed large as an organizing principle for policy-makers, it proved unable to account for differential rates of technological innovation and economic development experienced by industrialized countries.

Despite similarly large investments in R&D by various industrialized and semi-industrialized countries starting in the 1950's and 60's "evidence accumulated that the rate of technical change and of economic growth depended more on efficient diffusion than on being first in the world with radical innovations and as much on social innovations as on technical innovations" (Freeman, 2012). This evidence, gathered in numerous studies at the level of the firm and industry, was reinforced by two contrasting experiences in the 1980's on the one hand the extraordinary success of first Japan and then South Korea in technological and economic catch-up; and on the other hand the collapse of the Socialist economies of Eastern Europe (Freeman, 2012). Lundvall and colleagues speculate that NIS thinking gained ground in part due to the fact that mainstream macroeconomic theory and policy have failed to deliver an understanding and control of the factors behind international competitiveness and economic development (Lundvall, 2014). The increase in practices and policies that focused on innovation and its sources became a central theme for international and national economic bodies, most notably the OECD, which National Innovation Systems:

H_1: NIS factors have a significant effect on the institutional linkages in NIS.

2.4 Innovation Incentives, NIS Factors and Institutional linkages in NIS

Liu and White (2011) created a different method of distinguishing the operational frontiers of an NIS, outlining five major activities as the core of a framework that can be thought of as "nation-specific". These are research, implementation, end-use, linkage, and education. While the individual institutions that constitute of both the broad and narrow innovation systems are important, the strength and variability of knowledge flows among constituents of a national system are critical determinants of its 'distribution power' (Altenburg, 2013). We may thus draw the hypothesis below consistent with objective 2 of this study:

The National Innovation System (NIS) concept first appeared in the mid-1980s in the context debates over industrial policy in Europe (Sharif, 2016). Today, OECD, European Commission,UNCTAD, and the World Bank have incorporated the concept of NIS as an important part of their analytical perspective while countries in Scandinavia, Western Europe, Asia, and Latin America also show their special interest in NIS approach when making innovation policies (Lundvall, 2014).

For an innovation system, activities or functions are important. Liu and White (2011) argued that early studies focusing on actors, policies and institutions of NIS may cause "the lack of system-level explanatory factors". Therefore, they identified five fundamental activities in their framework for analyzing innovation system, that is, research (basic, developmental, engineering), implementation (manufacturing), end-use (customers of the product or process outputs), linkage (bringing together complementary knowledge) and education.

Although there is no consensus as to which activities or functions should be included in NIS,it is clear that NIS itself is far extended beyond traditional R&D systems and innovation in NIS approach is also a much broader concept not only referred to market introduction of new combinations but also include its diffusion and use. Edquist (2015) argued that the overall function of an innovation system is to pursue innovation process, i.e. to develop, diffuse and use innovation. The crucial contribution made by NIS scholars is that they have developed a new analytical framework that places learning and innovation at the center of the focus. Unlike standard economic theory which assumes that all agents have equal access to technologies and are equally competent in developing and utilizing them, NIS approach assumes that organizations and agents have a capability to enhance their competence through searching and learning and that they do so in interaction with other agents.

In NIS approach, innovation is no longer categorized as a one-way, linear flow from R&D to new products. It is seen as a systemic process involving multiple interactions between different actors and types of learning. NIS approach also adopts a holistic perspective and tries to encompass a wide array of important determinants of innovation (including economic, social, political, organizational, and institutional factors) for consideration.

Therefore, NIS approach is more appropriate for policy makers to take full account of factors when designing innovation policies. Its comprehensive-perspective and national-focus make NIS approach feasible and popular. That‟s why many counties have adopted NIS approach in policy making content. As will be introduced in the next section, the recent NIP-program in China is also a practice following NIS approach.

Lundvall (2014) pointed out that learning-by-interacting, involving users and producers in an interaction, results in product innovation. In a recent research, Lundvall (2007) identified two models of innovation according to different types of knowledge. One is called the Science, Technology and Innovation (STI) mode, which is based on the production and use of codified scientific and technical knowledge. The other, called the Doing, Using and Interacting (DUI) mode, relies on informal processes of learning and experience-based knowledge. Both STI and DUI modes are typically embedded in organizational framework and institutional arrangements that support different kinds of interactions and accelerate exchange of both codified and tacit knowledge among actors.

In summary, NIS approach provided us a systematic and holistic framework for analyzing innovation and learning. NIS approach highly emphasizes interaction and cooperation, which can be accomplished through a series of organizational designs and institutional arrangements.Bridging agencies in NIS encourage the flow of codified and non- codified

knowledge and make interactive learning between actors easily happen. Government support and cooperation among actors respectively decreases the macro-level and micro-level risk of innovation.Now we would like to raise an important question “how to shape an effective NIS”. As far as we know, few NIS researches are concerned with system building. Edquist (2012) argued that innovation system evolves over time in a largely unplanned manner and even we know all the determinants of innovation processes in detail, we can not design or build innovation system. Liu and White (2011) presented a less fatalistic and more normative view that the evolutionary process and outcomes can be managed or at last constructively influenced. For example, consciously designed government policy can change the behavior of individual actors and in aggregate change the system structure, dynamics, and performance. Lundvall (2014) also emphasized the significance to turn to system construction and system promotion when applying NIS approach to the South. The following hypothesis guide the study to explore more on this relationship.

H_2: Innovation incentives have a significant moderating effect on the relationship between NIS factors and the institutional linkages in NIS.

2.5 Innovative Culture, NIS Factors and Institutional linkages in NIS

Important cultural norms can facilitate interactive learning in a regional innovation system. These norms include openness to learning, trust and cooperation between firms (Cooke and Morgan, 2013).Ney (2013) indicated the weakness of the national innovation systems account of culture, where the national differences from an empirical and theoretical perspective are not considered in the constructs of national innovation systems. A culture is an expression of a group of people. Every culture reflects the current beliefs and behaviors of its people, as well as the history that shaped them. History is an essential

attribute of culture because one of culture's defining characteristics is that it persists over time; it gets transmitted from the present to the future with notable continuity. Hence, when we reflect on our own situation today, we can see that the past interacts with new forces from our own times, and the aggregate picture is exactly what constitutes our culture right now.

The innovation culture, of course, is likewise an expression of people, their past, and their current beliefs, ideas, and behaviors. They make innovation happen, and they do so consistently over time. Since the innovation culture is not all that common among today's organizations, we know that it's not so easy to create one. A key reason for this is that the characteristics needed to achieve an innovation culture are not seen as the some ones that are needed in successful companies. For example, it's only a slight exaggeration to say that companies love stability and predictability because these factors make it easier to earn profits;innovation, however, is about adaptation and change, which can be very difficult to live with or to profit from.Companies seem to adore repetition because it suggests business scalability,but innovation is all about novelty and the unexpected.

By enhancing workplace social networks, collective knowledge establishes a foundation for promoting innovative behaviour of employees as opposed to individualism. Making awareness of the existence of innovation can lead to uptake and the consequent transfer of knowledge between actors in an innovation system (Lundvall et al., 2010). Innovative culture can encourage innovative behaviour among all employees of a firm by influencing the behaviour patterns of employees, increasing their participation and making innovation be vital part of company policy (McDonald, 2011). In addition, there are several adhocracy cultures that promote innovation, namely: creativity (Cassiolato et al., 2011), empowerment (Durongkaveroj, 2010), freedom and autonomy (Fagerberg & Sapprasert, 2011), and risk- taking (Hoogendoorn et al., 2012).

Competitive advantage is gained by the nation that enhances an infrastructure of interconnectedness among organizations, universities and the government via faster information diffusion and deployment of innovation. Institutional linkages among various actors of a national innovation system is a major component in the competitiveness of a knowledge-based economy (McDonald, 2011). Infrastructure of communications in the form of diffused innovation is vital in strengthening the connectedness of NIS actors and streamlining the movement of knowledge and resources between actors (Koria et al., 2012). Research done by Koria et al. (2014) indicated that institutional linkages within actors as well as interaction among various factors that affect the national innovation system, determined the level of innovativeness in both Ghana and Kenya. Based on these observations, we may thus draw the following hypothesis consistent with research objective 3:

H_3: Innovative culture has a significant intervening effect on the relationship between NIS factors and the institutional linkages in NIS.

2.6 NIS Factors, Innovation Incentives, Innovative Culture and NIS Institutional linkages

Since industrial revolution, networks created by zonal institutional linkages of organizations have been vital (McDonald, 2011) to the advancement of innovation. Foray (1991) points out that regional inter-firm interaction includes the basic principle of functioning and innovativeness of these firms. Most of these NIS scholars focussed on relationships between three main actors: universities, government and inventive firms. Shared knowledge between knowledge generators and end users plays vital role in an NIS. As Mulgan (2012) puts forth, institutional linkages among the actors within the systems of

innovation are weak and institutional structures are ill developed. The systems of innovation in developing countries are weak and fragmented. In some developing countries and regions, one may even see two separate and coexisting systems of innovation (Nicholls & Murdock, 2012).

OECD (2016) notes that the innovative performance of a nation mainly relies on how actors interact with each other as items of a collective system of knowledge creation and application. The relationships among these actors may be in the way of colloborative research, staff exchange, cross-licensing, and a variety of other methods. Starting from the Schumpeterian legacy, researchers have perceived regional networks as a privilege leading to innovation. From these observations, the hypothesis below may be drawn consistent with research objective 4:

H_4: NIS factors, innovation incentives and innovation culture have significant joint effect on NIS institutional linkages

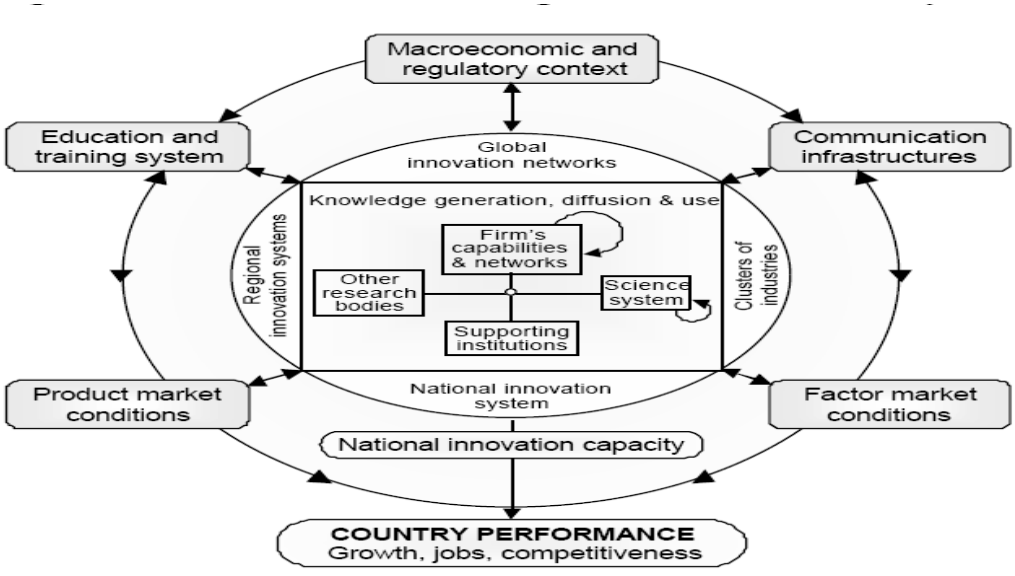

Figure 2.1: OECD Framework on Managing National Innovation Systems

The systemic approaches to innovation will continue to constitute a decisive framework for empirical studies in the economics of innovation literature, especially in the context of highly industrialized and newly industrialized countries. Concerning the use of the national innovation systems approach as a framework to carry out country-level comparisons of technological performance, it is plausible that some of the recently introduced models will not be put aside but will be applied and further elaborated in future research. This appears likely considering the apparent interest in international evaluations of innovative strength (Peter, 2012). However, there is still much room for extension of the NIS concept. At least three areas for broadening the approach shall be brought up here.

First, a clearer and more explicit combination of the NIS approach with economic growth is still lacking. While the linkage between technical change and economic growth has long been studied through distinct models of economic growth, modern concepts of innovation like that of (national) innovation systems have thus far not been tied with economic growth in an analytical way(Stern, 2014). This constitutes a gap in the literature, even though it has been stated elsewhere that the NIS approach per secould be viewed as a means to study economic growth (Lundvall ,2014).

Second, the interplay between a country's innovation system and other economic subsystems (for instance, the labor market or the financial system) is far from being studied exhaustively. This limitation is even more striking since innovation systems have been defined as being open systems and since it is widely held that the strength of an innovation system depends upon the linkage with other sub-segments of an economy.

A third course to extend the NIS approach has to do with our still limited knowledge on the dynamic properties of national innovation systems, especially with regard to their stability and their structural evolution.

By studying these aspects, the NIS concept would be more aligned with its theoretical foundation of system theory and evolutionary economics(McKelvey ,2014). It is a basic element of this line of economic theorizing to consider qualitative change, implying that dynamic processes have to lie in the center of attention. In addition, the variety of the units of analysis and their observable performance levels are usually given special interest. So if the theoretical foundation of the notion of innovation systems is to be taken seriously, a more subtle understanding of the evolution of the systems is required (Saviotti, 2013).

Above all, it seems appealing to retrace different development stages of national systems together with the structural and institutional modifications entailed in the course of time. By carrying out this type of analysis, it could be demonstrated that different countries have taken different roads to cope with the competitive and technological challenges they have been and still are exposed to. Perhaps, and viewed from a methodological perspective, it may be helpful to build simulation models resorting to this type of models (Porter & Stern, 2012). This gap has also been identified by Carlsson et al. (2012) who argue that "there is nothing preventing a more dynamic analysis" of national innovation systems. It has been clarified repeatedly that evolutionary economic theory constitutes the theoretical fundament of the NIS approach (Edquist et al., 2011). However, the relation between system theory and the NIS approach is barely investigated (Pyka, 2009). This is because in most cases, both the values of the units of analysis and the very units of analysis change.

Beije (2013) avers that the continuing significance of the national innovation systems approach for granted. Rather, it is also conceivable that in the near future, the research focus may shift from the now frequently chosen national perspective of innovation systems towards a sectoral or a regional perspective including cluster theories. Stankiewicz (2015) posits that such shifts in the preferred analytical level are likely if international intrasectoral ties in the generation of innovations will continue to intensify while domestic ties lose importance, and if the significance of national institutional framework conditions should descend at the expense of regional or sectoral framework conditions. Trends like these could very well reduce the relevance and usefulness of the concept of nationally demarcated innovation systems. Besides this, it is preferable to use less aggregated concepts of innovation systems than the NIS concept if sector-specific or region-specific criteria in the organization of innovation processes are sought to be studied in great detail. That is because the concept of national systems of innovation puts emphasis on national differences in the relationship between the institutional set-up, technical development and on national differences in economic structures.

The usefulness of a national boundary of innovation systems can also be reduced through growing international economic integration if national specifics and national determinants of innovative action are removed at the expense of international economic framework conditions. In the context of the European Union, for instance, less self-determination of the participating nation-states in numerous fields, including innovation policy design, could be a logical outcome of increasing institutional harmonization across countries. In this case, and if the concept of innovation systems is to be applied, a supranational analytical level may be advantageous to a national one (Etzkowitz & Leydesdorff , 2015).

However, as such possible changes in analytical levels do not mean that the various sub-approaches of the innovation systems approach exclude one another. The same line of reasoning is taken by Beije (2015) who underlines that "regional or sectoral innovation systems are subsystems of the national system in which the institutions (or some of them) are specialized in the innovation problems of a specific sector or region". Growing economic integration can indeed be understood ambiguously: It includes either the geographical extension of international (trade) agreements or the deepening of existing international economic integration by harmonizing more and more formal institutions in the member countries. Recent research on this topic has shown, it is too early to think in terms of a supranational European innovation system (Peres, 2013).

Table 2.1: Summary of Knowledge Gaps

Author (s)	**Subject**	**Methodology**	**Findings**	**Knowledge gap**	**Addressing knowledge gap in current study**
Jowi and Obamba (2013)	A comparative analysis of research and innovation in Ghana, Kenya and Uganda	Comparative study, case studies of Ghana, Kenya and Uganda	The study established that internationalization through transnational and transdisciplinary collaborations amongst universities is one of the most valuable choices for enhancing governance, research skills and innovation in sub-Saharan countries.	The study mainly focused on one factor namely universities as a linkage.	However, there is need to investigate the NIS institutional linkages as it is impossible for one linkage to work in isolation as argued by Roos *et al* (2005)
Intarakumnerd (2013)	Research to measure innovation incentives in catching-up-economies with reference to Thailand	Study to measure innovation incentives in catching-up-economies with reference to Thailand	Study found that nations participate in the innovation process by funding and coordinating public enterprises participating in creation and	The study was done in Thailand and limited to interaction between the government and public institutions that generate knowledge. It	This study will be focused on Kenya in particular and consider interaction of all players in the innovation process. Besides innovation incentives, this study will consider how NIS factors and innovation culture influence NIS

Author (s)	Subject	Methodology	Findings	Knowledge gap	Addressing knowledge gap in current study
			dissemination of knowledge as well as providing fiscal and governmental incentives to all players in the system of innovation.	also limited the scope to effect of innovation incentives on the innovation process	institutional linkages
House et al (2012)	Conducted study on innovative culture, leadership and organizations	Comparative study in 62 countries sampled from both developed and developing economies	The study found that in NIS, innovative culture is attributed with providing structure and guidance for learning behavior and outcomes which in turn influence the absorptive capacity of the country.	The study was limited to innovative culture at organizational level ignoring other factors that can affect an NIS and absorptive capacity of a country	Besides innovative culture, this study will focus on how various NIS factors and innovative incentives influence NIS institutional linkages
Munyoki et al. (2011)	Extent to which university-industry linkage exists in Kenya: A study of medium and large manufacturing firms in selected industries in Kenya	Descriptive cross-sectional study to ascertain the existence of institutional linkages between universities and industry in Kenya	The results of the study revealed that research firms of the local government were the initiators of technology transfer for manufacturing entities in Kenya despite the same entities disclosing that local universities were their preferred originators of technology. On the other hand, multinationals preferred obtaining technology internationally.	Study was limited to only two actors within NIS institutional linkages and did not consider NIS factors, innovation incentives and innovative culture that may influence the strength of institutional linkages between these actors.	The study will consider the wider spectrum of institutional linkages of NIS including more than two actors as well as the factors that can determine the extent of the NIS institutional linkages in Kenya. These will include NIS factors, innovation culture and innovation institutional linkages.

Author (s)	Subject	Methodology	Findings	Knowledge gap	Addressing knowledge gap in current study
Gehani, (2007)	A study on NIS and disruptive inventions in Synthetic rubber and tire technology	Empirical Study on American Innovation policy and Synthetic Rubber Innovations	Empirical examination of the advancement of the latex technology as well as the rise and fall of Rubber Capital in Akron, Ohio , viewed as America's innovative region.	Study was limited to NIS model based on interactions only between government, university and industry, and including the regional actors such as the regional/state innovation institution	This study will emphasize on the effect of institutional, education, communication, market, product factors and moderating effect of innovation incentives on the NIS institutional linkages

Source: Author, 2018

2.7 Conceptual Framework

Borrowing from the OECD framework on Managing National Innovation Systems shown in Figure 2.1, the following conceptual framework was developed. As illustrated in the figure, the NIS factors, namely institutional, educational, market, product and communication, form the independent variable, conceptualized as influencing NIS institutional linkages which form the dependent variable. The relationship is however hypothesized as being moderated by innovation incentives and mediated by innovation culture, which forms the intervening variable.

The emergence of national and organisational innovation is distinct but it shares the focus of defining “the values that distinguish different groups from each other” as noted by Leidner and Kayworth (2014). This then follows a value-based theoretical approach dominated by cultural studies and underpins the relationship between culture and adoption of innovations in the organisation.

This research adopts a value-based model as a conceptual framework to determine the relationship between NIS factors and institutional linkages in the NIS with relevant moderating effect of the innovation incentives, intervening effect of the innovation culture as well as the joint effect of both innovation incentives and innovation culture on this relationship. Figure 2.2 below summarises the conceptual framework of the relationship of the constructs in the study.

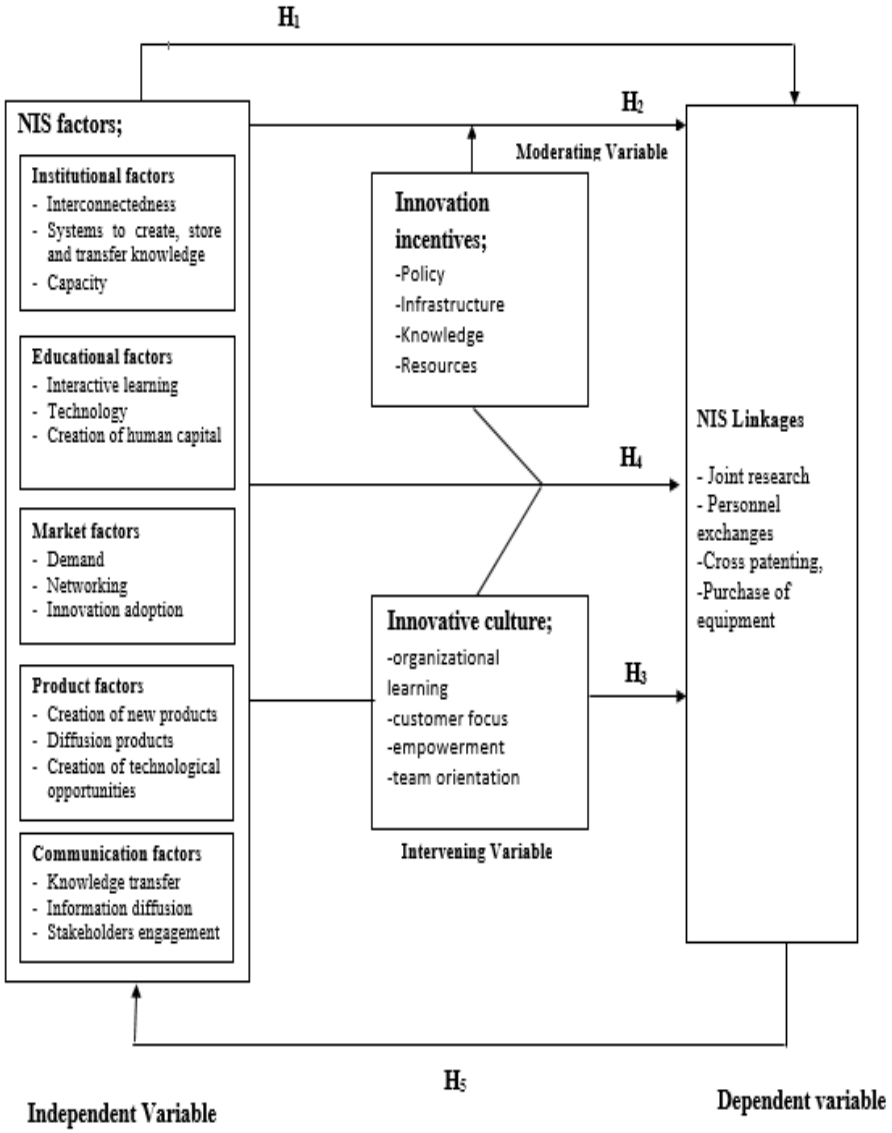

Figure 2.2: Conceptual model (Source: Author,2018)

2.8 Summary of Conceptual Hypotheses

Based on the relationships in the conceptual model under Figure 2.2 above, the following hypotheses were formulated:

H_1: NIS factors have significant effect on the institutional linkages in NIS.

H_2: Innovation incentives has moderating influence on the relationship between NIS factors and the institutional linkages in NIS.

H_3: Innovation culture has intervening influence on the relationship between NIS factors and the institutional linkages in NIS.

H_4: NIS factors, innovation incentives and innovation culture have significant joint effect on NIS institutional linkages

H_5: There exists reverse causality amongst NIS factors and institutional linkages in NIS.

The study had five hypotheses that were stated as above and tested in null form. Test results of these hypotheses are shared in chapter four of this thesis.

H_1 was the primary hypothesis of the study which tested the the effect between NIS factors and institutional linkages in the NIS in Kenya. This hypothesis was set to find out if the NIS factors such as institutional factors, educational factors, market factors, product factor and communication factors do affect the institutional linkages in NIS in Kenya. To test the relationship between the NIS factors and NIS institutional linkages, individual and combined effects of these factors were tested.

The study also hypothesized the influence of innovation incentives on the relationship between the NIS factors and institutional linkages in the NIS in Kenya. This influence was stated and tested as **H_2**. This hypothesis was set to find out if innovation incentives had moderating influence on the relationship between NIS factors and the institutional linkages in NIS.

The intervening influence of innovation culture on the relatonship between NIS factors and institutional linkages in the NIS in Kenya was hypothesized as $\mathbf{H_3}$ and was also tested. This hypothesis was set to find out if innovation culture had significant intervening influence on the relationship between NIS factors and the institutional linkages in NIS in Kenya.

The joint influence of innovation incentives and innovation culture on the relationship between NIS factors and institutional linkages in the NIS in Kenya was hypothesized and stated as $\mathbf{H_4}$. This hypothesis was also tested. This hypothesis was set to find out whether the NIS factors, innovation incentives and innovation culture jointly influenced NIS institutional linkages in Kenya. The last hypothesis $\mathbf{H_5}$ was to test if there is reverse causality that exists between NIS factors and NIS institutional linkages.

2.9 Chapter Summary

This chapter delved into a detailed literature review to help appreciate the main constructs of the study based on relevant previous studies touching on all variables of the study. The chapter also gave detailed description of the theories on which the study was anchored on. These include resource based view (RBV), social network theory (SNT) and diffusion of innovation theory (DIT).

Further review was done to ascertain conceptual relationships of the study variables by conducting pairwise reviews on the relationship between NIS factors and NIS institutional linkages, influence of innovation culture on the relationship between NIS factors and NIS institutional linkages, influence of innovation incentives in the relationship between NIS

factors and NIS institutional linkages as well as the joint effect on NIS factors, innovation culture and innovation incentives on the institutional linkages of the NIS. These relationships were discussed in details with the literature review of the relationships between variables disclosing gaps in literature that this study sought to address.

A conceptual framework was then schematized along with arguments in the literature to demonstrate relationships among the research variables of the study. From this framework, hypotheses of the study were formulated, tested and presented in chapter four of this thesis. In addition, the research methodology employed in this study is presented in the following chapter.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter covers the methods and procedures that were used to execute the study. It comprises of the research philosophy, research design and population. It also presents sampling, data collection, data analysis and research variables.

3.2 Research Philosophy

Research philosophy is a convion about the methods in which data about a phenomenon should be collected, examined and applied. It refers to the systematic manner in which the researcher searches for knowledge and values (Flowers, 2014). A research philosophy is a belief about the way in which data about a phenomenon should be gathered, analysed and used.

The term epistemology (what is known to be true) as opposed to doxology (what is believed to be true) encompasses the various philosophies of research approach. The purpose of science, then, is the process of transforming things Believed into things known: doxa to episteme. Two major research philosophies have been identified in the Western tradition of science,namely positivist (sometimes called scientific) and interpretivist (also known as anti-positivist) (Galliers, 2009). Four main research philosophies have been recognized namely positivist, interpretivist, realist and relativist views (Hughes, 2011).

Positivists hold that reality is stable and can be observed and described from an objective viewpoint, without interfering with the phenomena being studied. Predions can be made on the strength of the previously observed and explained realities and their inter-relationships (Hughes, 2011). Positivism is the epistemological position that this study adopted because the researcher holds that reality is stable and intends to investigate it objectively with a view to recommending a solution to the problem under study.

This study was guided by the positivistic paradigm. It was more concerned with a rational explanation of whether innovation incentives and innovation culture have a moderating effect on factors affecting the institutional linkages of National Innovation System in Kenya. It also developed a set of recommendations. In addition, positivism is the paradigm within which most business and management research operates. Positivism also describes the research task as entailing the collection of data upon which to base generalizable propositions that can be tested. Positivism approach therefore guided the study to collect all the facts and figures in relation to the influence of innovation incentives and innovation culture on the NIS factors on institutional linkages between various actors within the Kenyan NIS.This therefore implies that descriptive design would be appropriate research design to achieve the objectives of the study. These are further discussed as shown in the sections below.

3.2.1 Positivism

Positivists believe that reality is stable and can be observed and described from an objective viewpoint (Levin, 2014), i.e. without interfering with the phenomena being studied. They contend that phenomena should be isolated and that observations should be

repeatable. This often involves manipulation of reality with variations in only a single independent variable so as to identify regularities in, and to form relationships between, some of the constituent elements of the social world. Predictions can be made on the basis of the previously observed and explained realities and their inter-relationships. "Positivism has a long and rich historical tradition. It is so embedded in our society that knowledge claims not grounded in positivist thought are simply dismissed as a scientific and therefore invalid"(Gicheru, 2013) view is indirectly supported by Alavi and Carlson (2012) who, in a review of 902 Information Systems research articles, found that all the empirical studies were positivist in approach.

Positivism has also had a particularly successful association with the physical and natural sciences. There has, however, been much debate on the issue of whether or not this positivist paradigm is entirely suitable for the social sciences (Hirschheim, 2015), many authors calling for a more pluralistic attitude towards IS research methodologies (Remenyi & Williams, 2015).

While this debate shall not elaborated on further, it is germane to this study since it is also the case that Information Systems, dealing as it does with the interaction of people and technology, is considered to be of the social sciences rather than the physical sciences (Hirschheim, 2012). Indeed, some of the difficulties experienced in IS research, such as the apparent inconsistency of results, may be attributed to the inappropriateness of the positivist paradigm for the domain. Likewise, some variables or constituent parts of reality might have been previously thought unmeasurable under the positivist paradigm - and hence went unresearched (Galliers, 2011).

3.2.2 Interpretivism

Interpretivists contend that only through the subjective interpretation of and intervention in reality can that reality be fully understood. The study of phenomena in their natural environment is key to the interpretivist philosophy, together with the acknowledgement that scientists cannot avoid affecting those phenomena they study. They admit that there may be many interpretations of reality, but maintain that these interpretations are in themselves a part of the scientific knowledge they are pursuing. Interpretivism has a tradition that is no less glorious than that of positivism, nor is it shorter.

3.3 Research Design

A study design shows how the investigation was undertaken and solved (Orodho & Kombo, 2003). According to Cooper and Schindler's (2003) definition," this research adopted a descriptive survey design". According to Kothari (2004), a descriptive design involves the use of statistical methods in processing raw facts into information.

This design enables the generalisation of the findings to the larger population. The research design was deemed fit to establish the influence of cultural factors that affect the adoption of information technology at the Africa Union Commission. Consequently, this was used to collect processed data about the characteristics of respondents on educational or social issues (Orodho & Kombo, 2003). This design is appropriate for this research as it attempts to describe the effects of the social aspect such as culture, and it allows for standardised instruments like questionnaires and interviews to be used for a survey and for the examination of records. The following research steps were followed during the research:

Table 3.1: Research Procedure

#	Design steps	Research deliverables
1.	Research, collection and review of existing literature	Review other studies
2.	Design a conceptual framework for the study	Conceptual Framework
3.	Develop a measuring tool	Questionnaire
4.	Conduct research by administering questionnaires to Kenyan ICT Innovation Institutions	Quantitative study design
5.	Processing of gathered data	Quantitative research design
6.	Discussions on the findings	Results on the findings
7.	Conclusions and recommendations	Interpretations of quantitative data

This research study adopts cross-sectional survey design (Saunders et al., 2009; Kumar, 2011). Cross-sectional study seeks to establish the relationship of variables at a specified time so as to describe the incidence of a phenomenon and how the variables are related (Saunders, Lewis & Thornhill, 2009). This study seeks to establish the correlational relationship between NIS factors, innovation incentives, innovation culture and institutional linkages in NIS in Kenya.

This research is based on describing characteristics of items in the research by first gathering data that describe events and then processing the results that describe the data and hence it adopted a descriptive survey design that involves. According to (Cooper & Schindler, 2013), descriptive survey method focuses on finding out the five key questions of who, what, where, when and how much. Mugenda and Mugenda (2003) contend that a descriptive "survey enables researchers to summarize and organize data in an effective and meaningful way". According to Kothari (2004), research design is "a plan, a roadmap and blueprint strategy of investigation conceived so as to obtain answers to research questions; it is the heart of any study". This design is also useful to collect qualitative data that arise

from a depth of responses from the population that supply that well describe research phenomenon. According to Ngechu (2004) population is defined "as a collection and total inclusion of all people, services, elements, events, and group of things or households that are being focused in a study". This definition ensures that the population of interest is homogeneous.

3.4 Target Population

Population is a well-defined as a total collection of a set of people, services, elements, events, group of things or households that are being investigated (Ngechu, 2004). This definition ensures that population of interest is homogeneous.

The target population in this study comprised of all ICT innovation-based institutions in Kenya including the Ministry of Information Communication Technology MoICT), Ministry of Education and Science and Technology (MoEST), universities, technology research institutions, innovation hubs, and ICT professional bodies, with the units of analysis being Kenyan ICT innovation institutions.

The study considered all universities according to Commission for University Education report of 2015 (that is, 33 public universities, 22 private universities, 14 institutions with letters of interim authority, 1 registered private institution) (Appendix II), 11 institutions under the Ministry of Information Communication Technology (Appendix III) according to Taskforce on Parastatal Reforms Report of 2013, 6 institutions under Ministry of Higher Education Science and Technology (Appendix IV) & 5 research institutes (Appendix V) according to UK Department for International Development (DFID) report of 2014, 11 innovation hubs (Appendix V) and 9 professional bodies (appendix VI) according to World Bank (2014). The population of the study was 112.

Table 3.2: Population Distribution

Institutions	Population
Universities	70
Ministry of Information Communication Technology (MoICT)	11
Ministry of Education, Science and Technology (MoeST)	6
Research Institutions	5
Innovation hubs	11
ICT professional bodies	9
Total	**112**

Source: Commission for University Education report of 2015 , Taskforce on Parastatal Reforms Report of 2013, UK Department for International Development (DFID) report of 2014 and World Bank (2014)

In this study, a census was conducted thus targeting the entire population. This agrees with recommendation of the United Nations (2008) on the best approach to use when systematically obtaining and capturing information about participants of a given population. Targeted respondents mainly included leaders and employees in ICT departments and innovation sections in Kenyan ICT innovation institutions.

3.5 Data Collection

This study employed primary data. The data was collected using questionnaires as they are appropriate tools that can provide a high degree of data standardization and are cheap to administer (Kombo & Tromp, 2016). It is also convenient to collect data from a large population. The study used both quantitative and qualitative data on all the variables in the study. This was gathered by use of a semi-structured questionnaire with both closed and open-ended questions. Most of the items on the questionnaire were put up using a five-point Likert scale going from “not at all” (1) to a “very large extent” (5). This tool was successfully applied by Irungu (2014) and Mutuku (2012) who conducted similar studies.

The questionnaire consisted of five parts. First part was to obtain the general knowledge of the respondents. Second part was to seek information on NIS factors affecting institutional linkages on NIS. Third section was to seek information on innovation incentives that moderate relationship between NIS factors and NIS institutional linkages while the fourth section was to seek information on innovation culture that mediates on the relationship between NIS factors and NIS institutional linkages. The last section of the questionnaire was to seek information on the NIS institutional linkages. The respondents were one of Chief Information Officers, Chief Operations Officers, research and development managers and other key officials charged with managing innovations in the selected institutions. Drop and pick method as well as electronic mail was used to administer the questionnaires.

The primary data was collected using questionnaires. Choice to use questionnaires was made since they provide an efficient way of collecting raw facts from a large number of respondents and they also included data collection, management and administration easier. Online questionnaires were preferred for the simplicity of sending emails to multiple participants .

Oates (2006) also states that questionnaires allow for the posing of identical questions and a pre-defined range of answers to each respondent. In line with this, the majority of the questions were closed questions with some multiple questions, while others were Likert scale-based questions and to collect and analyse data. There were also, some questions that were open-ended where participants were asked to give their own independent views.

This research mainly made use of nominal data and ordinal data. For nominal data, the responses were categorised by numbers which made it possible for analysis via frequency of responses from participants. For ordinal data, on the other hand, Likert scale-based questions were used where a range of responses were allocated to a quantitative scale. Once numeric data was obtained from the results, it was easier to graphically display findings in figures and tables for further data processing.The questionnaire collected the details and relevant information of the research which allowed "for intensity and richness of individual perceptions in respondent responses" (Mugenda & Mugenda, 2003).

3.5.1 Administration of the Questionnaire

Introduction was done through a letter informing the participants the aim of the research, the rights of the participants with regard to participation and an assurance that the researcher would treat all the information received with utmost confidentiality. The questionnaires were sent to the participants via email addresses and hand delivery. They were given three weeks to complete. However, in this time the researcher followed up with the participants on the progress of participants completing the questionnaire. It was discovered that some participants had not received the questionnaires as their mailboxes were full to the capacity allowed.

After two week, most questionnaires were filled and returned. The researcher then further followed up participants to ensure their compliance in the completion of the questionnaires. In some instances, the researcher had to talk to the line managers to request their subordinates to participate in the survey. By end of the fourth week, the researcher had collected all the completed the questionnaires and the few participants who had not returned their questionnaires by the deadline, were considered as non-participants.

Table 3.3: Operationalizing of Research Variables

Variable	Nature	Indicators	Informing literature	Questionnaire Section
NIS factors	Independent		(Niosi, 2002, Mytelka 2001, Lundvall, 2000, Edquist, 2001, Mapila et al., 2011, Mulgan et al., 2011, Schiller & Leifner, 2012, Speirs et al., 2010)	Section B Question 4
Institutional factors		Interconnectedness		
		Systems to create, store and transfer knowledge		
		Capacity		
Educational factors		Interactive learning		
		Technology		
		Creation of human capital		
Market factors		Demand		
		Networking		
		Innovation adoption		
Product factors		Creation of new products		
		Diffusion products		
		Creation of technological opportunities		
Communication factors		Knowledge transfer		
		Information diffusion		
		Stakeholders engagement		
Innovation incentives	Moderating	Policy	(Liu &White, 2001, Caloghirou et al. ,2001)	Section C Question 5
		Infrastructure		
		Knowledge		
		Resources		
Innovation Culture	Intervening	Organizational learning	(Dobni, 2008, Martins & Terblanche, 2003, Abidin et al., 2012, Stock& Zacharias, 2011).	Section D Question 6
		Customer focus		
		Empowerment		
		Team orientation		
NIS institutional linkages	Dependent	Joint research	(Caloghirou et al., 2001, OECD, 1999)	Section E Question 7
		Personnel exchanges		
		Cross patenting,		
		Purchase of equipment		

Source: Author, 2018

3.6 Reliability

According to Saunders, Lewis and Thornhill (2007) Reliability refers "to the consistency of scores or answers provided by an instrument". In this study, reliability was ensured by pre-testing the questionnaire with a sample of respondents .A pilot study was then conducted by the researcher staffs and other colleagues to measure the reliability, correctness of the language, to identify poor wording in questions, and also to assess the time required to complete the questionnaire. Cronbach Alpha coefficients were also calculated for the intended constructs and unreliable questions taken out for the final study.The accuracy of data collected largely depend on the data collection instruments in terms of validity and reliability. Reliability refers to a measure of the degree to which research instruments yield consistent results. In this study, reliability was tested using Cronbach Alpha. Gall and Borg (2007) note that the internal consistency reliability is higher if the Cronbach's alpha coefficient is closer to 1. Thus, for this study, a Cronbach Alpha value of 0.7 and above was considered adequate and the research tool termed reliable.

Item analysis was done to assess the reliability of the different dimensions or constructs. After the data for the main study was collected, reliability was tested for the constructs was determined with the exploratory factor analysis in the questionnaire via Cronbach's Alpha values. Cronbach alpha, which is a measure of internal consistency, was used to test the internal reliability of the measurement instrument using the following equation:

$$\alpha = \frac{N \cdot \bar{c}}{\bar{v} + (N-1) \cdot \bar{c}}$$

. ……..Equation (Cronbach, 2004).

The higher the score, the more reliable the generated scale is indicated 0.7 to be an acceptable reliability thus it was considered adequate for this study (Nunnally, 2011). Based on the feedback from the pilot test, the questionnaire was modified and a final one developed and further interpretation of overall Cronbach's Alpha values were also described as follows: Cronbach's alpha of above 0.8 was said to be of good reliability, Cronbach's alpha of between 0.6 and 0.8 was said to be of acceptable reliability while Cronbach's alpha of below 0.6 was said to be of unacceptable reliability. However, some authors use another cut-off of 0.7, which is suggested by Nunnally (2011) for acceptable reliability.

3.7 Validity

Validity is concerned with the integrity of the research tool and adequacy of variables to provide more reliable results that maintains consistency in the findings. It refers to the appropriateness, meaningfulness and usefulness of any inferences a researcher draws based on data obtained through the use of an instrument (Mugenda & Mugenda, 2003). Validity, as noted by Robinson (2002), is the degree to which result obtained from the analysis of the data actually represents the phenomenon under study.

Messick (1995) aver that validity can be measured via content validity, construct validity, criterion validity and consequential validity measures. For this study, validity was ascertained using construct validity and content validity. Construct validity has been ensured by reviewing what other studies on NIS have done. Unbiased questions were added to the instrument to ascertain content validity. This was attained by conducting a pre-test on the questionnaire as underscored by Cooper and Schindler (2013) inorder to detect and alter any vague or impolite questions. The test focuses on ensuring research tool effectively and comprehensively measure the abilities required to successfully perform the study (Shuttleworth, 2009).

3.8 Data Analysis

Data was entered in spreadsheet after collection. It was then examined and checked for completeness and comprehensibility. The results were processed and presented in frequency tables and charts. Further analysis used exploratory factor analysis where factor loadings, regression and correlation analysis were performed. Before processing the responses, the collected data was prepared for statistical analysis and correlation analysis.

For this study, regression analysis was the preferred choice with the aim of establishing the relationship between and among the research variables. Regression analysis was also applied in evaluating the statistical significance of the estimated relationships between NIS institutional linkages and each variable. Baron and Kenny (2010) model was employed in the testing of the moderating and intervening roles. Path analysis was used to test the magnitude and strength of effects within the hypothesized causal system. In addition, multiple regression analysis was used to help in assessing causal effect of one variable upon another. On the other hand, correlation analysis was carried out to establish the relationship between variables and to describe the direction of the relationships.

The general formula for predicting NIS institutional linkages was presented by the model as follows:

$$\mathbf{Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + ... \beta_n X_n + \varepsilon_1;}$$

Where Y is the dependent variable (NIS institutional linkages) and is a linear function of, $X_1, X_2, X_3, ...X_n$ plus ε_1;

α is the regression constant or intercept.

β_{1-n} are the regression coefficients or change induced in Y;

ε_1 is the error term that accounts for the variability in Y which cannot be explained by the linear effects of the independent variables.

Results of quantitative data analysis was presented using charts and tables. Qualitative data from open-ended questions was analyzed by common themes and presented in a narrative form.

3.8.1 Mediating Effects

A mediating variable is one that accounts for or alters another relationship. A strict definition is that the mediating variable has to greatly reduce or even eliminate the relationship. A more lenient definition is that it affects the relationship . In statistics, a mediation model is one that seeks to identify and explain the mechanism or process that underlies an observed the relationship between an independent variable and a dependent variable via the inclusion of a third hypothetical variable, known as a mediator variable (also a mediating variable, intermediary variable, or intervening variable (MacKinnon, 2008). Rather than a direct causal relationship between the independent variable and the dependent variable, a mediation model proposes that the independent variable influences the (non-observable) mediator variable, which in turn influences the dependent variable. Thus, the mediator variable serves to clarify the nature of the relationship between the independent and dependent variables (MacKinnon, 2008).

Mediation analyses are employed to understand a known relationship by exploring the underlying mechanism or process by which one variable influences another variable through a mediator variable (Cohen et al., 2013). Mediation analysis facilitates a better understanding of the relationship between the independent and dependent variables when the variables appear to not have a definite connection.

The moderation effect was tested using stepwise regression as suggested by Baron and Kenny (2010) where regression analyses are conducted and the significance of coefficients is tested at each step. The moderation model tests whether the prediction of a dependent variable, Y, from an independent variable, X, differs across levels of a third variable, Z (Baron &Kenny, 2010). Moderator variables affect the strength and/or direction of the relation between a predictor and an outcome: enhancing, reducing or changing the influence of the predictor. Moderation effects are typically discussed as an interaction between factors or variables, where the effects of one variable depend on levels of the other variable in analysis. Moderation effects are tested with multiple regression analysis, where all predictor variables and their interaction term are centered prior to model estimation to improve interpretation of regression coefficients.

The moderating effect was tested as follows:

$Y = \alpha + \beta_1 X_1 + \beta_2 X_2 + \varepsilon$ ..... (1)

Intervening effect was also tested using stepwise regression equation. Intervening effect is a combined effect between the relationship of independent and dependent variable.It was achieved by use of the model below.

$Y = \alpha + \beta_1 X_1 + \beta_{13}(X1X3) + \varepsilon$.....(II)

Where (β=Co-efficient, Y = NIS institutional linkages, α = intercept/constant, ε = error term, X_1 = NIS Factors, X_2 =innovation incentives and X_3 =innovation culture).

3.8.2 Hypothesis Testing

Hypothesis Testing is basically an assumption that we make about the population parameter. Null hypothesis is a statistical hypothesis that assumes that the observation is due to a chance factor . The *p*-value approach involves determining "likely" or "unlikely" by determining the probability assuming the null hypothesis were true of observing a more extreme test statistic in the direction of the alternative hypothesis than the one observed.

If the *p*-value is small, say less than (or equal to) α, then it is "unlikely". And, if the *p*-value is large, say more than α , then it is "likely". If the *p*-value is less than (or equal to) α , then the null hypothesis is rejected in favor of the alternative hypothesis. And, if the *p*-value is greater than α, then the null hypothesis is not rejected. The co-efficients of the two models were used to make a decision on whether the independent variable has a significant influence on the NIS linkage variable as recommended by Conover (2009) and, Malhotra and Dash (2011).

The significance level for the study is that if the *p*-value<0.05, the hypothesized relationships are taken to be significant and this can lead to rejecting the null hypothesis. The direction of influence is determined by the sign on β_i.

3.8.3 Diagnostic Tests

It addresses the various forms of bias that may occur in research aiming to evaluate the accuracy of diagnostic tests. Diagnostic accuracy is defined by the extent to which a test correctly indicates the (“true”) presence or absence of the disease at issue as determined by a particular reference. The sensitivity of a diagnostic test is the probability that a diseased individual will have a positive test result. Sensitivity is the true positive rate (TPR) of the

test. The specificity of a diagnostic test is the probability that a disease-free individual will have a negative test result. The relationship between variables should satisfy the assumption of normality, linearity and multicollinearity (Greene, 2012). Before conducting the regression analysis, several diagnostic tests like normality, linearity and Levene tests will be taken to establish the appropriateness of the data for making an inference. Levene's test checks the null hypothesis that the variances in dissimilar sets are equivalent.

To check for normality, the study used the Shapiro-Wilk Test. The Shapiro-Wilk Test is more appropriate for small sample sizes (< 50 samples), but can also handle sample sizes as large as 2000. For this reason, the Shapiro-Wilk test as our numerical means of assessing normality was used. If the Sig. value of the Shapiro-Wilk Test is greater than 0.05, the data is normal. If Sig. value is below 0.05, the data significantly deviate from a normal distribution to detect the departure from normality as recommended by Myoung (2013). Normality check is key since regression model estimation methods are founded on the supposition of normalcy since normally distributed data ascertains that the data is proper for additional statistical evaluation and does not result in overstated statistics or underestimated standard errors as noted by Greenland (2016).

The linearity of variables was to be tested using correlation coefficients (Cohen, West & Aiken, 2012) using both heteroscedasticity and autocorrelation tests. Linearity is ascertaining whether the connection between explanatory variables and outcome variable is linear. Multicollinearity denotes the linear relationship between variables. It occurs when two or more predictors in the model are correlated and provide redundant information about a response.

To check for correlated variables, multicollinearity will be tested using variance inflation factor (VIF). A VIF for all the independent and dependent variables less than 3 (VIF≤ 3) shows no multicollinearity while a VIF of more than 10 (VIF ≥10) indicates a problem of multicollinearity (Cohen et al., 2012) and this should be a concern to the researcher. At each level of the predictor variable(s), the variance of the residual terms is expected to be constant (homoscedasticity). If variances are very unequal, this is said to be heteroscedasticity (Greenland, 2016). Multicollinearity creates a problem for multiple regression models given that as collinearity increases the standard error of coefficients and makes them less reliable.

For each of the hypothesized relationships, the general forms of the resultant empirical models are presented in Table 3.4 below. Hypotheses was tested at 95% confidence level (α=0.05) and was subjected to regression analysis to determine the influence of innovation incentives and innovation culture on the relationship between NIS factors and institutional linkages in the NIS.

Table 3.4: Summary of Data Analysis Procedures

Hypothesis	Research objective	Data Analysis Technique	Interpretation
H_1:	To establish the effect of NIS factors on the institutional linkages of the National Innovation System in Kenya	Multiple linear regression $Y= \alpha+\beta_1 X_1 +e$ where Y = NIS institutional linkages, β= Co-efficient, X_1 = NIS Factors e = error term	p-value to test significance. R to show relationship between NIS factors and NIS institutional linkages. R^2 to show the extent to which variations in NIS institutional linkages are explained by NIS factors. F-ratio to show the significance of the model used. p-value for F-test should be below 0.05 for the model to be termed as fit.
H_2:	To investigate the moderating influence of innovation incentives on the relationship between NIS factors and institutional linkages in the National Innovation System in Kenya	Stepwise multiple linear regression (3-Step) using Baron and Kenney (1986). Step1: $Y = \alpha + \beta_1X_1 +\varepsilon$ Step2: $Y = \alpha + \beta_1X_1+ \beta_2X_2+\varepsilon$ Step3: $Y = \alpha + \beta_1X_1+ \beta_2X_2+ \beta_{12(}X_1 X_{2)}+\varepsilon$ where Y = NIS institutional linkages, (β= Co-efficient, X_1 = NIS Factors, X_2 = innovation incentives, X_1 X_2 = Interaction term	R to show relationship between NIS factors and NIS institutional linkages. R^2 to show the extent to which variations in NIS institutional linkages are explained by moderating effect of innovation incentives on NIS factors. F ratio to show the significance of the model used. The p-value for F-test should be below 0.05 for the model to be termed as fit.
H_3:	To determine the intervening influence of innovation culture on the relationship between NIS factors and institutional linkages in the National Innovation System in Kenya	Path analysis (4-Step) using Baron and Kenney (1986). Step1: $Y = \alpha + \beta_1X_1 + \varepsilon$ Step2: $M= \alpha + \beta_1X_1 + \varepsilon$ Step 3: $Y= \alpha + \beta_3M + \varepsilon$ Step4: $Y = \alpha + \beta_1X_1 + \beta_3M+\varepsilon$ Where: Y = NIS institutional linkages, α = intercept/constant, β_1 and β_3 = beta coefficients for X_1 = NIS factors M = innovation culture (mediating variable) while ε = error term	R to show relationship between NIS factors and NIS institutional linkages. R^2 to show the extent to which variations in NIS institutional linkages are explained by intervening effect of innovation culture and NIS factors. F ratio to show the significance of the model used. The p-value for F-test should be below 0.05 for the model to be termed as fit.
H_4:	To determine the joint effect of NIS factors, innovation incentives and innovation culture on NIS institutional linkages	Multiple linear regression Joint effect $Y = \alpha+\beta_1 X_1 + \beta_2 X_2 + \beta_3X_3 +e$ Where (β= Co-efficient, X_1 = NIS Factors, X_2 =innovation incentives and X_3 =innovation culture)	R to show relationship between NIS factors and NIS institutional linkages. R^2 to show the extent to which variations in NIS institutional linkages are jointly explained by innovation incentives, innovation culture and NIS factors.

Hypothesis	Research objective	Data Analysis Technique	Interpretation
			F ratio to show the significance of the model used. The p-value for F –test should be below 0.05 for the model to be termed as fit.
H_5:	To examine reverse causality among the NIS factors and institutional linkages in the NIS in Kenya	$X1(t)=\sum j=1pA11,jX1(t-j)+\sum j=1pA12,jX2(t-j)+E1(t)$ $X2(t)=\sum j=1pA21,jX1(t-j)+\sum j=1pA22,jX2(t-j)+E2(t)(1)$ Where: $X1(t)$=Output at time 1 $X2(t)$=Output at time 2 $E1(t)$=Error 1 at time t $E2(t)(1)$=Error 2 after time t P = Probability A = an arbitrary non-empty set *I (t)] and* $I\text{-}_x$ *(t)* = information available as of time *t* n the entire matrix, and that in the modified universe in which x is excluded.	If the above hypothesis is accepted, we say that X Granger-causes Y. This can be tested by conducting F-test of the null hypothesis that $A12 = 0$, given suppositions of covariance stationarity on $X1$ and $X2$.

Source: Author, 2018

CHAPTER FOUR
DATA ANALYSIS INTERPRETATION

4.0 Introduction

This section covers response rate, tests of null hypotheses, institutional information, descriptive statistics and analysis of the influence of NIS factors, innovation incentives and innovation culture on the institutional linkages of the NIS in Kenya. Multiple, stepwise and linear regression analysis were performed to test null hypotheses. The chapter also presents and interprets the results of the data analysis using tables and figures. In addition, diagnostic tests were conducted and results interpreted based on the output of the analyzed data.

4.1 Response Rate

The sample for the study was 112 respondents; 103 questionnaires were distributed since 6 organizations had shut down by the time the data was being collected and 3 organizations refused to participate in this study. All the questionnaires were successfully delivered to all willing organizations and one respresentative was requested to fill the questionnaire. Only 73 questionnaires were filled and returned after completing them while 30 organizations did not attempt to fill the questionnaires at all. This because the people who were issued with the research tools were not keen to meet the deadline and some were not cooperative after picking the research tool. This gave a response rate of 71% which is a high and adequate rate for this study.

A response rate of 65% is acceptable for such studies (Awino, 2011). This is also affirmed by Tomaskovic- Devey, Leiter and Thompson (2014) who aver that any response rate of about 15.4% is considered as yielding a relatively high response rate considering the demands of the employees in this institutions. The distribution of the organizations as per the responses are displayed as shown in the table below:

Table 4.1: Distribution of the Respondents

	Organizations fall into the following categories:							
Your designation	**Ministry of Higher Education, Science and Technology**	**Innovation hub**	**Ministry of Information Communication Technology**	**ICT professional body**	**Research institution**	**University**	**Count**	**%**
Assistant ICT manager	6%	17%	33%	20%		6%	7	10%
Assistant ICT officer				20%		3%	1	2%
CEO	6%		22%	20%			4	5%
Head of ICT		17%	11%		17%	23%	9	13%
ICT Director	13%			20%	17%	3%	5	7%
ICT officer	12%		11%	20%	50%	39%	20	28%
Lecturer	44%					6%	9	13%
Network administrator	6%						1	1%
Operations Coordinator		66%					3	4%
Procurement Officer			11%				1	1%
Research Grants officer	6%						1	1%
System administrator	6%		11%			13%	6	8%
System analyst						3%	1	1%
Technical Assistant					17%		1	1%
Web master						3%	1	1%
Total	100%	100%	100%	100%	100%	100%	73	100%

From Table 4.1, majority of the respondents were ICT officers (28%). This becauses most of the policy makers for innovation are ICT officers in these institution especially in research institutions where majority (50%) responded and are involved in formulation of policies to address shortfalls identified in the NIS in Kenya. In Science and Technology institutions, lecturers were majority (44%) of the respondents since many of them are in

line with the curriculum to the sectoral needs since universities are under Ministry of Science and Technology and are broadly recognized as vital institutional players in NIS. On innovation hubs, majority (66%) were Operations Coordinator since they are the ones that lead innovation projects and thus understand innovations in these institutions. Majority of respondents from the Ministry of Information Communication Technology were assistant managers (33%) since they provide constant contribution and take control over implementatio of any innovation activity within these institutions. On universities ,majority of the respondents were officers (39%) since they are involved in designing stage of any innovation and monitor innovation stages within the universities. Interestingly, respondents within ICT professional bodies were equally distributed at 20% within the governance structure indicating good flow of knowledge of innovation amongst all staff working in these institutions.

4.2 Diagnostic Tests

These included statistical tests that were performed to test the reliability, validity, normality, linearity and multicolinearity of the variables in this study. These were discussed as explained in the sections below:

4.2.1 Validity test

Cooper and Schindler (2006) defines validity as the capability of a research instrument (in this case, a questionnaire) to quantify what it is intended measure. It reflects the level at which study conclusions offer accurate details of what transpired during the study (Ericksson and Kavalainen, 2008). Validity is of various types: construct, content, face and criterion related validity. Validity is assessed to be good if the research instrument covers a representative sample of the global subject matter being studied. To ascertain content

validity and ensure all areas of study were covered, literature review was done and items needed to measure constructs were identified. The research instrument was piloted in 6 institutions not included in the study that were selected randomly prior to data collection. Any vague, contradictory and unclear questions were pointed out and corrected. As guided by Munyoki (2007), expert opinion was sought to evaluate and update the research instrument for validity.

4.2.1.1 Construct Validity Test using Exploratory Factor Analysis (EFA)

To test validity of all the dimensions of constructs in the questionnaire, an exploratory factor analysis was performed. This was aimed at determining if the individual questions contribute to the constructs as intended in the questionnaire. In this instance exploratory factor analysis was used as a first step in the validation process to establish the structure of factors.

Firstly, the number of factors of the individual statements under each indicator per variable were averaged. Exploratory factor analysis was then conducted to yield one or more factors from the statements under consideration: NIS factors, innovation incentives, innovation culture as influenced by institutional linkages in NIS in Kenyan ICT innovation institutions. The cumulative variance percentage explained by the factors > 60%, Eigen values > 1 (also called the Kaiser Guttman rule) criteria was used to determine the number of factors to be extracted and results were displayed in the table below:

Table 4.2: Factor analysis table of Eigen values

Total Variance Explained						
Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	7.665	45.091	45.091	7.665	45.091	45.091
2	2.167	12.749	57.840	2.167	12.749	57.840
3	1.059	6.232	64.073	1.059	6.232	64.073
4	.889	5.229	69.302			
5	.816	4.799	74.101			
6	.761	4.474	78.575			
7	.674	3.967	82.542			
8	.551	3.242	85.784			
9	.506	2.979	88.763			
10	.426	2.503	91.266			
11	.324	1.908	93.174			
12	.293	1.725	94.898			
13	.280	1.648	96.546			
14	.259	1.525	98.071			
15	.202	1.190	99.261			
16	.120	.706	99.967			
17	.006	.033	100.000			
Extraction Method: Principal Component Analysis.						

Based on the Kaiser Guttman rule(cumulative variance percentage explained by the factors > 60%, Eigen values > 1), the output from table 4.2 shows 64.073% cumulative variance of data is explained by 3 factors whose Eigen values >1 and each having between 4 to 6 statements (Guttman, 1954). This means that the items/statements may be reduced to three factors and hence the three factors can be used for further analysis (the rotation). This indicates that only three factors (institutional factors, educational factors and market factors) were extracted and are significantly observed during innovation by Kenyan ICT institutions. That is, only 3 construct items loaded into their measuring variables. And hence, the 3 items can be used to significantly predict institutional linkages in NIS in Kenyan ICT innovation institutions.

4.2.2 Reliability

Based on the feedback from the pilot test, the questionnaire was modified and a final one developed and further interpretation of overall Cronbach's Alpha values was determined for the main variables in the study. These variables included institutional factors, education factors, market factors, product factors, communication factors, innovation incentives, innovation culture and NIS institutional linkages. The results for Cronbach's Alpha based on standardized items were displayed as shown in the table below:

Table 4.3: Cronbach's Alpha and Reliability Statistics

Items	**Cronbach's Alpha Based on Standardized Items**	**Meaning**
Institutional factors	0.804	Acceptable
Educational factors	0.738	Acceptable
Market factors	0.907	Acceptable
Product factors	0.956	Acceptable
Communication factors	0.933	Acceptable
Innovation incentives	0.973	Acceptable
Innovative culture	0.742	Acceptable
NIS institutional linkages	0.764	Acceptable

From Table 4.3, the Cronbach's Alpha value based on all standardized items greater than 0.7 which is within a good reliability range. Hence this indicates that the research study tool was reliable.

4.2.3 Validity

Content validity was carried out to check how well the instrument was used to measure the NIS factors, innovation incentives, innovation culture and institutional linkages in the NIS. Content validity was carried out by use of a structured questionnaire to measure a

theoretical construct for each key indicator that was used to measure NIS institutional linkages. This was used to measures how well some test items or questions measured particular characteristics or variables (NIS factors,innovation incentives,innovation culture and NIS Institutional linkages) in the model.

A pre-test was carried out by use of 6 research questionnaires that were distributed to institution in a given category from the study to test the construct validity. The organization that was piloted was not included in the main study.

4.2.4 Normality

Normality was tested by Shapiro-Wilk test. The normality for each variable to eliminate biasness during inclusion of respondents in the sample size and data collection is discussed in the following sections:

4.2.4.1 National Innovation System (NIS) Factors

The response in this variable was collected based on institutional factors, educational factors, market factors, product factors and communication factors. The test for normality on this response was carried out and the results were displayed as shown in the table below:

Table 4.4: Normality Test for NIS Factors

		Shapiro-Wilk	
National Innovation System (NIS) factors	Statistics	Df	Sig.
Institutional factors	.343	4	.220
Educational factors	.385	4	.079
Market Factors	.306	4	.328
Product factors	.260	4	.089
Communication Factors	.385	4	.720

From Table 4.4, based on the Shapiro-Wilk tests, the significance value for all of the National Innovation System factors is not significant since *p*-value > 0.05 for Shapiro-Wilk tests. This indicates probability values greater than 0.05 for inclusion of respondent in the sample size to enhance objectivity of data collection and hence this means the data collected on this variable is normal. The application of Shapiro-Wilk test is because sample size was greater than 50.

4.2.4.2 Innovation Incentives

The response in this variable was collected based on policy, infrastructure, knowledge and resources. The test for normality on this response was carried out and the results were displayed as shown in the table below:

Table 4.5: Normality Test for Innovation Incentives Factors

	Shapiro-Wilk		
Innovation incentives	Statistics	df	Sig.
Policy	.443	4	.420
Infrastructure	.275	4	.061
Knowledge	.234	4	.671
Resources	.617	4	.072

From Table 4.5, the significance value for all of the innovation incentives is not significant, since the *p*-value > 0.05 for Shapiro-Wilk tests. This indicates that the probabilities are greater than 0.05 for inclusion of respondent in the sample size to enhance objectivity of data collection. Hence this means the data collected on this variable was normal.

4.2.4.3 Innovation Culture

The response in this variable was collected based on organizational learning, customer focus, employment and team orientation. The test for normality on this response was carried out and the results were displayed as shown in the table below:

Table 4.6: Normality Test for Innovation Culture Factors

	Shapiro-Wilk		
Innovation Culture	Statistics	Df	Sig.
Organizational learning	.403	4	.520
Customer Focus	.287	4	.661
Employment	.242	4	.601
Team Orientation	.517	4	.425

From Table 4.6, based on the Shapiro-Wilk test, the significance value for all of the innovation cultures is not significant since p-value > 0.05 for Shapiro-Wilk tests. This indicates that the probabilities is greater than 0.05 for inclusion of respondent in the sample size to enhance objectivity of data collection. Hence this mean the data collected on this variable was normal.

4.2.4.4 NIS Institutional linkages

The response in this variable was collected based on joint research, personal exchanges,cross-patenting and purchase of equipment.The test for normality on this response was carried out and the results were displayed as shown in the table below:

Table 4.7: Normality Test for NIS Institutional linkages

	Shapiro-Wilk		
NIS Institutional linkages	Statistics	df	Sig.
Joint Research	.891	4	.520
Personal exchange	.754	4	.661
Cross-patenting	.143	4	.601
Purchase of Equipment	.612	4	.425

From Table 4.7, based on the Shapiro-Wilk tests, the significance value for all of the NIS institutional linkages is not significant since *p*-value > 0.05 for Shapiro-Wilk tests. This indicates that the probabilities are greater than 0.05 for inclusion of respondent in the sample size to enhance objectivity of data collection. Hence this mean the data collected on this variable is normal.

4.3 Institutions Information

This sub-section presents the analysis of the general information of the respondents. For this study, general information section focused on the year of establishment, level of innovation, number of employees, how long has the respondent worked in target institution and current level of education for each respondent. These were further discussed as follows:

4.3.1 Year of Establishment

The respondents were asked to indicate the years of establishment of the institution that they were working in at the time of the interview and they responded as shown in the table below:

Table 4.8: Institution Year of Establishment

Year	Frequency	Percent	Cumulative Percent
1908-1928	4	5%	5%
1929-1949	2	3%	8%
1950-1970	2	3%	11%
1971-1991	14	19%	30%
1992-2012	34	47%	77%
After 2012	17	23%	100%
Total	73	100	

From Table 4.8, cumulatively, most of the institutions were established from 1971 onwards. This is so because some of the ministries were not formed by then. For example Ministry of Science and Technology was founded in 2009 by the national government under the office of the president with the aim of funding, formulating policy and planning of the ST& I sector.

4.3.2 Level of Innovation

The respondents were asked to indicate the level of innovation for the institution that they were working in at the time of the interview and they responded as shown in the figure below:

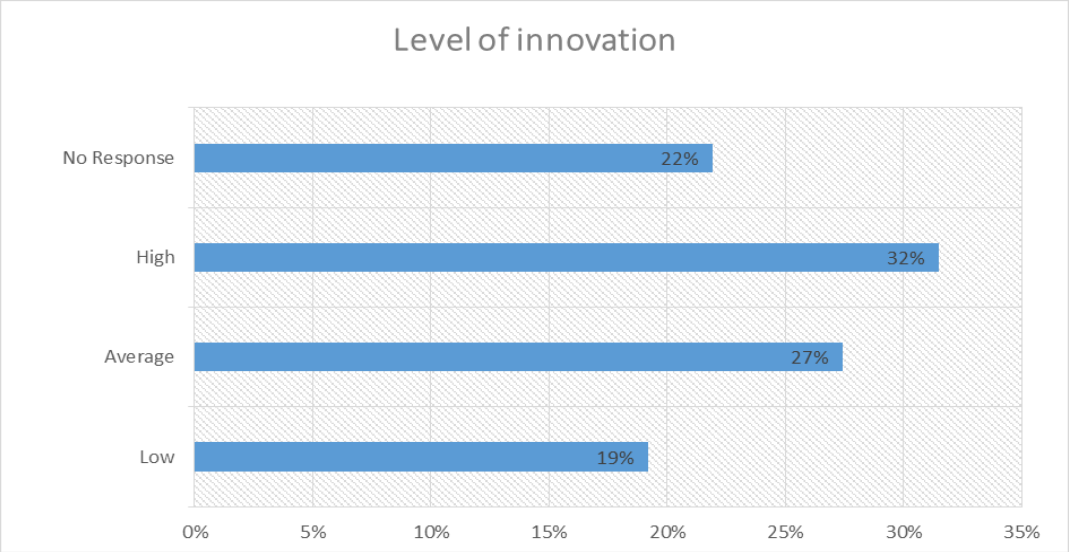

Figure 4.1: Level of Innovation for the Institution

From Figure 4.1, majority of the respondents rated the level of innovation in their institutions as high.

4.3.3 Number of Employees

The respondents were asked to indicate the number of employees working in their institutions at the time of the interview and they responded as shown in the table below:

Table 4.9: Number of Employees

Employees	Number	Percentage
1-500	52	71%
501-1000	8	11%
1001-1500	3	4%
1501-2000	2	3%
2001-2500	4	5%
2501-3000	3	4%
3001-3500	1	1%
Total	73	100

From Table 4.9, majority of the respondents had less than 500 employees. The respondents were asked to respond based on the number of employees within the department and in the organization that are involved in innovation. Since most of these institutions are barely less than 50 years old, then this indicates that many are starting or are expanding hence many have less than 500 employees. Many of the innovations in these firms are being implemented in ICT department which is mostly a function with few employess. Hence from this results, it indicates that very few employees contribute to the innovation process which may impair the diffusion of innovations within the firms and on their social networks.

4.3.4 Duration of Working in the Institution

The respondents were asked to indicate how long they had worked for their institutions at the time of the interview and they responded as shown in the figure below:

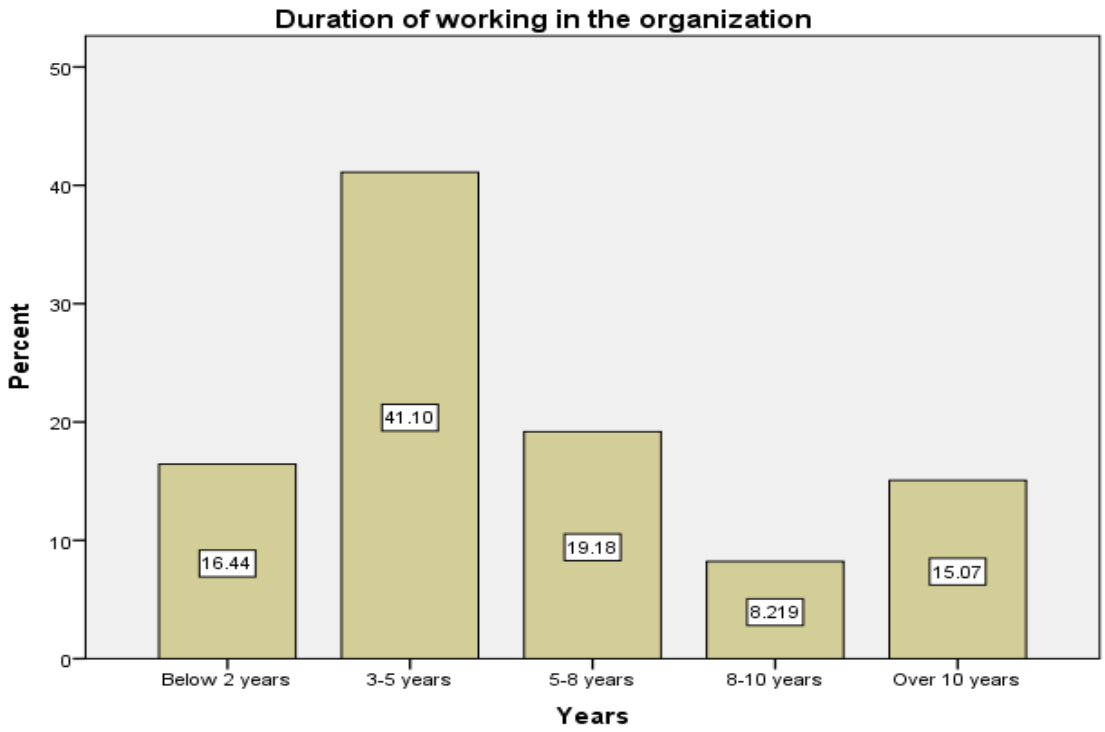

Figure 4.2: Duration Working for the Institution

From Figure 4.2, majority of the respondents had worked between 3-5 years in the same institution. This reflects the profile of the respondents in the organizational hierarchy, majority of whom were either at officer level or were assistant managers . The duration is adequate for the employees to understand the institution and its functions and hence its easy to understand any implementation of innovation system.

4.3.5 Level of Education

The respondents were asked to indicate their level of education as per their professional bodies and their responses are shown in the table below:

Table 4.10: Current Level of Education * member of any Professional Bodies Cross Tabulation

	Member of any professional body		Total
Level of education	No	Yes	
Diploma	7.1%	2.2%	4.1%
Postgraduate	53.6%	68.9%	63.0%
Undergraduate	39.3%	28.9%	32.95
Total	100%	100%	100%

From Table 4.10, majority of the respondents had a postgraduate level of education and a majority of them were members a professional body. This is so because many of the respondents were from Ministry of Science and Technology which includes universities whose majority of employees have postgraduate qualification. This also explains why the level of innnovation is high in Kenya since many were involved in partnering with other professional bodies to improve on their skills and knowledge.

4.4 Descriptive Statistical Analysis of Key Indicators

The key indicators in this study were national innovation system factors, Innovation incentives, Innovative culture and NIS Institutional linkages.These were measured based on likert scale as 1 = not at all; 2 = less extent; 3= moderate extent; large extent =4 and very large extent = 5. These were analyzed and discussed as shown below:

4.4.1 National Innovation System (NIS) Factors

These factors were grouped into educational, market,products, institutional and communication factors. Education factors sought information on whether R&D is undertaken in collaboration with other institutions, there is adequate funding of universities to facilitate R&D in the country, government invests in technical and vocational training and we encourage staff to develop competences in areas of interest aligned to market needs.

Market factors sought information on explicit governmental policies for protecting the local market innovations from foreign innovations, whether there are strong intellectual property rights to encourage foreign companies invest their most advanced technologies in the country, that there is great need for respondent institution's existing products among its clients, that there is great need for respondent institution's new products among its clients and the market easily embraces new ideas and/or products.

Product factor sought information on whether production of goods and services is becoming more technology-intensive, production of goods and services in respondent's institution is becoming more skills-intensive,respondent's institution have adequate resources to produce prototypes and that the institution carries out effective R&D.

Communication factors included statements on whether respondent's institution is innovative in organization and management to enable technology diffusions,there are frequent collaborations between industry and public research institutes and large private firms share their R&D with smaller firms and startups.Institutional factors included statements on whether respondent's institution has regular interactions with stakeholders

for various reasons such as regulation and sourcing new knowledge,they have in place efficient systems to generate knowledge,they package knowledge into marketable products,they have policies that govern internal and external communications,they ensure regular sharing of knowledge and skills through induction programmes for new staff and inhouse training as well as address knowledge gap through measures such as hiring specialists and conducting inhouse R&D. The statements on each of the factors were responded on and average was taken to represent each factor to describe national innovation system(NIS). These were then presented in the table below:

Table 4.11: Descriptive Statistics

	N	Mean		Std. Deviation
	Statistic	Statistic	Std. Error	Statistic
Institutional Factors	73	3.75	.079	.672
Educational factors	73	3.36	.095	.809
Market Factors	73	3.52	.083	.708
Product Factors	73	3.55	.094	.802
Communication Factors	73	3.26	.108	.920

From Table 4.11, the average of the respondents on National Innovation system (NIS) was based on the response of 73 participants. This implies that an innovation system is regulated by the current firms and rules affecting the actors' performance and laws on the advanced technologies.

4.4.2 Innovation Incentives

This study sought to find out the innovation incentives that influence institutional linkages of various actors in the NIS in Kenya. Response on innovation incentives was classified into policy, infrastructure, knowledge and resources. Policy component was guided by whether respondent's firm has policy incentives to promote innovation, offers conducive

environment to enhance innovation, trains staff with skills that are relevant in promoting innovation at service and product level, and sets aside and utilizes critical resources that are geared towards fostering innovation.Infractructure component was guided by respondent's firm in collaboration with institutions performing R&D in the innovation process,collaboration with institutions financing R&D in the innovation process,existence of explicit governmental policies for offering significant subsidies for foreign investors in the country, and firm'sawareness of the tax subsidy accrued from training staff with trainers approved by government's national industrial training authority (NITA).

Knowledge component was guided by whether respondent firm has access to knowledge-intensive services,the scope of technology diffusion promoted by the firm's ability for identifying, accessing and incorporating new knowledge and techniques,whether firm encourages flexible management structures, organizational change and training, and whether the government promotes the firm's interaction with public research through partnership schemes, co-operative research and matching funding. Resources component was guided by whether respondent's firm has access to capital for financing innovations e.g. private venture capital, government grants and fund, donor funds, subsidized loans, etc, whether government addresses specific factors that restrain the firm's entrepreneurial technology-based projects such as taxes, whether government has reformed regulations which unduly inhibit entrepreneurship and there are not regulatory barriers to entry within the national innovation policy for new institutions. The statements on each of the factors were responded on and average was taken to represent each factor to describe innovation incentives. These were then presented in the table below:

Table 4.12: Descriptive Statistics of Innovation Incentives

	N	Mean		Std. Deviation
	Statistic	Statistic	Std. Error	Statistic
Policy	73	3.60	.187	1.594
Infrastructure	73	3.76	.267	2.285
Knowledge	73	3.58	.103	.877
Resources	73	3.28	.105	.900

From Table 4.12, policy was rated to large extent as per the Likert scale. This means that the Kenyan governments conduct the role of coordinator among research initiators regarding their visions, perspectives and policy instruments for the future improvement in innovation. Infrastructure was rated to large extent in that many of these institutions invest a lot in the infrastructure so that they can lay a strong foundation for innovation which will enhance strong connections among each other. Knowledge was also rated to a larger extent which implies that there is a national trend of innovation, technology flow and learning within these institutions. Resources were rated to moderate extent which means that many of these institutions lack enough resources to implement innovation and hence this can slow pace of development of technology in Kenya.

4.4.3 Innovative Culture

This study sought to determine the influence of innovation culture on the relationship between NIS factors and institutional linkages in the NIS in Kenya. Response on innovation culture was classified into organizational learning, customer focus, empowerment and team oreientation. Organization learning was guided by whether

respondent's firm encourages investment in skills and improves, channels for disseminating technology and codified knowledge include information networks, has demonstration and benchmarking schemes, and the firm's organizational culture is conducive for innovation and entrepreneurship.

Customers focus was guided by whether respondent firm's innovative processes rest on a sound knowledge base informed by market research, firm is market-oriented, firm profits strongly from product and process innovations that have a high IT content and operates a linked set of processes involved in concept generation or market identification, product and process development, production, market introduction and feedback.

Empowerment was by whether respondent firm's flexible labor markets facilitate the transfer of skills between enterprises and within the innovation system,scientific advances are the firm's wellspring of technical innovation,firm uses university and government research directly through joint research or acquisition of patents and licenses and whether the firm relies on the science base for trained personnel and access to methods and techniques. Team orientation was guided by whether respondent firm has better access and exploit new technologies, employs industry cost-sharing through better designed and integrated public schemes,skill requirements in the firm includes working in teams and maintaining interpersonal relationships and whether the firm innovates through strong forward and backward interactions with suppliers and customers. The statements on each of the factors were responded on and an average was taken to represent each factor to describe innovation culture. These were then presented in the table below:

Table 4.13: Descriptive Statistics of Innovation Culture

	N	Mean		Std. Deviation
	Statistic	Statistic	Std. Error	Statistic
Organizational Learning	73	3.67	.101	.860
Empowerment	73	3.71	.253	2.164
Team Orientation	73	3.68	.200	1.710
Customer Focus	73	3.55	.111	.950

From Table 4.13, Organizational Learning was rated to large extent which means that it affects innovation since from other studies it was confirmed that 30% to 50% of a society's innovative ability is affected by the national culture. Empowerment was rated to large extent and this means that after new innovations are put in place then employees get used to it and henced they are likely to be empowered. This also can lead to frequent personnel exchange of innovation among thed main actors of innovations.

Team orientation was rated to large which means that information about innovation is sourced from ICT-based institutions and users require orientation to effectively work with a lot of independency. Customer focus was rated to a large extent since institutional linkages require cross patenting and purchase of equipment and facilities which hence demands that customers should be well thought about since they are the final consumers of innovations.

4.4.4 NIS Institutional Linkages

Response on NIS institutional linkages was classified into joint research, personnel exchanges,cross-patenting and purchase of equipment. Joint research component was guided by whether respondent's firm has increasing number of inter-sectoral joint research

being carried out betweenit and the industry, the firm shares and continuously implements findings of the joint research with its peers, and whether there are forums for inter-sectoral research interactions. Personnel exchange was based on whether the firm has an effective personnel exchange programme, always engages the stakeholders in every aspect of personnel exchanges and staff on exchange programmes introduce new ideas.

Cross-patenting was based on whether the firm has effective and regularly updated patenting policy, is aware of databases for accessing patents and licensing offices, and whether its patenting activity is growing rapidly.Purchase of equipment was based on whether respondent's firm efficiency and intensity of innovative activity depends on access to capital,whether the firm uses the latest hardware in realizing business objectives and wether the firm has an IT-asset policy with clear timelines on when to replace/upgrade its hardware. The statements on each of the factors were responded on and average was taken to represent each factor to describe NIS institutional linkages .These were then presented in the table below:

Table 4.14 Descriptive Statistics of NIS Institutional Linkages

	N	Mean		Std. Deviation
	Statistic	Statistic	Std. Error	Statistic
Joint Research	73	3.31	.100	.857
Personal Exchanges	73	3.18	.130	1.113
Cross-patenting	73	3.47	.230	1.967
Purchase of equipment	73	3.69	.110	.941

From Table 4.14, joint research was rated moderate extent which means that there is still need for various actors to work close during the development of new innovations by these institutions. Personal Exchanges was rated to moderate extent which means that majority of these institutions need to encourage personnel exchange when they are conducting NIS institutional linkages.

4.5 Test of Hypotheses and Interpretation of the Study Objectives

Data was analyzed in this section based on the objectives of the study. Key inferential statistics were then used to test the significance of the effects and influence of the key indicators and estimate the sample statistics into parameters to measure population and guide in general interpretation. Path analysis, that entails use of correlation and regression analysis, was used to derive the coefficients and strength of influence for the key indicators. This was achieved using Amos in SPSS.

Structural Equation Modeling (SEM) is quantitative research technique that can also incorporate qualitative methods hence it is best suited for this study. SEM is used to show the causal relationships between variables. This method indicates the influence of the relationship between independent and dependent variables. SEM also explains the effect by indicating the direction of the relationships that exists within the variables. SEM is best used when processing multiple regression of Likert scaled data. The relationships shown in SEM represent the hypotheses of the research. Also, it indicates the relationship between variables and other indicators that are used to measure the variables involved in the study. Typically, these relationships cannot be statistically tested for directionality based on the hypothesis formulated to guide this study.

SEM is mostly used for research that is designed to confirm a research study design rather than to explore or explain a phenomenon as described in this study where the effects of innovation incentives, innovative culture and NIS factors on NIS institutional linkages. That is to say that a researcher may be interested in the strength of the relationships between variables in a hypothesis, and SEM is a way to examine those variables without committing to an expensive research project. SEM produces data in a visual display as shown in the figure below which is part of its appeal. When using SEM, the researcher gets a tidy visual display that is easy to interpret, even if the statistics behind the data are quite complex.

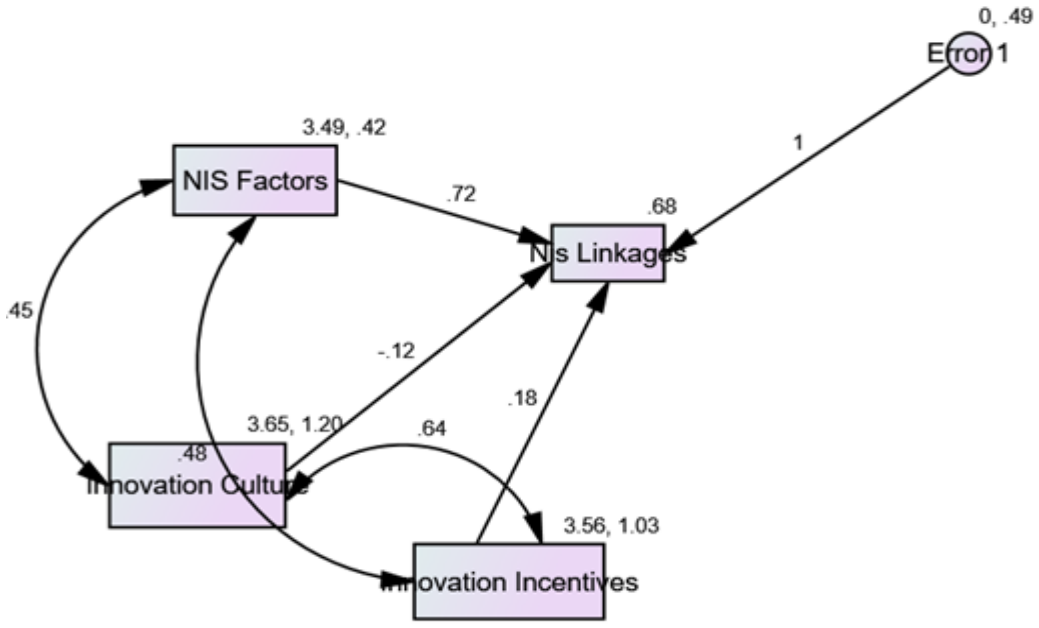

Figure 4.3 Path analysis (Source: Author, 2018)

The items in Figure 4.3 indicate the weights and covariances between and amongst the dependent variables using the double-edged arrows. The uni-directional arrows indicate the paths and weights between individual dependent variable and the independent variable with error term introduced on the dependent variable.

Table 4.15: Labels to the Path Analysis diagram

Item	Value
Covariance between NIS factors & Innovation incentive	.48
Covariance between NIS factors & Innovative culture	.45
Covariance Innovation incentives & Innovative culture	.64
Path between NIS factors & NIS linkages	.72
Path between Innovation culture & NIS linkages	.12
Path between Innovation incentives & NIS linkages	.18
Error path	1

The Table 4.15 above indicates there exists positive relationship between NIS factors and innovation incentives which is shown by (cov= 0.48). This might also bring the pooled influence of the two variables on the dependent variable positively. There exists positive relationship between NIS factors and innovation culture which is shown by (cov= 0.45). This might also bring the pooled influence of the two variables on the dependent variable positively. There exists positive relationship between innovation culture and innovation incentives which is shown by (cov= 0.64). This might also bring the pooled influence of the two variables on the dependent variable positively. The path between NIS factors and NIS linkages has a weight of 0.72 which indicates that NIS factors has a positive influence on NIS linkages. The path between innovation culture and NIS linkages has a weight of 0.12 which indicates that innovation culture has a positive influence on NIS linkages. The path between innovation incentives and NIS linkages has a weight of 0.18 which indicates that innovation incentives has a positive influence on NIS linkages.

The general objective of this research was to investigate the influence of innovation incentives and innovation culture on the relationship between NIS factors and institutional linkages in NIS in Kenya. To meet this objective, five specific objectives and their respective hypotheses were set and formulated accordingly. In order to attain the objectives and test the hypotheses, the research study applied several inferential statistical functions. Influence of independent variables on dependent variable was ascertained using simple and multiple regression analyses. On the other hand, moderating effect was tested via hierarchical regression. From regression analyses, various values were derived including F-Change, p-values, R, R^2, R adjusted and t-values. Strength of the relationship between variables is indicated by R while R^2 reflects extent to which variations in indicators are interpreted. Statistical significance of the overall model is explained by F-value while significance of individual variables is explained using t-values.

Beta values depict effect (positive or negative) of the independent variable on the dependent variable while p-values show the level of significance. For this study, relationships were tested at 95% confidence level (p-value = 0.05) where decision to accept hypothesis (*i.e. reject null hypothesis*) was arrived at values of F-ratio with p-values < 0.05 and reject hypothesis ((*i.e. accept null hypothesis*) where p-value> 0.05. Lastly, to test intervening and moderating effect, hierarchical regression analysis was applied where the intervening or moderating variables were added to independent variables to establish the direct influence of independent variables on dependent variable.

4.5.1 The Relationship of NIS Factors on the Institutional Linkages of the National Innovation System in Kenya

The effect of NIS factors on the institutional linkages of the National Innovation System in Kenya was studied using multiple regression analysis. This relationship was also tested by using null hypotheses which was stated as **H_{01}:** NIS factors have no significant effect on the institutional linkages in the NIS.

The variation in the model were explained based on the model summary table as shown below:

Table 4.16: Model Summary of NIS Factors

Model	R	R^2	Adjusted R^2	Std. Error of estimates	F-change	Sig. F-change
1	.614	.377	.330	.729	8.102	0.001

From the Table 4.16, R=0.614. This indicates that there exists a strong positive relationship between NIS factors and NIS institutional linkages. Using adjusted R^2 = 0.330, the model can show up to 33% of variations when estimating the effects of NIS factors on the institutional linkages of the National Innovation System to the larger population in general. The hypothesis was tested with the results computed using ANOVA and the outcomes shown in the table below:

Table 4.17: ANOVA table of NIS Factors

Model	Sum of Squares	Df	Mean Square	F	Sig.
Regression	21.557	5	4.311	8.102	.021
Residuals	35.651	67	.532		
Total	57.207	72			

From the Table 4.17, using F-test, the p=0.021 which is significant at p<0.05. Since the p-value of F <0.05, it led to rejection of the stated null hypothesis (**H_{01}**) and thus conclude that NIS factors have significant effect on the institutional linkages in the NIS in Kenya.

The relationship between NIS factors and NIS institutional linkages was further analyzed and the results were displayed in the table below:

Table 4.18: Effects of NIS factors on Institutional linkages of the National Innovation System

	Coefficients	Standard error			Collinearity statistics	
	β	ε	t	Sig.	Tolerance	VIF
Constant	.910	.514	1.771	.041		
Institutional factors	-.084	.189	-.411	.031	.456	2.194
Education factors	.191	.160	1.198	.025	.442	2.263
Market factors	.242	.225	1.073	.027	.290	3.448
Product factors	.081	.163	.499	.019	.431	2.319
Communication factors	.316	.135	2.246	.043	.482	2.074

From the Table 4.18, institutional factors have a negative significant effect at p-value<0.05. This indicates that NIS institutional linkages strengthens if institutional factors reduce hence giving a negative effect which is significant. Effect of NIS factors on Institutional linkages of the National Innovation System was presented using a linear multiple regression equation which was stated as shown below:

Y= 0.910 - 0.084*Institutional factors + 0.191*Educational factors + 0.242*Market Factors + 0.081*Product factors + 0.316*Communication factors

The model indicated that only institutional factors had a negative effect on Y(Institutional linkages in the National Innovation System in Kenya)

4.5.2 Influence of Innovation Incentives on the Relationship between NIS Factors and Institutional linkages in the National Innovation System in Kenya

The influence of innovation incentives on the relationship between NIS factors and institutional linkages in the NIS in Kenya was determined using stepwise multiple linear regression analysis. This relationship was also tested by using null hypotheses which was stated as **H_{02}:** Innovation incetives have no significant moderating effect on the relationship between NIS facors and institutional linkages in the NIS in Kenya.

First, the effect of NIS factors on institutional linkages in the NIS in Kenya was studied. This effect was tested using three steps of Baron and Kenny(1986). The first step was to find out the effect of NIS factors on NIS institutional linkages, second step tested the influence of innovation incentives on NIS institutional linkages and the third step tested the effect of interaction between NIS factors and innovation incentives on NIS institutional linkages. The influence of interation term is displayed below:

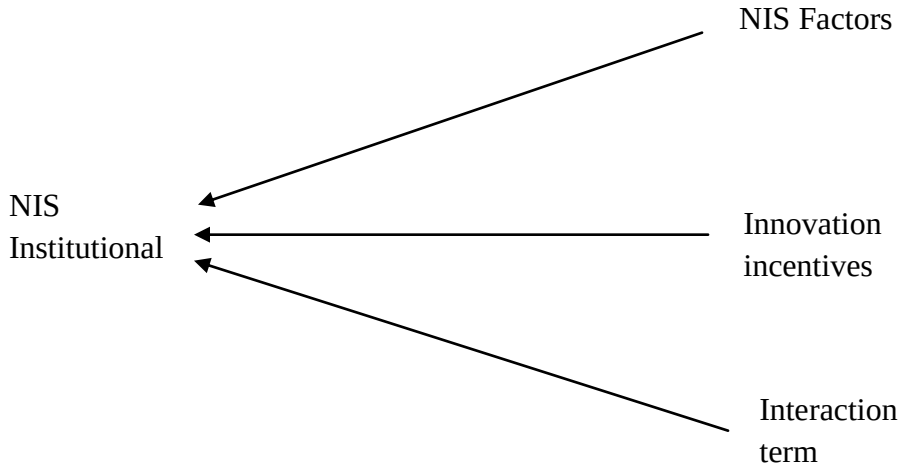

Figure 4.4: Influence of Interaction Term (Source: Author, 2018)

The findings of these tests are presented in the table below:

Table 4.19: Regression results Depicting Moderating effect of innovation Incentives on the Relationship between NIS factors and NIS Institutional Linkages

Model summary							
Model		R	R^2	Adjusted R^2	Std. Error of estimates	F-change	Sig. F-change
1		.591	.350	.341	.724	38.194	0.023
2		.603	.363	.345	.721	5.890	0.003
3		.609	.370	.343	.723	4.175	0.385
ANOVA							
Model		Sum of Squares	Df	Mean Square	F	Sig.	
1	Regression	20.010	1	20.010	38.194	.000	
	Residual	37.197	71	.524			
	Total	57.207	72				
2	Regression	20.787	2	10.394	19.977	.000	
	Residual	36.420	70	.520			
	Total	57.207	72				
3	Regression	21.184	3	7.061	13.525	.000	
	Residual	36.024	69	.522			
	Total	57.207	72				
Co-efficients							
Model		Unstandardized co-efficients		Standardized co-efficients	t	Sig.	Collienarity
		B	Std. Error	Beta			Tolerance / VIF
1	(Constant)	.599	.463		1.295	.200	
	NIS Factors	.806	.130	.591	6.180	.000	1.000 / 1.000
2	(Constant)	.666	.464		1.434	.016	
	NIS Factors	.634	.192	.465	3.306	.001	.460 / 2.176
	Innovation incentives	.150	.123	.172	1.222	.026	.460 / 2.176
3	(Constant)	-.443	1.355		-.327	.045	
	NIS Factors	.917	.378	.673	2.428	.018	.119 / 8.422
	Innovation incentives	.553	.478	.633	1.156	.022	.030 / 2.864
	Interaction term	.102	.117	.635	.871	.387	.017 / 8.290

a. Dependent Variable: NIS Institutional linkages
b. Predictors in the Model: (Constant), National Innovation System (NIS)factors
c. Predictors in the Model: (Constant), National Innovation System (NIS)factors, Innovation Incentives

The findings of step one, two and three are shown in Table 4.19 above. The findings of step one indicates that NIS factors (B=.806,p-value=0.000<0.05) has a positive significant inflect on NIS institutional linkages. The model has R=0.591, which indicates that there exists a strong positive relationship between NIS factors on NIS institutional linkages. Using adjusted R^2 =0.341, the model can show up to 34.1% of variation when estimating the relationship between NIS factors on NIS institutional linkages to the larger population in general. Step two results indicates that NIS factors (B=.634,t=3.306,p<0.05) and Innovation incentives(B=.150,t=1.222,p<0.05) have a positve significant inflect on NIS institutional linkages. R=0.603, this indicates that there exists a strong positive relationship of innovation incentives and NIS factors on NIS institutional linkages. Using adjusted R^2 =0.345, the model can explain upto 34.5% of the variation when estimating the effects of the NIS institutional linkages based on NIS factors and innovation incentives to the larger population in general. In the third step, the effect of interaction term on controlling the two independent variables (NIS factors and innovation incentives) was not statistically significant (B=.102,t=.871,p>0.05). The insignificant of the interaction term indicated a possibility of NIS factors and innovation incentives being independent contributors to influencing NIS institutional linkages. The model explaining the relationship was statistically significant and accounted for 34.3% explained variation (Adjusted R^2 =0.343,F=13.525,p<0.05).

The VIFs of all the variables is <10 and tolerances is >0.10, hence there is no presence of multicolinearlity among the variables that were used to develop the model to determine the moderating influence of innovation incentives on the relationship between NIS factors and the institutional linkages of the National Innovation System in Kenya. The influence of these relationship was studied using stepwise multiple linear regression equation which was stated as follow:

Y= -.443+ .0917* NIS factors + 0.553* Innovation incentives + 0.102 * Innovation incentives and NIS factors.

The findings led to accepting null hypothesis $\mathbf{H_{02}}$ that stated innovation incentives have no significant moderating effect on the relationship between NIS factors and institutional linkages in NIS in Kenya. This then results to a revised model after dropping insignificant moderating component (i.e. p=0.387 of interaction term, thus p>0.05) as follows:

Y= -.443+ .0917* NIS factors + 0.553* Innovation incentives

4.5.3 The Influence of Innovation Culture on the Relationship between NIS Factors and Institutional linkages in the National Innovation System in Kenya

The influence of innovation culture intervening the relationship between NIS factors and institutional linkages in the National Innovation System in Kenya was determined using path analysis and followed four steps analysis as described below. This effect was also tested by using null hypotheses which was stated as $\mathbf{H_{03}}$**:** Innovation culture has no significant intervening effect on the relationship between NIS facors and institutional linkages in the NIS in Kenya.

The first step was to find the influence of NIS factors on NIS institutional linkages .The second step was to determine the influence of NIS factors on innovation culture.The third step was to determine the influence of innovation culture on NIS institutional linkages and the fourth step was to determine the effect of NIS factors and innovation culture on NIS institutional linkages. The direct and indirect effect in testing for the intervening effect was as presentesd in the path diagram below:

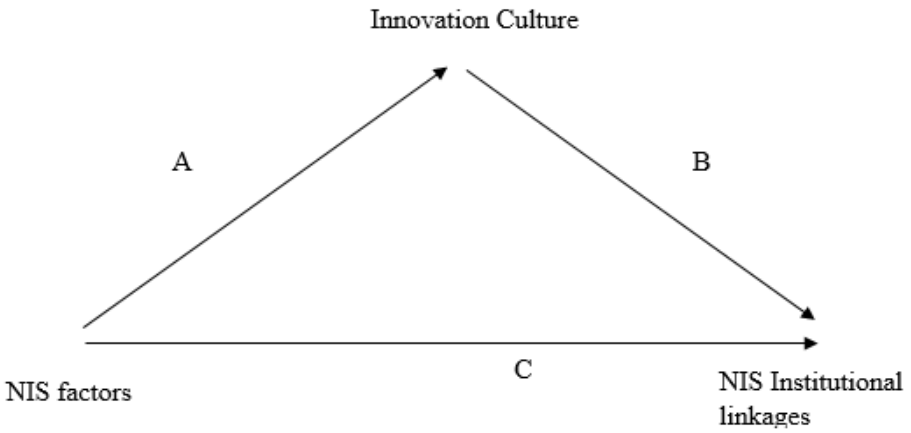

Figure 4.5 Path diagram for intervening effect (Source: Author, 2018)

Step one of the testing intervening effect of innovation culture on the relationship between NIS factors and NIS institutional linkages was performed. This step involved evaluating the influence of NIS factors on NIS institutional linkages.The results were as shown in Table 4.20 below:

Table 4.20: Influence of NIS factors on NIS Institutional linkages

Model summary					
Model	R	R^2	Adjusted R^2	Std. Error of estimates	
1	.591	.350	.341	.724	
ANOVA					
	Sum of Squares	Df	Mean Square	F	Sig.
Regression	20.010	1	20.010	38.194	.000
Residual	37.197	71	.524		
Total	57.207	72			
Co-efficients					
	Unstandardized co-efficients		Standardized co-efficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	.599	.463		1.295	.200
NIS factors	.806	.130	.591	6.180	.000

a. Dependent Variable: NIS Institutional linkages
b. Predictors: (Constant), National Innovation System (NIS)factors

From Table 4.20 indicates that the influence of NIS factors and NIS institutional linkages had a positive significant effect (B=0.806,p<0.05). This indicates that an increase in NIS factors increases NIS institutional linkages. R=0.591, which indicates that there exists a strong positive relationship between NIS factors on NIS institutional linkages. Using adjusted R^2 =0.341, the model can show up to 34.1% of variation when estimating the relationship between NIS factors on NIS institutional linkages to the larger population in general. The results confirmed the first step of testing for intervening effect of innovation culture on the relationship between NIS factors and NIS institutional linkages since it was significant.

The second step for testing the intervening effect of innovation culture on the relationship between NIS factors and NIS institutional linkages involved testing the influence of NIS factors on innovation culture. The results were shown in Table 4.21 below.

Table 4.21: Influence of NIS Factors on Innovation culture

Model Summary					
Model	R	R^2	Adjusted R^2	Std.Error of estimates	
1	.628	.394	.386	.864	
ANOVA					
	Sum of Squares	Df	Mean Square	F	Sig.
Regression	34.475	1	34.475	46.175	.000
Residual	53.010	71	.747		
Total	87.484	72			
Co-efficients					
	Unstandardiesed co-efficients		Standardiesed co-efficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	-.035	.552		-.063	.950
NIS factors	1.058	.156	0.628	6.795	.000

a. Dependent Variable: Innovation culture
b. Predictors: (Constant), National Innovation System (NIS)factors

From Table 4.21 indicates that the influence of NIS factors and innovation culture had a positive significant effect (B=1.058,p<0.05). This indicates that an increase in NIS factors increases innovation culture. R=0.628, which indicates that there exists a strong positive relationship between NIS factors on NIS institutional linkages. Using adjusted R^2 =0.386, the model can show up to 38.6% of variation when estimating the relationship between NIS factors on innovation culture to the larger population in general. The results confirmed the second step of testing for intervening effect of innovation culture on the relationship between NIS factors and NIS institutional linkages since it was significant.

The third step for testing the intervening effect of innovation culture on the relationship between NIS factors and NIS institutional linkages involved testing the influence of innovation culture on NIS institutional linkages.The results were shown in Table 4.22 below:

Table 4.22: Influence of Innovation Culture on NIS Institutional Linkages

Model summary					
Model	R	R^2	Adjusted R^2	Std. Error of estimates	
1	.307	.094	.081	.854	
ANOVA					
	Sum of Squares	Df	Mean Square	F	Sig.
Regression	5.389	1	5.389	7.384	.008
Residual	51.818	71	.730		
Total	57.207	72			
Co-efficients					
	Unstandardized co-efficients		Standardized co-efficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	2.503	0.348		.000	2.503
Innovation culture	.248	.019	2.717	.008	.248

a. Dependent Variable: NIS Institutional linkages
b. Predictors: (Constant), Innovation culture

From Table 4.22 indicates that the influence of innovation culture on NIS institutional linkages had a positive significant effect (B=0.248,p<0.05). R=0.307, which indicates that there exists a weak positive relationship between innovation culture on NIS institutional linkages. Using adjusted R^2 =0.094, the model can show up to 9.4% of variation when estimating the relationship between innovation culture and NIS institutional linkages to the larger population in general. The results confirmed the third step of testing for intervening effect of innovation culture on the relationship between NIS factors and NIS institutional linkages since it was significant.

The fourth step for testing the intervening effect of innovation culture on the relationship between NIS factors and NIS institutional linkages involved testing the influence of innovation culture and NIS factors on NIS institutional linkages. The results were shown in Table 4.23 below:

Table 4.23 Influence of Innovation Culture on NIS Institutional Linkages

Model summary					
Model	R	R^2	Adjusted R^2	Std. Error of estimates	
1	.676	.458	.426	.676	
ANOVA					
	Sum of Squares	Df	Mean Square	F	Sig.
Regression	22.019	4	5.505	10.638	.008
Residual	35.188	68	.517		
Total	57.207	72			
Co-efficients					
	Unstandardized co-efficients		Standardized co-efficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	-1.220	1.179		-1.035	0.304
NIS factors	1.342	.314	0.23	4.278	.030
Innovation culture	-0.160	0.096	0.008	-1.671	0.009

a. Dependent Variable: NIS Institutional linkages

b. Predictors: (Constant),NIS factors, Innovation culture

From Table 4.23 indicates that the influence of NIS factors on NIS institutional linkages had a positive significant effect (B=1.342,p<0.05) and innovation culture on NIS institutional linkages (B=-0.160,p<0.05). R=0.676, which indicates that there exists a strong positive relationship between innovation culture and NIS factors on NIS institutional linkages. Using adjusted R^2 =0.426, the model can show up to 42.6% of variation when estimating the relationship between innovation culture, NIS factors on NIS institutional linkages to the larger population in general. The results confirmed the fourth step of testing for intervening effect of innovation culture on the relationship between NIS factors and NIS institutional linkages since it was significant. Hence this result supports that innovation culture has an intervening effect on the relatioship between NIS factors and NIS institutional linkages. The study therefore rejects the null hypothesis.

The outcome was indicative that the NIS factors intervened by innovation culture influences the NIS institutional linkages of Kenyan ICT institutions.

Since the p-value<0.05 for the ANOVA table using F-test, hence this result leads to rejecting null hypotheses **H_{03}**: Innovative culture has no significant intervening effect on the relationship between NIS factors and the institutional linkages in NIS. The influence of these relationship was studied using a stepwise multiple linear regression equation. It was established that innovation culture has an intervening effect on the relationship of NIS factors and institutional linkages in the NIS in Kenyan ICT institutions. The results yield equation shown below:

Y= -1.22 + 1.3427*NIS factors - 0.160*Innovation culture

The equation indicates that the introduction of innovation culture after the effect of NIS factors on NIS institutional linkages changes to negative leading to innovation culture giving a negative effect on NIS institutional linkages. This implies that given NIS factors that have positive influence on NIS institutional linkages, the introduction of diverse cultures might reduce the influence of NIS factors on the strength of NIS institutional linkages.

4.5.4 The joint effect of NIS factors, Innovation Incentives and Innovation Culture on Institutional linkages in the National Innovation System in Kenya

The joint influence of both innovation incentives and innovation culture on the relationship between NIS factors and institutional linkages in the NIS in Kenya was determined using simple linear regression for individual effect and multiple regression analysis for joint effect.

This relationship was also tested as shown below by using the null hypothesis $\mathbf{H_{04}}$ which was stated as: NIS factors, innovation incentives and innovation culture have no significant joint effect on NIS institutional linkages:

Table 4.24: The Joint Influence of NIS Factors, Innovation Incentives and Innovation Culture on NIS Institutional Linkages

Model summary							
Model		R	R^2	Adjusted R^2	Std.Error of estimates	F-change	Sig.F-change
1		.591[a]	.350	.341	.724	.159	0.023
2		.597[b]	.357	.338	.725	.759	0.04
3		.613[c]	.376	.348	.720	.316	0.013
ANOVA							
Model		Sum of Squares	Df	Mean Square	F	Sig.	
1	Regression	22.019	4	5.505	10.638	.008[a]	
	Residual	35.188	68	.517			
	Total	57.207	72				
2	Regression	20.401	2	10.200	19.400	.000[b]	
	Residual	36.806	70	.526			
	Total	57.207	72				
3	Regression	21.484	3	7.161	13.832	.000[c]	
	Residual	35.724	69	.518			
	Total	57.207	72				
Co-efficients							
Model		Unstandardized co-efficients		Standardized co-efficients	T	Sig.	Collienarity
		B	Std. Error	Beta			Tolerance / VIF
1	(Constant)	.758	.926		.818	.416	
	NIS Factors	.411	.199	.591	2.069	.042	.376 / 2.662
2	(Constant)	.596	.464		1.286	.003	
	NIS Factors	.897	.168	.658	5.343	.000	.606 / 1.650
	Innovation incentives	.134	.225	0.445	.595	.004	.120 / 8.319
3	(Constant)	.676	.463		1.458	.014	
	NIS Factors	.722	.206	.530	3.508	.001	.397 / 2.520
	Innovation incentives	.117	.101	.145	1.160	.025	.578 / 1.731
	Innovation culture	.384	.186	0.256	2.067	.043	.278 / 3.602

a. Predictors: (Constant), National Innovation System (NIS)factors

b. Predictors: (Constant), National Innovation System (NIS)factors, Innovation Culture

c. Predictors: (Constant), National Innovation System (NIS)factors, nnovation Culture, Innovation Incentives

d. Dependent variable: NIS Institutional linkages

From model l in Table 4.24 above, NIS factors had a positive significant effect at p-value<0.05(B=.411,P<0.05). This indicates that NIS institutional linkages increases if NIS factors increases hence giving a positive effect which is significant. The model have an adjusted R^2=0.341 which indicates that the model can explain up to 34.1% of the variation when determining NIS institutional linkages based on NIS factors. In model 2, innovation incentives had a positive significant effect at p-value<0.05(B=.134,P<0.05). This indicates that NIS institutional linkages increases if innovation incentives increases hence giving a positive effect which is significant. The model has an adjusted R^2=0.338 which indicates that the model can explain up to 33.8% of the variation when determining NIS institutional linkages based on innovation incentives. The B=0.411 for NIS in model 1 increased by 118% to B=0.897 which indicates that the introduction of innovation incentives strengthens the relationship between NIS factors and NIS institutional linkages. In model 3, the three factors (NIS factors, innovation incentives and innovation culture) have a positive significant effect at p-value<0.05. The model have an adjusted R^2=0.348 which indicates that the model can explain up to 34.8% of the variation when determining NIS institutional linkages based on joint effects.

The VIFs of all the variables is <10 and tolerances is >0.10, hence there is no presence of multicollinearity among the variables that were used to develop the model to determine the joint influence of NIS factors, innovation incentives and innovation culture on the NIS institutional linkages in Kenyan ICT innovation institutions. The relationships among these actors may be in the way of collaborative research, staff exchange, cross-licensing and a variety of other methods. Since for table 4.24, the p-value<0.05 for the ANOVA table and using F-test the p-value of F<0.05, we reject null hypothesis $\mathbf{H_{04}}$ that had concluded that NIS factors, innovation incentives and innovation culture have no significant joint effect on NIS institutional linkages. The analysis yielded the model given below:

Y= 0.676 + 0.722*NIS factors + 0.117*Innovation incentives + 0.384* Innovation culture

From this model, NIS factors, innovation incentives and innovation culture all had positive effect on NIS institutional linkages which is significant at $p<0.05$. Overall the combined influence of the three variables (NIS factors, innovation incentives and innovation culture) was found to be greater than the individual influence of the variables. The results indicate that in the near future, the research focus may shift from the now frequently chosen national perspective of innovation systems towards a sectoral or a regional perspective including cluster theories based on the joint effects.

4.6 To Examine Reverse Causality among the NIS factors and institutional linkages in the National Innovation System in Kenya

The reverse casuality worked on the theory that dependent variable can be independent variable and independent variable can be dependent variable. Hence the NIS Institutional linkages was collapsed as it was operationalized and NIS factors were grouped into one variable to form a dependent variable. This lead to the variables being well presented as shown in the diagram below:

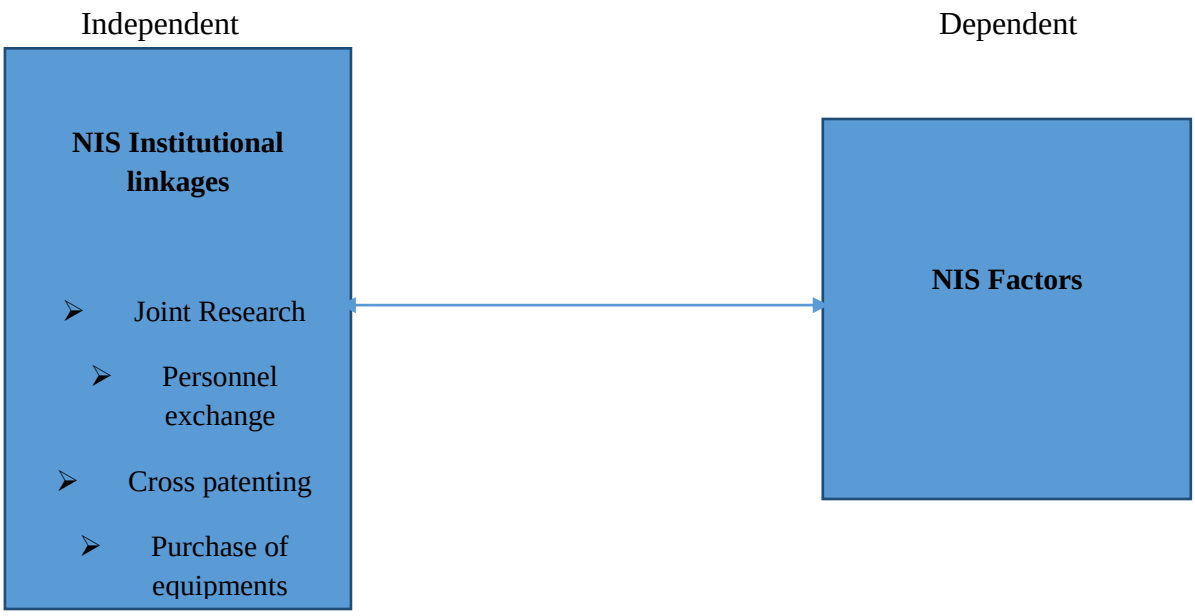

Figure 4.6 Conceptual framework for Granger-Sims Causality test
(Source: Author, 2018)

Figure 4.6 indicates the relationship between NIS Institutional linkages and NIS factors. The figure indicates the causality test framework where the indepent variable is being interchanged with dependent variable from original relationship as described in the conceptual framework of this study. NIS Institutional linkages was operationalized into joint research, personnel exchange, cross-patenting and purchase of equipment. The Granger-Sims Causality test was further performed to check for reverse causality amongst the independent and dependent variables. G-causality is tested in the context of linear regression models. The following bivariate linear autoregressive model was employed:

$$X1(t)=\sum j=1pA11,jX1(t-j)+\sum j=1pA12,jX2(t-j)+E1(t)$$

$$X2(t)=\sum j=1pA21,jX1(t-j)+\sum j=1pA22,jX2(t-j)+E2(t)(1)$$

$$A=\begin{bmatrix} A11 & A12 & A13 & A14 \\ A21 & A22 & A32 & A42 \\ A31 & A32 & A33 & A34 \\ A41 & A42 & A43 & A44 \end{bmatrix}$$

Where p is the maximum number of lagged findings included in the model, matrix A contains the coefficients of the model (that is, the contributions of each lagged observation to the predicted values of $X1(t)$ and $X2(t)$, and $E1$ and $E2$ are residuals (prediction errors) for each time series. If the variance of $E2$ (or $E1$) is reduced by the inclusion of $X1$ (or $X2$) terms in the first (or second) calculation, then $X1$ (or $X2$) Granger-(G)-causes $X2$ (or $X1$). In other words, $X2$ G-causes $X1$ if the coefficients in $A12$ are jointly significantly different from nil. This can be tested by conducting F-test of the null hypothesis that $A12 = 0$, given suppositions of covariance stationarity on $X1$ and $X2$.

This objective was achieved by use of Granger-SIMS Causality test and the results were displayed as show in the table below:

Table 4.25: Reverse Causality among the NIS Factors

	Coefficients	**Standard error**		
	β	1.225	.225	Sig.
Constant	.758	-.878	.383	.416
Joint Research	.215	1.608	.112	.042
Personnel Exchange	-.192	2.140	.036	.004
Cross-patenting	.162	1.549	.126	.043
Purchase of Equipment	.258	2.079	.041	0.021
Joint Research and Personnel Exchange	.184	1.127	.264	.316
Joint Research and Cross-patenting	.157	1.051	.297	.042
Joint Research and Purchase of Equipment	.309	2.108	.039	.024
Personnel Exchange and Cross-Patenting	.136	1.683	.097	.033
Personnel and Purchase of Equipment Exchange and	.210	.900	.371	0.01
Cross-Patenting and purchase of equipment	.217	1.225	.225	0.041

Source: Author, 2018

From Table 4.25, based on the Granger-Sims causality, the matrix below was developed using coefficients.

$$A=\begin{bmatrix} .215 & .184 & .157 & .309 \\ .184 & -.192 & .136 & .210 \\ .157 & .136 & .162 & .217 \\ .309 & .210 & .217 & .258 \end{bmatrix}$$

This matrix indicates that at any point all the elements $\neq 0$ hence it indicates that there is some effects of the variables on the dependent. Using the ANOVA -test shown below, the F-values are significant at $p>0.05$ hence reject the null hypothesis ($\mathbf{H_{05}}$) that there is no significant reverse causality among the NIS factors and institutional linkages in the National Innovation System in Kenya is rejected.

Table 4.26: ANOVA Table for Reverse Causality Effect

Model	Sum of Squares	df	Mean Square	F	Sig.
Regression	10.773	1	10.773	38.155	.000[b]
Residuals	20.046	71	.282		
Total	30.819	72			

From Table 4.26, p-value < 0.05 showing there is significant reverse causality between independent and dependent variables. This result fail to agree with the null hypotheses $\mathbf{H_{05}}$ leading us to conclude that there actually exists reverse causality among the NIS factors and institutional linkages in the National Innovation System in Kenya.

4.7 Summary Results of the Test of Hypotheses

The summary of the test results of the four hypotheses are presented in Table 4.27 below:

Table 4.27: Summary Tests of Hypotheses

Objective	Hypothesis (Null)	Finding	Conclusion
To establish the effect between NIS factors and institutional linkages in the NIS in Kenya.	**H_{01}:** NIS factors have no significant effect on the institutional linkages in NIS.	The findings established that NIS factors have significant effect on the institutional linkages in NIS	**Reject H_{01}**
To investigate the influence of innovation incentives on the relationship between NIS factors and institutional linkages in the NIS in Kenya.	**H_{02}:** Innovation incentives have no moderating influence on the relationship between NIS factors and the institutional linkages in NIS.	The findings established that innovation incentives have no moderating influence on the relationship between NIS factors and the institutional linkages in NIS	**Accept H_{02}**
To determine the influence of innovation culture on the relationship between NIS factors and institutional linkages in the NIS in Kenya	**H_{03}:** Innovation culture has no intervening influence on the relationship between NIS factors and the institutional linkages in NIS.	The findings established that innovation culture has intervening influence on the relationship between NIS factors and the institutional linkages in NIS.	**Reject H_{03}**
To determine the joint effect of NIS factors, innovation incentives and innovation culture on NIS institutional linkages in Kenya.	**H_{04}:** NIS factors, innovation incentives and innovation culture do not have significant joint effect on NIS institutional linkages in Kenya.	The findings established that NIS factors, innovation incentives and innovation culture have significant joint effect on NIS institutional linkages in Kenya.	**Reject H_{04}**
To examine reverse causality amongst the NIS factors and institutional linkages in the National Innovation System in Kenya	**H_{05}**:There is no reverse causality among the NIS factors and institutional linkages in the National Innovation System in Kenya	The findings established that there actually exists reverse causality amongst NIS factors and institutional linkages in the NIS in Kenya	**Reject H_{05}**

Source: Author, 2018

4.8 New Conceptual Framework

Besed from the findings, the study established that there is relationship of NIS factors on NIS institutional linkages. The effects were also were found to be significant. The reverse effect from Granger-Sims causality was also significant at p-value<0.05. This hence led to the new conceptual framework as shown below:

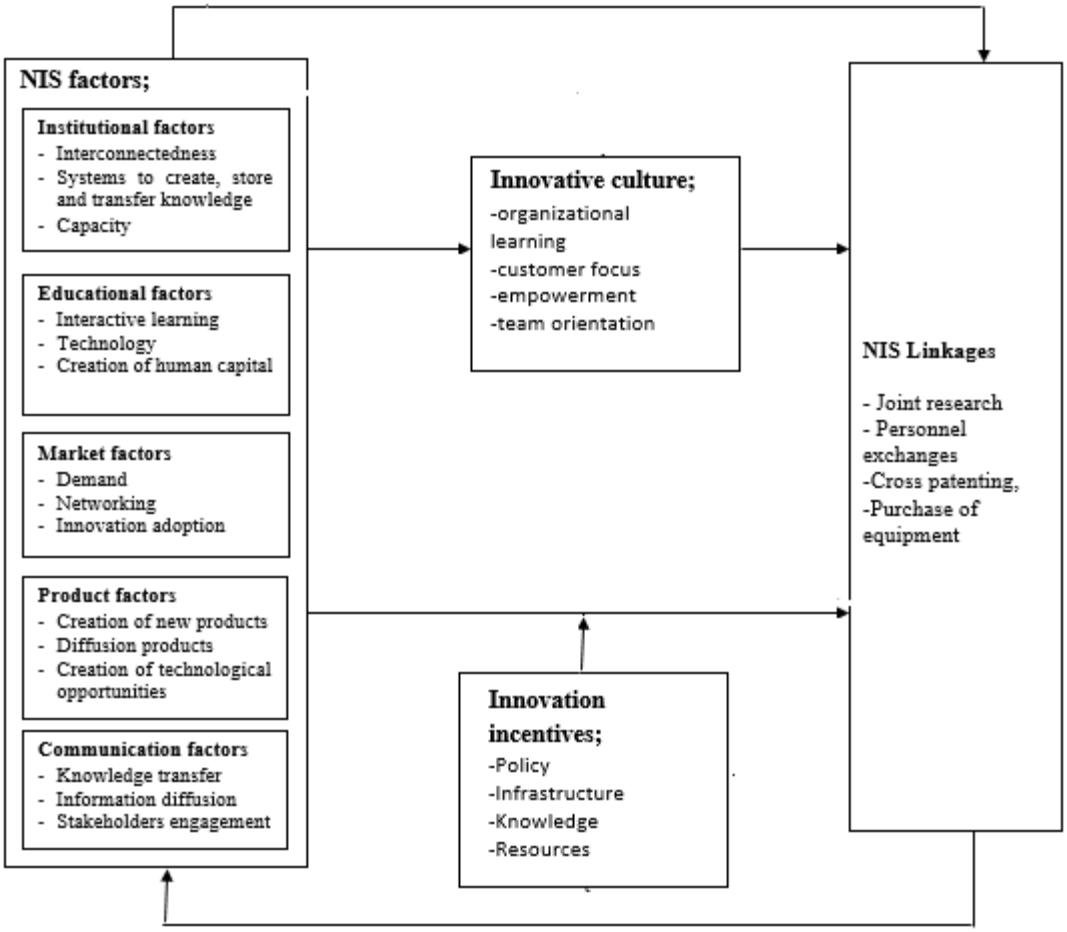

Figure 4.7: New Conceptual Framework (Source: Author, 2018)

From Figure 4.7, it indicates that there is causality among NIS factors and Institutional Linkages in that they can be related in any given model by interchanging one to be dependent and the other independent.

4.9 Discussion of Findings

This was done based on the results after analysis.It was based on the objectives of the study. To start with, the level of innovation in their institutions was rated high. This is mainly because the main components of the National Innovation System in Kenya include: demand for ST&I, education and research system, the business system and intermediate organizations (Jowi & Obamba, 2013; Republic of Kenya, 2012) which require rapid innovation to take place to satisfy the demands of the clients. Sustaining this national performance in innovation requires high level of innovation.

The ratings in assessing the level of innovation were guided by firm-based surveys which is one of the output-based approach in measuring a firm's innovativeness by conducting interviews and surveys on innovation undertaken across firms (Doroodian et al., 2014). The duration is adequate for the employees to understand the institution and its functions and hence its easy to understand any implementation of innovation system. This duration is adequate and it seeks to augment innovation networks and to design the flows, institutional linkages and partnerships in the most efficient manner where the employees can interract efficiently.

As highlighted by OECD (2010), these duration encourage concentration on improving the skills of each organization and boosting the relationships as well as innovative works of clusters of organizations and sectors. This also explains why the level of innnovation is high in Kenya since many were involved in partnering with other professional bodies to improve on their skills and knowledge.

The feedback on National Innovation system (NIS) in Kenya was based on the response of 73 participants. This implies that an innovation system is regulated by the current firms and rules affecting the actors' performance and laws on the advanced technologies. National innovation systems are therefore exploratory frameworks aimed at solving economic development challenges (Cozzens & Kaplinsky, 2012). Hence institutional factor was agreed to a large extent by majority of the respondents as one of the key indicator for NIS institutional linkages. Educational factors was rated to moderate extent as a key indicator of NIS institutional linkages since most NIS scholars focussed on institutional linkages between three main actors: universities, government and inventive firms.

In an NIS, shared knowledge between knowledge generators and end-users assume a key part for these institutions. As such, in the present study, the information pertinent to institutional linkages from ICT-based government ministries and parastatals, public research institutes, academia and industry .Market Factors was rated to alarger which means that institutional linkages can either be strong or weak depending on demand of the clients on innovation. Product factors were rated to large extent when linked to the innovation in that there is a need for various actors within national innovation system to be incentivized to promote funding for innovation, engaging in R&D and strengthening collaborative institutional linkages (Madill et al., 2010) which will results to many innovation that can lead to new product proposition. Communication Factors were reated to moderate extent which means that the information flow and learning in Kenya needs to be improved since it owns a significant for of NIS regardless the level of develpment in Kenya.

Personal Exchanges was rated to moderate extent which means that majority of these institutions need to encourage personnel exchange when they are conducting NIS institutional linkages. This is similar with the findings done by OECD(2017) who categorized Institutional linkages in the form of joint research, personnel exchanges, cross patenting, and purchase of equipment.

Most NIS scholars focussed on institutional linkages between three main actors: universities, government and inventive firms. In an NIS, shared knowledge between knowledge generators and end-users assume a key part. According to McDonald (2011), these institutional linkages can either be strong or weak. As such, in the present study, the information pertinent to institutional linkages was sourced from innovation-based government entities, public research institutes, academia and the industry. Cross-patenting was rated to moderate extent which means that the institutions are not well conversant with what other organization produce as innovation since they are not frequently participating in cross patenting.

Purchase of equipment was rated to a large extent which means that during NIS institutional linkages these institutions are involved in purchase of equipment where many of the main actors participate during purchase of the equipment. This also enhances the role and importance of institutional linkages in the science and innovation system emerges in the context of the global knowledge economy. The growth in the knowledge intensity of all goods and services and business processes, and the commodification of knowledge itself, has placed a premium on generating, accessing and extracting economic value from knowledge.

Globalisation of trade, finance and competition has made the need to access this knowledge more urgent, technically easier, but as a result of this competition, more challenging. One consequence is that innovation is becoming increasingly distributed, and in this way more complex as discussed by Gupta (2015) who indicated that as a result, organisations are adopting many of the well-established practices of the scientific community, such as identifying important new knowledge and finding more about it through direct contact, based on an accepted canon of knowledge sharing by engaginig in to business where they share ideas.

Firms search for institutional linkages to access knowledge (that is, learning) from outside organisations and networks, be they other firms, universities or research institutions, with the intent of extracting economic value from it. Innovation is thus the result of numerous interactions by a community of actors and institutions, together form national innovation systems. Essentially they consist of the flows and relationships which exist among industry, government and academia in the development of science and technology and innovations within any entity.

4.9.1 The Relationship of NIS Factors on the Institutional Linkages of the National Innovation System in Kenya

The effect of NIS factors on the institutional linkages of the National Innovation System in Kenya was studied using null hypothesis ($\mathbf{H_{01}}$) which was tested using F-test, the p=0.021 which is significant at p<0.05. Since the p-value of F <0.05, it led rejection of the null hypothesis ($\mathbf{H_{01}}$) and thus conclude that NIS factors have significant effect on the institutional linkages in the NIS in Kenya. The results agree with the findings by OECD (2017) that the interactions within NIS influence the innovative performance of firms and

economies was significant. One consequence is to place considerable emphasis on knowledge management, both within and outside organisations, be they private or public. Ability in acquiring, assimilating, sharing and creating knowledge is the ultimate organisational capability, a meta-competence which allows an organisation to consistently outperform its rivals (OECD, 2017).

NIS institutional linkages strengthens if institutional factors reduce hence giving a negative effect which is significant. This agrees with Lundvall (2007) when understanding the concept of NIS where it was found to be mainly informed by the uniqueness of the developed world context, where he undertook his initial studies. Manzini (2012) found out that the application of the term in context of developing world is a key point for research. This was also confirmed by the response of participants in this study when responding to the statements that were used to measure NIS factors.

The findings showed that only institutional factors had negative effect on NIS factors. Educational factors, had a positive influence on NIS factors. However, from these finding, there is an emphasis on institutional linkages in the current analysis and policy literature, also treated under the labels of networks, interaction, and collaboration and to some extent clusters.

In the context of mapping, the focus is on:identifying and counting relationships (for instance, the number of business-university institutional linkages or agreements) identifying resources crossing organisational boundaries (e.g. university R&D funded by business, participant contribution to CRCs, students employed by industry); and in some cases identifying measurable outputs (the number of co-publications, patents, licenses,

etc). While these provide an essential base-line description of the extent of interactions, they provide little information about their performance or the extent of their outcomes. They do not even provide an indication of the characteristics of institutional linkages that are most effective (Romero et al., 2017).

The components and the processes within the science and innovation system are so heterogeneous that a very different model may be more appropriate (Johnston et al., 2013). Nevertheless some attempts have been made to go beyond the simple counting of institutional linkages, resource flows and bibliometric outputs. These include mapping of knowledge flows embodied in capital equipment, publications and humans (that is, mobility), analyses of private and social returns from investment in knowledge generation and application through R&D, and measurement of knowledge networks through innovation surveys (OCED, 2016). This is in agreement with other researchers in that according to Mapila et al. (2011), product factors such as the creation of new products, diffusion of products and creation of technological opportunities can affect the institutional linkages in the NIS.

Educational factors had a positive significant effect at p-value<0.05.This implies that as education factors increases also NIS institutional linkages strengthens and vice verser. Educational factors such as interactive learning, technology and creation of human capital (Schiller & Leifner, 2012) leads to strengthening or weakening of NIS institutional linkages .These factors can contribute to innovation in that they enhance partnership through communication and interraction with other stakeholders as suggested by Lacave and Vullings (2013) who observed that plausibility for national ST&I programs, consisting of its enterprises, activities and processes, is enhanced by countrywide assimilated support platform for ST&I and this can be strenghten based on the kind of knowledge that is shared.

Market factors had a positive influence on NIS institutional linkages which means that as market factors increases also NIS institutional linkages continue to strengthen and vice-verser.This is true since Promoting ST&I acceptance and support of national ST&I activities requires communication between stakeholders.

Exchange of information through print and electronic media is of significant importance since it increases knowledge and understanding of adoption and utilization of technologies.According to the Science, Technology and Innovation Act that was adopted in 2013 with the aim of re-orienting ST&I programs to market needs and national objectives as well as make the ST&I bodies more impactful and supporting to the national system of innovation (Lacave & Vullings, 2014), this has led to strenghthen the NIS institutional linkages in Kenya and hence it confirms a strong positive relation ship with NIS institutional linkages in Kenya. Product factors had a positive influence on NIS factors, which means that as product facyors improves,then NIS institutional linkages continues to strengthen and vice-versa.

This effect is significant at p-value<0.05. This is also in line with the work of the Commission for University Education (CUE) that offers quality control on higher education which includes, among other institutions, the universities. (Republic of Kenya, 2005a). Universities are charged with assisting the country to attain its development objectives via knowledge generation, research and innovation (Commission of University Education, 2013) which is important during product development which strengthens NIS institutional linkages in Kenya.

4.9.2 Influence of Innovation Incentives on the Relationship between NIS Factors and Institutional Linkages in the National Innovation System in Kenya

The relationship between NIS factors and institutional linkages in NIS in Kenyan ICT institutions was found to be strong and postive. This relationship was studied using null hypothesis ($\mathbf{H_{02}}$) which was tested using t-test, the p=0.387 for interaction term which is insignificant since p>0.05. This led to acceptance of the null hypothesis ($\mathbf{H_{02}}$) and thus conclude that innovation incentives has no moderating influence on the relationship between NIS factors and NIS institutional linkages. This also indicates that there is no partial moderation of the relationship of NIS factors and NIS institutional linkages. NIS factors had a positive significant effect at p-value<0.05. This indicates that the strength of institutional linkages in NIS increases if NIS factors increases hence giving a positive effect which is significant. Innovation incentives factors had a positive significant effect at p-value<0.05 which agrees with the study done by Klerkx and Leeuwis (2013) that indicates that governments conduct the role of coordinator among research initiators regarding their visions, perspectives and policy instruments for the future.

The research finding adds weight to prior observations on ineffectiveness of incentives to the innovation process if they are appear vague to innovation actors (Misiko et al., 2013) and where these develop dependency (Triomphe et al., 2012) on incentive programs. This is especially detrimental to the innovation process since benefits from incentives may be realized over time and are not immediate. Negative effect of innovation incentives may also reflect the profile of the respondents, majority of whom are government affiliated firms that are guaranteed of innovation incentives through national budgetary allocation.

These include universities and institutions under Ministry of Education Science and Technology and Ministry of ICT. As such, innovation incentives do not in any way change their approach to innovation as it is not a motivation to the innovation process.

At the same time, the research findings contradicts with the study by Madill et al.(2010) which states that there is need for various actors within national innovation system to be incentivized to promote funding for innovation, engaging in R&D and strengthening collaborative institutional linkages. This also contradicts study by Hekkert and Negro (2009) who found need for researchers and the industry to lobby government for additional incentives in a bid to attract more investments in knowledge generation, dissemination and adoption across the economy. From these findings, it seems that there is a need for various actors within national innovation system to be incentivized to promote funding for innovation, engaging in R&D and strengthening collaborative institutional linkages among these institutions which requires a lot of innovation to be carried out. Also from the study, African incentives regimes are not as impactful compared to non-African nations leading to the slow pace of development of technology in the continent. Among others, fiscal and monetary incentives can include tax breaks, subsidized loans, donor funds, government-backed venture capital, favorable regulation and government procurement policy (Bartels & Koria, 2012).

4.9.3 The Influence of Innovation Culture on the Relationship between NIS Factors and Institutional Linkages in the National Innovation System in Kenya

The influence of innovation culture intervening the relationship between NIS factors and institutional linkages in the National Innovation System in Kenya was determined using

stepwise multiple linear regression analysis with the relationship established using null hypotheses (**H_{03}**) which was tested using F-test with p=0.005 which is significant at p<0.05. Since the p-value of F <0.05 for the ANOVA table using F-test, it led rejection of the null hypothesis (**H_{03}**) and thus conclude that innovation culture has intervening influence on the relationship between NIS factors and institutional linkages in the NIS in Kenya. The findings are similar to OECD (2016) that notes that the innovative performance of a nation mainly relies on how actors interact with each other as items of a collective system of knowledge creation and application. This is in agreement with other studies that indicated making awareness of the existence of innovation can lead to uptake and the consequent transfer of knowledge between actors in an innovation system (Lundvall et al., 2010). Innovative culture can encourage innovative behaviour among all employees of a firm by influencing the behaviour patterns of employees, increasing their participation and making innovation be vital part of company policy (McDonald, 2011). Conducive innovation culture can also enhance a firm's performance and growth (Stock et al., 2013; Meyer, 2014; Gomes et al., 2015; Ali and Park, 2016).

Innovative culture can encourage innovative behaviour among all employees of a firm by influencing the behaviour patterns of employees, increasing their participation and making innovation to be vital part of company policy (McDonald, 2011). Due to the scarcity of natural resources, transformational leaders around the world have embraced this changing process informed by the fact that successful creation of new knowledge will sustain the economic competitiveness of nations (Fier, 2013). A third course to extend the NIS approach has to do with our still limited knowledge on the dynamic properties of national innovation systems, especially with regard to their stability and their structural evolution.

By studying these aspects, the NIS concept would be more aligned with its theoretical foundation of system theory and evolutionary economics (McKelvey, 2014). It is a basic element of this line of economic theorizing to consider qualitative change, implying that dynamic processes have to lie in the center of attention. In addition, the variety of the units of analysis and their observable performance levels are usually given special interest. So if the theoretical foundation of the notion of innovation systems is to be taken seriously, a more subtle understanding of the evolution of the systems is required (Saviotti ,2013).

This suggests that innovation culture do affect the NIS factors when determining the linkage in NIS in the Kenyan ICT innovation institutions. Other research done by Koria et al. (2014) indicates that institutional linkages within actors as well as interaction among various factors that affect the national innovation system, determined the level of innovativeness in both Ghana and Kenya as indicated by the intervention of innovation culture between the relationship of NIS factors and institutional linkages in NIS in Kenya ICT innovation institutions. Since the p-value<0.05 for the ANOVA table using F-test, hence these results led us to reject $\mathbf{H_{03}}$: Innovative culture has no significant intervening effect on the relationship between NIS factors and the institutional linkages in NIS.

The influence of this relationship was studied using a stepwise multiple linear regression equation. It was established that innovation culture has an intervening effect on the relationship of NIS factors and institutional linkages in the NIS in Kenyan ICT institutions. The effect of NIS factors on institutional linkages was positive and after it was intervened by innovation culture, magnitude of the influence was reduced and the efffect diverted from negative to positive (β=0.634 to β=-0.16) based on the regression equations that were developed. The relationship between NIS factors and institutional linkages in the NIS in

Kenyan ICT institutions was (R=0.591) which was strong. After the intervening effect of innovation culture factor, it increased to (R=0.603) with positive relationship. These results are also similar to the findings in developing economies such as sub-Sahara Africa where the topic of innovative economy and NIS is especially current.

In addition, there are several adhocracy cultures that promote innovation, namely: creativity (Cassiolato et al., 2011), empowerment (Durongkaveroj, 2010), freedom and autonomy (Fagerberg & Sapprasert, 2011), and risk- taking (Hoogendoorn et al., 2010). This suggests that innovation culture do affect the NIS factors when determining the institutional linkages in NIS. Other research done by Koria et al. (2014) indicates that institutional linkages within actors as well as interaction among various factors that affect the national innovation system, determined the level of innovativeness in both Ghana and Kenya as demonstrated by the intervention of innovation culture on the relationship between NIS factors and institutional linkages in NIS in Kenya innovation institutions.

Porter and Stern (2012) propose resorting to building simulation models to complete a system of innovation. Hence this findings fill the gap that was identified by Carlsson et al. (2012) who argues that "there is nothing preventing a more dynamic analysis" of national innovation systems with no connection to culture of the institution. It has been clarified repeatedly that evolutionary economic theory constitutes the theoretical fundamentals of the NIS approach (Edquist et al., 2011). However, the relation between system theory and the NIS approach is barely investigated. Pyka (2009) suggests a concise outline of the basic principles of evolutionary economic theorizing since not only the values of the units

of analysis vary but the very units of analysis themselves are also subject to change. Even though we have just exposed possible directions to extend the NIS approach, it shall be emphasized that we do not take the continuing significance of the national innovation systems approach for granted as discussed by Beije (2013) on innovation culture.

4.9.4 The Joint effect of NIS Factors, Innovation Incentives and Innovation Culture on NIS Institutional Linkages in Kenya

The study also sought to ascertain joint effect of NIS factors, innovation incentives and innovation culture on institutional linkages in NIS in Kenya. Null hypothesis (**H_{04}**) stated as NIS factors, innovation incentives and innovation culture have no significant joint effect on NIS institutional linkages, was tested. Since the p-value<0.05 for the ANOVA table using F-test, hence these results led to rejection of the null hypothesis (**H_{04}**): NIS factors, innovation incentives and innovation culture have no significant joint effect on NIS institutional linkages in Kenya. Since for Table 4.24, using F-test the p-value of F<0.05, we reject null hypotheses (**H_{04}**) and thus concluded that NIS factors, innovation incentives and innovation culture have significant joint effect on institutional linkages in NIS in Kenya.

These results indicate that soon, focus might shift from the now often preferred national innovation systems perspective towards a wider sectoral or regional perspective including cluster theories based on the joint effects. Such shifts in the preferred analytical level are likely if international intrasectoral ties in the generation of innovations will continue to intensify while domestic ties lose importance, and if the significance of national institutional framework conditions should descend at the expense of regional or sectoral framework conditions (Stankiewicz, 2015). Also trends like these could reduce the relevance and usefulness of the concept of nationally demarcated innovation systems.

The trends are in line with the weaknesses of social network theory where space between nodes has been rendered irrelevant due to increased activities between actors in distant nodes with prefence given to “far” as opposed to “near” interactions (Borgatti, Brass & Halgin, 2014). The usefulness of a national boundary of innovation systems can also be reduced through growing international economic integration if national specifics and national determinants of innovative action are removed at the expense of international economic framework conditions. Less self-determination of the participating nation-states in numerous fields, including innovation policy design, could be a logical outcome of increasing institutional harmonization across countries. In this case, and if the concept of innovation systems is to be applied, a supranational analytical level may be advantageous compared to a national one (Etzkowitz & Leydesdorff, 2015).

However, as such possible changes in analytical levels do not mean that the various sub-approaches of the innovation systems approach exclude one another. The same line of reasoning is taken by Beije (2015) who opines that "regional or sectoral innovation systems are subsystems of the national system in which the institutions (or some of them) are specialized in the innovation problems of a specific sector or region". Increasing economic integration includes either the geographical extension of international (trade) agreements or the deepening of existing international economic integration by harmonizing more and more formal institutions in the member countries. However, recent research on this topic has shown, it is at the present time far too early to think in terms of a supranational European innovation system (Peres, 2013).

This agrees with the study carried out by Foray (1991) who points out that regional inter-firm interaction includes the basic principle of functioning and innovativeness of these firms. Most of the NIS scholars focussed on relationships between three main actors: universities, government and inventive firms. Shared knowledge between knowledge generators and end-users plays an important role in an NIS. Innovations increases the institutional linkages whether it is in incentive provisions or culture modification. Thus, increased innovations may remedy the weaknesses noted by Mulgan (2012) who points out that institutional linkages among actors within the systems of innovation are weak and institutional structures are ill developed.

The systems of innovation in developing countries are weak and fragmented. This then suggests that as the improvement is carried out on NIS factors, innovation culture and incentives, then strenghth of institutional linkages in the NIS improves. This also concurs with the study by OECD (1997) who noted that the innovative performance of a nation mainly relies on how actors related with each other as items of a linked system of knowledge generation and application. The relationships amongst the players can be by way of colloborative research, staff exchanges and cross-licensing, among other methods.

4.9.5 To Examine Reverse Causality among the NIS factors and Institutional linkages in the National Innovation System in Kenya

The reverse casuality worked on the theory that dependent variable can be independent variable and independent variable can be dependent variable. Null hypothesis (**H_{05}**) stated as there is no reverse causality amongst the NIS factors and Institutinal linkages in NIS in Kenya, was tested. Since for Table 4.27 the p-value<0.05 for the ANOVA table using F-

test, hence these results led rejection of the null hypothesis ($\mathbf{H_{05}}$): there is no reverse causality amongst the NIS factors and institutional linkages in the NIS in Kenya. We thus concluded that there exists reverse causality amongst NIS factors and institutional linkages in NIS in Kenya.

The findings indicate that there is reverse causality amongst NIS factors and institutional linkages in the National Innovation System in Kenya. This is in line with causality studies by Asteriou and Hall (2011) who established that a variable X is said to Granger-cause another variable Y if past values of X help predict the current level of Y given all other appropriate information. In addition, Granger causality testing has been the approach used by most studies that try to detect the "causal validity" of energy-output models (Stern & Enflo, 2013). Granger-Sims causality implies causality in the sense of predicting the outcome rather than in a more structural sense and is mainly based on the idea that "the future cannot cause the past" (Chontanawat et al., 2008). It is based on the concept of causal ordering, meaning that two variables could be correlated by chance but only if X can actually cause Y, in a philosophical sense, could the past values of X be used to predict the levels of Y (Stern & Enflo, 2013).

The study finding that NIS factors Granger-cause institutional linkages in NIS and vice versa also agrees with research outcomes of Ghoshray et al (2018) who established reverse causality between energy consumption and oil prices. In their study, they ascertain that energy consumption Granger-caused economic growth, oil prices Granger-caused energy consumption and also, that energy consumption Granger-caused oil consumption.

4.10 Chapter Summary

The chapter detailed the study's response rate, tests of hypotheses, institutional information, descriptive statistics and analysis of the influence of NIS factors, innovation incentives and innovation culture on the institutional linkages of the NIS in Kenya. Although the researcher encountered some limitation in receiving responses, the response rate of 71% was assessed to be adequate for the study since it was above the 65% response rate of such studies as noted by Tomaskovic- Devey, Leiter and Thompson (2014). The approaches used to test the hypotheses included multiple, stepwise and linear regression analysis. Relevant data was analysed with test results presented and interpreted using tables and figures. Diagnostic tests were also carried out with the interpretation of the results being informed by the outcome of the data analysis. These tests included statistical tests for reliability, validity, normality, linearity and multicolinearity of the study variables. Research tool was established to be reliable after all research variables recorded Cronbach's Alpha value greater than 0.7 (Nunally, 1978). In addition, content validity was conducted using a structured questionnaire to ascertain appropriateness of the research tool in measuring the NIS factors, innovation incentives, innovation culture and institutional linkages in the NIS. Since the study had sample a size of over 50 respondents, Shapiro-Wilk test to test for normality for each variable to enhance objectivity of respondents during data collection. This indicated significance of each variable at 95% confidence level.

Majority of the respondents had atleast graduate level education, had worked for 3-5 years rated the level of innovation at their institutions as high and came from entities that had staff workforce of 500 or less. Further, majority of the firms involved in the study were set up from 1971 onwards, these being universities that were given charters after year 2013

and institutions within Ministry of ICT which was set up in year 2004. This confirms observation by Abidin et al. (2012) that knowledge flow through research undertakings is enhanced via "knowledge workers" supplied to the economy by universities. This further indicates the move from agrarian economy to knowledge-based economy where knowledge supersedes land and other traditional factors of production.

In addition, descriptive statistical analysis was carried out using Likert scale on all research variables to establish the extent to which they meet the research objectives. In testing study hypotheses, data was also analyzed based on study objectives using key inferential statistics to ascertain the significance of the effects and influence of the key indicators and estimate the sample statistics into parameters to measure population and guide in general interpretation. Path analysis was used to derive the coefficients and strength of influence for the key indicators.

Relationships were tested at 95% confidence level. Hierarchical regression analysis was applied where the intervening or moderating variables were added to independent variables to establish the direct influence of independent variables on dependent variable. Research hypotheses were tested using the results that were computed using ANOVA and relevant results interpreted in tabulated format giving both directional and significance of the research variables. Decision was then made to accept or reject the null hypotheses with the chapter endings with a summary table of research objectives with the related outcomes of hypothesis tests. Besides establishing that the research variables had significant effect on the institutional linkages of the NIS, existence of reverse causality amongst independent and independent variables was ascertained using Granger-Sims causality test.

Further discussions, recommendations and conclusions derived from the outcomes of the tests of the hypotheses against study objectives are detailed in chapter five.

CHAPTER FIVE

SUMMARY, DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS

5.0 Introduction

This chapter outlines summary of the findings, conclusions, implications and recommendations of the study as per research objectives. It aims at discussing the results of the study and compares them with the work already published by other researchers as per the literature review of this study. Also indicated are the proposals for future research are also given and limitations encountered while undertaking the study.

5.1 Summary of the Findings

The goal of the study was to understand the NIS factors, innovation incentives, innovation culture and institutional connectednesses in NIS in Kenyan ICT innovation firms. The observations are aimed at assisting various actors in the NIS understand their contribution towards improving its strength by resolving any short falls in resourcing and competencies identified. It will also enlighten and encourage these institutions to formulate strategies that may enhance growth and competitiveness of innovation sector.

Majority of these institutions were established between 1992 and 2012. Although majority indicated that the level of innovation was high, these results were below the average cumulatively for all the institutions that were involved in these study. Many institutions have employees numbering less than 500. Majority of employees in these institutions had worked for 3 to 5 years. The finding also indicate that majority of the respondents were undergraduates and majority were not members of any professional body which could help to advise and mentor employees during the process of innovation.

Majority of the respondents rated the factors under National innovation system (NIS) factors at large extent with only communication factors being rated at moderate extent. On innovation incentives, majority rated factors at a larger extent with only resources rated at moderate extent. For innovation culture, all rated the factors at larger extent. On institutional linkages, majority rated the factors at moderate extent with only purchase of equipment being rated at large extent. Cross-patenting was rated to a moderate extent where majority indicated that most of the ICT innovation institutions do cross-patenting to a moderate extent during the innovation processes.

The study established that there exists significant positive effect between NIS factors and institutional linkages in the NIS in Kenya. This implies for proper institutional linkages in NIS, then an improvement has to be done on NIS factors. Innovation incentives and cultures were also found to have positive significant effect on institutional linkages in NIS in Kenya. Lastly, study confirmed existence of reverse causality amongst NIS factors and institutional linkages in NIS in Kenyan ICT innovation firms,

5.2 Conclusion

Since the study established NIS factors had significant effect on the institutional linkages in NIS, it is thus a major determinant for influencing institutional linkages in Kenya ICT innovation firms. On the other hand, communication as an NIS factor portrayed positive insignificant effect on the institutional linkages in NIS for Kenyan ICT innovation institutions. Thus, institutional linkages in NIS in Kenya can be still perfectly estimated using NIS factors without communication since it not a key component of the model. Using ANOVA table based on F-test, the results were significant at p-value<0.05 leading to rejection of the null hypothesis ($\mathbf{H_{01}}$) and thus concluded that NIS factors have significant effect on the institutional linkages in NIS.

The study ascertained that innovation incentives had insignificant moderating effect on the relationship between NIS factors and NIS institutional linkages. The null hypothesis ($\mathbf{H_{02}}$) was tested for interaction term using t-test with the p=0.387 which was insignificant at p<0.05, thus accepting the null hypotheses ($\mathbf{H_{02}}$) and concluded that innovation incentives did not have significant moderating effect on the relationship between NIS factors and institutional linkages in the NIS in Kenya. This indicates there was no partial or full moderating influence of the innovation incentives on the relationship between NIS factors and NIS institutional linkages. Individually, these variables had significant effect on the NIS institutional linkages and increasing either of the variables resulted in an increase in NIS institutional linkages and vice-versa. There is therefore need to have good mix of innovation incentives and NIS factors when studying the factors that influence the NIS institutional linkages in Kenyan ICT innovation institutions.

Further, the study established that innovation culture has a significant intervening effect on the relationship between NIS factors and institutional connectedness in NIS in Kenya. This hence indicated that when innovation culture is enhanced, then the relationship between the NIS factors and institutional linkages in NIS is strengthened. This led to rejection of the null hypothesis ($\mathbf{H_{03}}$) and concluded that innovation culture has significant intervening effect on the relationship between NIS factors and the institutional linkages in NIS.

The joint effect of NIS factors, innovation incentives and innovation culture on the institutional linkages in the NIS in Kenya was assessed to be positive. That is, enhancing both innovation incentives and innovation culture on NIS factors strengthens the NIS institutional linkages and vice versa. This led to rejection of the null hypothesis ($\mathbf{H_{04}}$) and

concluded that there is significant influence of both innovation incentives and innovation culture on the relationship between NIS factors and institutional linkages in NIS in Kenyan ICT innovation institutions. Reverse causality amongst NIS factors and institutional linkages in NIS in Kenya was assessed to be positive. That is, enhancing NIS factors strengthens the NIS institutional linkages and vice versa. This led to rejection of the null hypothesis (**H_{05}**) and concluded that there exists reverse causality amongst NIS factors and institutional linkages in NIS in Kenya.

NIS approach is a recent paradigm for organizing innovation in the national economies. This systems approach represents a more holistic view of innovation processes and is projected to boost innovation for firms, industries and countries. This study developed a proposed framework for better understanding of the NIS concept, expectation of various actors within the system and the relationships amongst them.

Moreover, it provides a better appreciation of workings of NIS and the barriers to innovation in the country. These barriers concern resource allocation, the nature of industry in Kenya, the integration of R&D into the innovation system, and the organization of the public sector component. It is important that the barriers to innovation in Kenya be removed. Policy recommendations to improve the functioning of the NIS and overcome barriers include: minimizing the conflicts in resource allocation for more efficient use; creating incentives for domestic innovation by attracting foreign-based R&D institutions to relocate, encouraging large domestic firms R&D that have the capital resources required for innovation, and building internal capacity to encourage domestic firms to develop R&D components to allow them to compete more favorably in evolving global economy;

strengthening the institutional linkages between university and industry affect university R&D; and creating trust and credibility within stakeholder partnerships for these links to form. An effectively organized government sector can accomplish these objectives through well-designed policy.

Most importantly, a new strategic direction for innovation policy and a truly "country-specific" framework for assessing Kenya's NIS in the future can be developed. This framework allows Kenya NIS policymakers to determine their own indicators that are "made to measure" their specific system. Besides assessing the components that make up the NIS by focusing on the questions mentioned above, the country-specific assessment framework emphasizes: the rationale and goals for NIS, the necessary instruments for NIS, the functioning of NIS components, and measures of NIS success.

5.3 Implications of the Study

Research findings from this study have the following future theoretical, practical and policy implications:

5.3.1 Theoretical Implications

From the research findings, the study established that the institutional linkages of the NIS in Kenya are significantly influenced by NIS factors, innovation culture and innovation incentives in a positive way. Enhancing any of these factors resulted in better institutional linkages in the NIS. As earlier observed, traditional National Innovation Systems were mainly informed by independent theories such as orthodox economic theory that laid emphasis on technical changes in innovation (Dosi et al., 1988), Resource Based View (RBV) that focused on unique set of resources of individual firms that enabled innovation aimed at attaining competitive advantage (Pearce & Robinson, 2007) at organization-level

and also on social network theory (SNT) that examined the interconnectedness of various actors within various nodes of the innovation systems (Borgatti, et al., 2009). Although the influence of the three theories on NIS institutional linkages have been studied differently in the past, this research study attempted to bridge this gap by using a combined theory approach.

The study established that institutional linkages in NIS strengthened when NIS factors, innovation incentives and innovation culture were enhanced. This is exhibited by the various test outcomes of this study that indicated significant influence the three study variables had individually and jointly on institutional linkages in the NIS in Kenya. It is thus important for firms within a network of innovation system to have ideal resource conditions for innovation to thrive by embracing right innovation culture.

Innovation incentives can be availed at the nodal level within a system of innovation by individual firms or within the wider network by government or donor agencies. Peteraf and Barney (2003) aver that majority of researchers in RBV opt to "review inside the fim and market factors that the company must meet, to look for likely contributors of reliable competitive gains" whilst freezing all exterior environmental elements (Foss & Knudsen, 2003). As such, the study established the importance of resource conditions at the firm level via various NIS factors and how these can affect institutional linkages in NIS in Kenya.

Product factors such as the creation of new products, diffusion of products and creation of technological opportunities can affect the institutional linkages in the national innovation system (Mapila et al., 2011). Institutional linkages in national innovation system can also

be influenced by communication factors such as knowledge transfer, information diffusion and stakeholders' engagement; educational factors such as interactive learning, technology and creation of human capital (Schiller & Leifner, 2012) and market factors such as demand, networking and innovation adoption (Speirs et al., 2010).

McDonald (2011) avers that for developed and developing countries, growth in productivity and wealth rely more on a nation's capacity to create new technological knowledge and to share it into marketable inventions than on the country's natural resources. Fier (2013) further notes that due to the scarcity of natural resources, transformational leaders around the world have embraced this changing process informed by the fact that fact that successful creation of new knowledge will sustain the economic competitiveness of nations.

Sustainable competitiveness is a key consideration in enhancing the economic suitability of a nation and value of the life of its residents. Over the years, nations have used various means of achieving sustainable competitiveness while at the same time blocking others with mixed success rates. Those who remain on top commonly have high incidences of innovations. During the elaboration of the research model, the multifactorial model of institutional linkages was developed based on the institutions NIS factors. Thus, this model could be exploited in further researches which are aiming to analyze innovation in a holistic and comprehensive way for easy adaption by the users of the technology. Innovation that currently exist in Kenya enables making specific policy recommendations that should be considered to improve the NIS.

In response to these impediments, conflicts in resource allocation must be minimized for more efficient use; incentives for domestic innovation must be created by attracting foreign-based R&D institutions to relocate and encouraging large domestic firms R&D that have the capital resources required for innovation; strengthening the institutional linkages between university and industry should be done to affect university R&D and trust and credibility within stakeholder partnerships must be created for these links to form. An effectively organized government sector can accomplish these through well-designed policy. Kenya government should address these problems using the recommendations provided here.

There is thus need to develop links between innovation policy and programs and creative industries. Niche markets exist for Kenya in terms of fashion, food, and culture, especially in the context of the growing tourist industry. In areas where advanced technology can assist the development of these industries, innovation policy and the innovation system should be present to provide that boost. It goes without saying that in the high -tech fields associated with the Creative Economy such as media and software design; innovation policy should be supportive and allow needed resources to flow. Within Kenya's NIS, these two innovation tracks should be complimentary and not competitive. By complimenting one another and efficiently allocating resources, larger benefits of innovation can be available. To stimulate private sector innovation and overcome the innovation barriers posed by the branch plant structure and the predominant firm size in Kenya, the government must attract foreign-based R&D institutions. It must also encourage R&D in its large domestic firms that have the capital and resources required for innovation.

Additionally, a privately-managed fund for technological upgrading in firms should be created. These three steps together can encourage domestic innovation. It needs to complement this scheme with an additional county government tax credit program. The county government would offer a further reduction in the corporate tax rate for companies that locate not only their offices, but also their R&D facilities. The Kenya government should couple this approach with further investment in university and public sector R&D labs and facilities. Kenya should focus on niche areas - what it does well or where opportunities exist and promote innovation within target industries.

A key lesson learned from the case studies of Finland, Korea, and Singapore was that major government-led investment in R&D is critical to successful NIS development. Kenya must continue with, and enhance, its plans to upgrade science parks and industrial estates. Centers of Excellence at universities need to be ready for action. These investments will go further in drawing foreign R&D institutions to Kenya by creating the innovation infrastructure these firms need.

5.3.2 Implications for Practice

The study findings encourage firms to customized training programs for personnel to use innovation more effectively as a value add. This is possible in cases where management of such firms identify main contributors and impediments to the innovation process and tailor-make awareness programmes aimed at boosting enterprise-wide use of knowledge towards meeting corporate objectives.

To increase the adoption rate of innovation in the organization, there should be a comprehensive peer review and/or 360^0 review amongst staff to have continuous feedback, support and encouragement for innovators so that they can internalize and escalate the innovation skills within a short duration of time. since employees are influenced by their social network in adopting or at considering an innovation, employers can use the framework proposed in this study to conduct social network analysis inorder to derive maximum value from their corporate and individual employee networks especially in contributing toward innovation by processes, products or adoption of new technology.

The outcomes of this study informed recommendations for improvements in the current Kenyan NIS. Thus, it could be exploited by the corresponding authorities in order to analyze current efficiency of innovation policy in Kenya. Embracing good governance will contribute greatly in strengthening the operational effectiveness of NIS at a national level. Countries that succeed in developing and sustaining strong innovation capabilities and well-functioning systems of governance do well economically while those that fail tend to fall behind. This is usually a challenge for many developing nations since a proper system of innovation is developed gradually over time. At times, such countries may need external financial and technological assistance in developing own national systems of innovation. There is also limited budgetary allocations for R&D on innovations in many a developing nations which may be a hindrance to developing NIS in these countries.

Although NIS as a field of literature has received wide recognition, at the same time, it has been confronted by a lot of critique . Critics' argue that national innovation systems have already been researched in developed countries, and that developing countries would require more research . Nevertheless, the researcher disagrees with this sort of thinking in

many aspects. In the opinion of the researcher, the current state of research has not managed to encompass the field of NIS comprehensively within developed countries. For instance, the dimension of national innovation systems and their influence on innovative institutions has not been addressed adequately.

Also, fewer studies have managed to study NIS from the innovative capacity that it holds. In view of this study, policymakers from other NISs (for instance, in Europe) could gain from these kind of comparative studies. Europe's economic market and viability revolves around SMEs, not only for generation of jobs, but also for initiation of innovations and informing behaviours of consequent innovations. Thus, this type of assessment enhances competitive gains for countries and boosts productivity. Therefore, comparative studies in developed economies should not be ignored since they offer vital knowledge for both the developed and developing countries.

If countries shared their successful innovation policies and programmes, as a consequence, other countries could benchmark and imbibe similar innovation strategies. This type of knowledge share between countries could potentially promote knowledge transfer not only within domestic borders, but also outside the country, could potentially be fundamental for innovativeness globally. Not only would policymakers benefit from comprehensive studies on NIS, but also universities. Actors within NIS could utilise research results on policies and activities on innovation. For instance, universities would be able to search and find information on what sort of innovation programmes and activities exist, which they could tap into.

5.3.3 Policy Implications

For policy-making, more emphasis has been given to practice than theory (Sharif, 2006). For instance, the OECD member countries are less interested in theory behind national innovation systems than are the academics (Lacave & Vullings, 2014). In addition, there has been scanty documentation on how a combination of more than one theory informs institutional linkages of NIS.

These failures in the innovation process and diffusion of knowledge suggest that, left to itself, the market will generate less innovation leading to diminished productivity than societal needs. In competitive world, this is a limitation that cannot be afforded. There are several ways in which government can improve the process. To begin with, government should subsidize both R&D and training of employees in use of latest technologies. Secondly, government should close financing gaps in the private R&D process, particularly for higher-risk, longer-term, and more generic research needs. Thirdly, government should incentify collaboration between industry, research firms and universities. Fourthly, government should provide information to firms, especially small and mid-sized enterprises (SMEs), on how to improve their performance and with its assistance in using that information effectively to gain competitive edge. Fifthly, government should regularize technology usage within research firms. Lastly, government should spur development of industrial clusters , as a way of reducing costs and improving productivity.

Government's role is to set and enforce criteria for the credit that reflect the public interest and then let individual firms make their own decisions about R&D. But to respond effectively to most of the market failures identified above, and even to identify them in a way that makes an effective response possible, governments need much more fine-grained knowledge about technology or business practice. Without such knowledge, the government cannot usefully decide which R&D projects to fund, help an industry cluster overcome the barriers that inhibit its development, understand the barriers to technological or organizational modernization, or help small firms understand how to upgrade their technologies.

Yet, the knowledge that is required is dispersed among private firms and other economic actors (such as educational and training institutions, regional business associations, trade associations, labor unions, and venture capitalists). It changes rapidly as business conditions change and can vary greatly between industries and across locations. It is not the kind of knowledge that a traditional bureaucratic agency, isolated from the day-to-day workings of business, can easily acquire or use. Instead, government needs a much closer and more colla borative relationship with business to gain the knowledge that will enable it to address the market failures.

The responsibility of the government in resolving these market shortfalls is not to control business or dictate technological or economic orientation despite the fact that government-initiated policy at industrial level would be preferable. Such policy initiative may not fully address market shortfalls that bedevil innovation process. Besides, it would not be appropriate to fund firms that do not serve public interests.

Further, government should be a facilitator that spurs firms to innovate in ways that serve the public interest. Rodrik (2012) captures our view of the appropriate relationship between government and business with respect to innovation policy when he describes an interactive process of strategic cooperation between the public and private sectors which, on the one hand, serves to elicit information on business opportunities and constraints and, on the other hand, generates policy initiatives in response. Breznitz (2011) similarly writes that a government innovation-promotion agency should not pick strategic products or technologies but should motivate firms, individually and in cooperation with other firms and government, to make the investments needed to innovate. Agency needs to be more familiar with science, technology, and business practice, and have more cooperative relationships with business, than a traditional bureaucrac entity.

Small innovative enterprises can become the locomotive pulling the development of the whole country. Innovation is seen as a future foundation of Kenyan competitiveness in the global market. In this context, it is particularly important to develop state innovation policy, regulatory aspects and support innovative entrepreneurship.

Thus, it is possible to conclude that the national innovation system in Kenya is spending huge amounts of resources for the financing of small innovative businesses. However, this approach does not always lead to an increase in its competitiveness. Untargeted cash infusions weaken incentives for innovative development and increase in productivity. Instead, the right way is the creation of favorable conditions for business development, including: the provision of preferential rental conditions; reduction of the tax burden;

creation of the favorable investment climate; development of the legal system and the improvement of legislation, including the field of intellectual property rights; revision of industrial standards; and creation of a framework to guide institutions of higher learning to offer academic programmes that meet demands for national strategic purposes.

5.4 Recommendations of the Study

From the observations of this study, the following propositions were recommended:

For more innovation to be realized through NIS, partnership with other stakeholders should be encouraged especially in universities who mainly deal with sharing knowledge and not necessarily transmission of skills. This can lead to sharing of information and interacting with new technology owned by other stakeholders and policy makers in the innovation of ICT.

There should be a good mix of innovation incentives and NIS factors when studying the factors that influence the institutional linkages of NIS in Kenyan ICT innovation institutions. This should be necessarily be monitored by the government since most of these institutions are government entities.

Government and innovation institutions should also put in place policies that encourage innovation. To increase transmission of innovation within the NIS through uptake of new innovations, both knowledge generators and knowledge seekers should create conditions for success. For instance, knowledge generators such as universities and research firms should obtain skills to enable them package innovation to marketable product. Knowledge generators should also engage in more research work to establish knowledge products that meet demand of knowledge seekers. This may inform policies of knowledge generators in

such ways as university curricula being aligned to demands of the industry and avoid cases where generated knowledge is not uptaken by the targeted actors. On the other hand, those seeking innovations such as the industry and government should interact with knowledge generators to stimulate demand for innovation relevant to their business needs. Where necessary, knowledge seekers can offer better policy incentives and institutional changes to attract additional investments towards generation, sharing and adoption of knowledge.

Institutions should be advised and encouraged to interact since this will strengthen interconnectedness and open an avenue of sharing knowledge with the aim of improving technology and creating conducive innovative corporate culture that will stimulate more innovation. Regular communication amongst institutions should be encouraged by the policymakers and other stakeholders to enhance smooth transition of knowledge. Efforts such as Nairobi Innovation Week by University of Nairobi can be augmented by enganging other actors in the innovation process and widening the outreach beyond Nairobi. Industry associations can initiate lobbying with government and peers to set aside more incentives towards generation, dissemination and adoption of knowledge across the economy.

5.5 Suggestions for Further Studies

Future researchers can add more value to the body of knowledge by implementing the following suggestions, based on the findings of this study:

Since this study uses RBV and SNT as anchor theories, future research may incorporate transactions cost economies and dynamic perspectives to address the weakness of these theories. Future studies may also emphasize on examining institutions in moderately

predictable environment. This is because this study and related empirical observations show that resource conditions are vital in determining institutional linkages in NIS in a state of influx. It would be prudent to examine these observations in moderately predictable environment. In addition, future research can be done to establish the number of employees in the Kenyan ICT innovation institutions and how their experiences plus innovations contribute to institutional linkages in the NIS in Kenya. This will encourage partnership among these institutions and other sectors of the economy such as academia, government, research institutions and the government itself. Studies should be carried out using factor analysis to understand the best constructs that can determine the institutional linkages in NIS within the institutions. This will give a clear picture on how individual NIS factors qualitatively relate with NIS institutional linkages.

This research applied only four variables to test the factors that influence institutional linkages in NIS in Kenya. Considering there are other factors that may affect institutional linkages in the NIS, researchers in future may seek to ascertain influence of such elements on NIS institutional linkages. For instance, more studies can be conducted to establish the appropriate culture that institutions can adopt to increase ICT innovation. The study should explore further and include factors such as religion and individual employee culture in relation to their perspectives on innovation. Studies should also be conducted to find the effect of institutional characteristics and the rate of innovation within the ICT innovation institutions in Kenya. In addition, studies should be conducted to establish other drivers of innovation in government-affiliated firms other than the current regime of budgetary incentives. It would be interesting to find out whether the results would be the same when these different variables are used.

Since the context of the study was Kenyan ICT innovation institutions, future studies can focus on a wider scope by engaging more sectors of economy with other innovations but using the same variables. This will give a better view of the level of innovations in Kenya and effectiveness of the NIS depicted by the strength of the institutional linkages among wider innovation institutions. This will also seek to establish whether the findings will remain the same. Lastly, a longitudinal study design may also be applied instead of a descriptive cross-sectional research design where data would be collected and analyzed over a period of time. The results from such a study may have different findings from the ones attained in this research study.

5.6 Limitations of the Study

Conceptual, contextual and methodological challenges were assessed whilst establishing objectives of this study.

The concept of NIS has generated attention both locally and internationally. However, Kenyan literature on the same is scanty mainly due to inadequate cooperation between Kenyan universities and the industry (Gechaga et al., 2005). This also applies to the literature of the NIS in the Sub-Saharan Africa which is also scanty. Thus, there was a limitation in comparing the outcomes of this study with prior research observations. This research sought to ascertain the influence of innovation culture and innovation incentives on the relationship between NIS factors and institutional connectedness in the NIS in Kenyan ICT innovation firms. However, literature supporting institutional linkages in NIS can also be influenced by other factors such as business environment, politics (national, corporate) and unpredictable changes in technology. These factors were not factored in this study.

Further, this research was only conducted on ICT innovation institutions in Kenya. This is despite innovation taking place in all sectors of the economy. There is thus need to exercise caution while using the results of the study since they may not apply across other sectors such as in manufacturing, real estate, farming, etc. This is mainly because of difficulty involved in identifying innovations in the developing world where the basis of innovations is still blurred and not understood (Pansera, 2013).

Results of the study may have been different if, for instance, longitudinal research design was used instead of descriptive cross-sectional survey design. This is because descriptive cross-sectional survey design does not focus on details of the factors examined in the study while longitudinal research design takes a longer time which would have catered for changes that took place during the study. For instance, 6 Kenyan ICT innovation institutions closed down in the course of the study while 3 institutions refused to participate. The researcher would have wanted to study the entire population of 112 institutions but had to remove the 9 institutions. This may have withheld crucial information on the variables of the study which may have resulted in different findings from the ones established in the research.

Obtaining responses from same level of employees across these institutions was not easy since they differ in organization structure and hence divergent views and focus of the research tools were realized and this could lead to alot of differences in response if data is not well cleaned and analyzed.

Another limitation was the fact that majority of the respondents were junior staff especially for universities outside Nairobi. These respondents may not have better understanding of innovations in their institutions especially at the policy level where senior management view of innovations incentives and innovation culture may be established. Some lecturers also doubled up as ICT officers in some of the universities that participated in the study due to the low staffing levels sustaining operations in these universities. Thus, the outcomes from these institutions may have been different if the participants were of higher hierarchies such as Chief Information Officers, Chief Operations Officers or even Chief Executives Officers, due to better understanding and holistic view of innovations at a higher level in these organizations.

The researcher also had a challenge in the timing of some participants to respond to the questionnaires due to their busy working schedules. The researcher made special arrangements to meet some of these participants outside office hours. In addition, the ICT innovation institutions are spread across the country which increased the time and cost incurred in data collection. In some cases, the researcher visited some respondents severally without any response. Most of the constructs were not significant although they had some effects. This indicates that some of the participants were not consistent when filling the questionnaires.

5.7 Chapter Summary

This was the last chapter of the thesis which summarized the study's research objectives, hypotheses and findings. The study concluded that NIS factors is a major determinant of institutional linkages in NIS in Kenya since it was established to significantly influence institutional linkages in the NIS. Study also established need to lay emphasis on both innovation incentives and innovation culture since they were both established to affect the strength of institutional linkages in the NIS in Kenya such that by increasing the two variables, there was notable improvement in the institutional linkages of the NIS. The implication of the study to theory, managerial practice and policy was also discussed. For better institutional linkages in the NIS, there is clear need for government to create policies that foster innovation. Generators of knowledge (universities and research firms) should attain skills of packaging innovation to marketable product while the industry should engage the the knowledge creators by instituting demand for innovation.

Limitations of the study were discussed followed by recommendations. Study encouraged interaction between actors within NIS to boost uptake of innovation especially between unversities, research institutions and the industry. Need for government involvement in issuing and monitoring of incentives to enhance innovation was also cited as a key driver to better institutional linkages in the NIS in Kenya. Lastly, suggestions were made for further research studies in National Innovation Systems. Key to this is additional studies to establish other factors that influence NIS institutional linkages as well as the most appropriate innovation culture and innovation incentives supportive of a National Innovation System.

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APPENDICES

Appendix 1: Questionnaire

Section A: General Information

1. Name and address of the organization……
2. Where does your organization fall in the following categories?

   Ministry of Information Communication Technology [ ]

   Ministry of Higher Education, Science and Technology [ ]

   University [ ]

   Research institution [ ]

   Innovation hub [ ]

   ICT professional body [ ]
3. When was the organization established?.....
4. What is the level of innovation in your organization?.....
5. What is the staff population?.....
6. Details of the respondents

   (a) What is your designation? ……..

   (b) How long have you worked with this firm?

Below 2 years	**3-5 years**	**5-8 years**	**8-10 years**	**Over 10 years**

(c) What is your current level of education?

Certificate	Diploma	Undergraduate	Postgraduate	Graduate

(d) Are you a member of any professional bodies?

…….....

Section B: National Innovation System (NIS) Factors

7. To what extent do you agree with the following statements? Please tick (**a**) appropriately in the spaces below using the key provided.

   Key: 1-Not at all; 2-Less extent; 3- Moderate extent; 4- Large extent; 5-Very large extent

	1	2	3	4	5
INSTITUTIONAL FACTORS					
We have regular interactions with stakeholders for various reasons such as regulation and sourcing new knowledge.					
We have in place efficient systems to generate knowledge					
We package knowledge into marketable products					
We have policies that govern internal and external communications					
We ensure regular sharing of knowledge and skills through induction programmes for new staff and inhouse training					
We address knowledge gap through measures such as hiring specialists and conducting inhouse R&D					

	1	2	3	4	5
EDUCATIONAL FACTORS					
Our R&D is undertaken in collaboration with other institutions					
There is adequate funding of universities to facilitate R&D in the country					
Government invests in technical and vocational training					
We encourage staff to develop competences in areas of interest aligned to market needs					
MARKET FACTORS					
There are explicit governmental policies for protecting the local market innovations from foreign innovations					
There are strong Intellectual Property Rights to encourage foreign companies invest their most advanced technologies in the country					
There is great need for our existing products among our clients					
There is great need for our new products among our clients					
The market easily embraces new ideas and/or products					
PRODUCT FACTORS					
Production of goods and services is becoming more technology-intensive					
Production of goods and services in this institution is becoming more skills-intensive					

	1	2	3	4	5
We have adequate resources to produce prototypes					
We carry out effective R&D					
COMMUNICATION FACTORS					
We are innovative in organization and management to enable technology diffusions					
There are frequent collaborations between industry and public research institutes					
Large private firms share their R&D with smaller firms and startups					

Section C: Innovation Incentives

8. To what extent do you agree with the following statements? Please tick (**a**) appropriately in the spaces below using the key provided.

   Key: 1-Not at all; 2-Less extent; 3- Moderate extent; 4- Large extent; 5-Very large extent

	1	2	3	4	5
POLICY					
Our firm has policy incentives to promote innovation					
Our firm offers conducive environment to enhance innovation					
Our firm trains staff with skills that are relevant in promoting innovation at service and product level					
Our firm sets aside and utilizes critical resources that are geared towards fostering innovation					

	1	2	3	4	5
INFRASTRUCTURE					
Our firm is in collaboration with institutions performing R&D in the innovation process					
Our firm is in collaboration with institutions financing R&D in the innovation process					
There are explicit governmental policies for offering significant subsidies for foreign investors in the country					
Our firm is aware of the tax subsidy accrued from training staff with trainers approved by government's National Industrial Training Authority(NITA)					
KNOWLEDGE					
Our firm has access to knowledge-intensive services					
The scope of technology diffusion has promoted our firm's ability for identifying, accessing and incorporating new knowledge and techniques					
Our firm encourages flexible management structures, organizational change and training.					
The government promotes our interaction with public research through partnership schemes, co-operative research and matching funding					

	1	2	3	4	5
RESOURCES					
We have access to capital for financing innovations e.g. private venture capital, government grants and fund, donor funds, subsidized loans, etc					
The governments addresses the specific factors that restrain our entrepreneurial technology-based projects such as taxes					
The government has reformed regulations which unduly inhibit entrepreneurship					
There are not regulatory barriers to entry within the National Innovation policy for new institutions					

Section D: Innovation Culture

9. To what extent do you agree with the following statements? Please tick (**a**) appropriately in the spaces below using the key provided.

   Key: 1-Not at all; 2-Less extent; 3- Moderate extent; 4- Large extent; 5-Very large extent

	1	2	3	4	5
ORGANIZATIONAL LEARNING					
Our firm encourages investment in skills and improves					
Our channels for disseminating technology and codified knowledge include information networks, demonstration and benchmarking schemes					

	1	2	3	4	5
Our organizational culture is conducive to innovation and entrepreneurship					
CUSTOMER FOCUS					
Our innovative processes rest on a sound knowledge base informed by market research					
We are market-oriented, profiting strongly from product and process innovations that have a high IT content					
We operate a linked set of processes involved in concept generation or market identification, product and process development, production, market introduction and feedback					
EMPOWERMENT					
Flexible labor markets facilitate the transfer of skills between enterprises and within the innovation system					
Scientific advances are our wellspring of technical innovation					
We use university and government research directly through joint research or acquisition of patents and licenses					
We rely on the science base for trained personnel and access to methods and techniques.					

	1	2	3	4	5
TEAM ORIENTATION					
To better access and exploit new technologies, we employ industry cost-sharing through better designed and integrated public schemes					
Skill requirements in our firm includes working in teams and maintaining interpersonal relationships					
We innovate through strong forward and backward interactions with suppliers and customers					

Section E: NIS Institutional linkages

10. To what extent do you agree with the following statements? Please tick (**a**) appropriately in the spaces below using the key provided.

    Key: 1-Not at all; 2-Less extent; 3- Moderate extent; 4- Large extent; 5-Very large extent

	1	2	3	4	5
JOINT RESEARCH					
There is increasing number of inter-sectoral joint research being carried out by us and the industry					
We share and continuously implement findings of the joint research with our peers					
There are no forums for inter-sectoral research interactions					

	1	2	3	4	5
PERSONNEL EXCHANGES					
We have an effective personnel exchange programme					
We always engage the stakeholders in every aspect of personnel exchanges					
Staff on exchange programmes introduce new ideas to the firm					
CROSS-PATENTING					
We have effective and regularly updated patenting policy					
We are aware of databases for accessing patents and licensing offices					
Our patenting activity is growing rapidly					
PURCHASE OF EQUIPMENT					
Efficiency and intensity of innovative activity depends on access to capital					
We use the latest hardware in realizing business objectives					
We have an IT-asset policy with clear timelines on when to replace/upgrade our hardware					

Thank you for your cooperation

Appendix 2: Letter of authorization by University of Nairobi

UNIVERSITY OF NAIROBI
COLLEGE OF HUMANITIES & SOCIAL SCIENCES
SCHOOL OF BUSINESS

Telephone: 4184160-5 Ext 215
Telegrams: "Varsity" Nairobi
Telex: 22095 Varsity

P.O. Box 30197
Nairobi, KENYA

23rd October, 2017

TO WHOM IT MAY CONCERN

Dear Sir/Madam,

INTRODUCTORY LETTER FOR RESEARCH
HILLARY WACHINGA– REGISTRATION NO. D80/73881/2012

The above named is a registered PhD candidate at the University of Nairobi, School of Business. He is conducting research on ***"National Innovation System Factors, Incentives, Culture and Linkages in Kenyan ICT Innovation Institutions".***

The purpose of this letter is to kindly request you to assist and facilitate the student with necessary data which forms an integral part of the thesis. The information and data required is needed for academic purposes only and will be treated in **Strict-Confidence**.

Your co-operation will be highly appreciated.

Thank you.

Graduate Studies Office
P.O. Box 30197
NAIROBI

Dr. Mary Kinoti
Associate Dean, Graduate Business Studies
School Of Business

MK/rm

Appendix 3: List of ICT Innovation Institutions in Kenya

List of universities

1. University of Nairobi (UoN)
2. Moi University (MU)
3. Kenyatta University (KU)
4. Egerton University (EU)
5. Jomo Kenyatta University of Agriculture and Technology (JKUAT)
6. Maseno University (Maseno)
7. Dedan Kimathi University of Technology
8. Chuka University
9. Technical University of Kenya
10. Technical University of Mombasa
11. Pwani University
12. Kisii University
13. Masinde Muliro University of Science and Technology (MMUST)
14. Maasai Mara University
15. South Eastern Kenya University
16. Meru University of Science and Technology
17. Multimedia University of Kenya
18. Jaramogi Oginga Odinga University of Science and Technology
19. Laikipia University
20. University of Kabianga
21. University of Eldoret
22. Karatina University

23. Kibabii University
24. Embu University College (UoN)
25. Kirinyaga University College (JKUAT)
26. Garissa University College (MU)
27. Murang'a University College (JKUAT)
28. Machakos University College (KU)
29. Rongo University College (MU)
30. Taita Taveta University College (JKUAT)
31. The Co-operative University College of Kenya (JKUAT)
32. Kaimosi Friends University College (MMUST)
33. Alupe University College (MU)
34. University of Eastern Africa, Baraton
35. Catholic University of Eastern Africa (CUEA)
36. Daystar University
37. Scott Christian University
38. United States International University
39. St. Paul's University
40. Pan Africa Christian University
41. Africa International University
42. Kenya Highlands Evangelical University
43. Africa Nazarene University
44. Kenya Methodist University
45. Strathmore University
46. Kabarak University
47. Great Lakes University of Kisumu

48. KCA University
49. Mount Kenya University
50. Adventist University of Africa
51. Hekima University College (CUEA)
52. Tangaza University College (CUEA)
53. Marist International University College (CUEA)
54. Regina Pacis University College (CUEA)
55. Uzima University College (CUEA)
56. Kiriri Women's University of Science and Technology
57. Aga Khan University
58. GRETSA University
59. Presbyterian University of East Africa
60. Inoorero University
61. The East African University
62. GENCO University
63. Management University of Africa
64. Riara University
65. Pioneer International University
66. UMMA University
67. International Leadership University
68. Zetech University
69. Lukenya University
70. KAG - EAST University

Source: Commission for University Education (2016)

(ii) List of institutions under Ministry of ICT

1. Brand Kenya Board
2. Communications Commission of Kenya (CCK)
3. Kenya Broadcasting Corporation (KBC)
4. Kenya Information Communication Technology Board
5. Kenya Institute of Mass Communication
6. Kenya Year Book Editorial Board
7. Konza Technopolis Development Authority
8. National Communications Secretariat
9. Postal Corporation of Kenya
10. Safaricom
11. Telkom Kenya

(iii) List of institutions under ministry of education, science and technology (MoEST)

1. National Commission for Science, Technology and Innovation (NACOSTI) - which replaces the former National Council for Science and Technology (NCST)
2. The Kenya National Innovation Agency (KENIA)
3. Technical and Vocational Education and Training Authority (TVETA)
4. National Research Fund (NRF)
5. Kenya National Acquisition Office(KNAO)
6. Kenya Industrial Property Institute (KIPI)

(iv) List of research institutes

1. KEMRI (Kenya Medical Research Institute)
2. KARI (Kenya Agricultural Research Institute)
3. KIRDI (Kenya Industrial Research and Development Institute)
4. KEFRI (Kenya Forestry Research Institute)
5. KEFMRI (Kenya Fisheries and Marine Research Institute)

(v) List of innovation hubs

1. iHub
2. m:Lab East Africa
3. GrowthHub
4. NaiLab
5. C4D Lab
6. Akirachix
7. Lake Hub
8. iBiz Africa
9. iLab Africa
10. FabLab Nairobi
11. 88 MPH /Start-up Garage

(vi) List of innovation professional bodies

1. ICTAK (Information Communication Technology Association of Kenya)
2. The Computer Society of Kenya (CSK)
3. ISACA – Local Chapter
4. The CIO magazine
5. KEPSA- ICT Committee - focuses on lobbying for business interests
6. TESPOK (Technology Service Providers of Kenya)
7. BAKE (Bloggers Association of Kenya) - looks out for bloggers
8. ICTAK (ICT Society of Kenya)
9. KICTAnet (Kenya ICT Action Network)