**International Journal of Research in Business Studies and Management**
**Volume 6, Issue 4, 2019, PP 36-50**
**ISSN 2394-5923 (Print) & ISSN 2394-5931 (Online)**

# Moderating Influence of Innovation Incentives on the Relationship between National Innovation System factors and Linkages in Kenyan ICT Innovation Institutions

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## ABSTRACT

*National Innovation System (NIS) is the set of institutions and their 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 aims to explore the understanding of NIS and competitiveness, both at sectoral and national level. The study is thus set to investigate the influence of innovation incentives on the NIS factors and linkages in Kenyan NIS. Specifically the study was set to investigate the influence of innovation incentives on the relationship between NIS factors and linkages in the NIS in Kenya. This research study adopted cross-sectional survey design. The population of the study was 112 and a sample of 73 institutions both private and public was obtained. 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 innovation incentives has no moderating influence on the relationship between NIS factors and linkages in the NIS in Kenya. All the effects of NIS factors and innovation incentives on linkages in the NIS in Kenyan ICT innovation institutions were significant. 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 and innovation incentives are key elements that influence the 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 NIS linkages. This points out to the need of pairing the theories as opposed to individual focus to better inform the linkages in NIS.*

**Keywords:** *NIS factors, Linkages, ICT innovation institutions, RBV,SNT ,DIT and Performance ,innovation incentives*

## INTRODUCTION

National Innovation System (NIS) is the set of institutions and their linkages that allows 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). 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.

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' 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, 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).

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 linkages (Mofor etal., 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).Therefore, linkages 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 linkages 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 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).

Innovation is required to takes place as a result of 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 support full 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 managementof 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).This leaves the gap of finding out the role of innovation incentives on the relatioship between NiS factors and linkages in Kenyan ICT Innovation Institutions.

### Research Problem

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 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 linkages between the industry and intermediate firms that develop and transmit knowledge.. This study assessed how the interrelationships among various NIS factors and incentives present opportunities for linkages in the country for NIS.Its therefore set to address the question: what is the effect of innovation incentives on the relationship between NIS factors and the linkages of the NIS in Kenya.

## Objectives of the Study

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

The specific objectives were to:

- Establish the effect between NIS factors and linkages in the NIS in Kenya.
- Investigate the influence of innovation incentives on the relationship between NIS factors and linkages in the NIS in Kenya.

## PURPOSE 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, both at sectoral and national level. The study will also act as a foundation for future research. The learning institutions will benefit from this study as they will know their contribution to the NIS and any short falls in skills required in the ICT sector.

## LITERATURE REVIEW

### Theoretical Review

The theories that guided the research study were Resource Based View Theory, Social Network Theory and Diffusion of Innovation Theory.

It is widely perceived that RBV theory, also called Resource Based Theory (RBT), was founded by Birge Wenefeldt in 1984. It is a technique of examining and detecting organization's tactical advantages centred on analyzing its unique mix of resources, intangibles, competencies and abilities.. In contrast, the emergent resource-based view argued that the source of sustainable advantage derives from doing things in a superior manner; by developing superior capabilities and resources ( Priem et al.,2014).

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. 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".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). 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).

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 linkages.

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.A combination of Social Network Theory (SNT), Resource-Based View (RBV) and Diffusion of Innovation Theory (DIT) are the major theories used to inform linkages in NIS in this study. 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).

## Empirical Review

### *NIS Factors and Linkages*

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). 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). 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)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). 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).

### Innovation Incentives, NIS Factors and 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. 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.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.

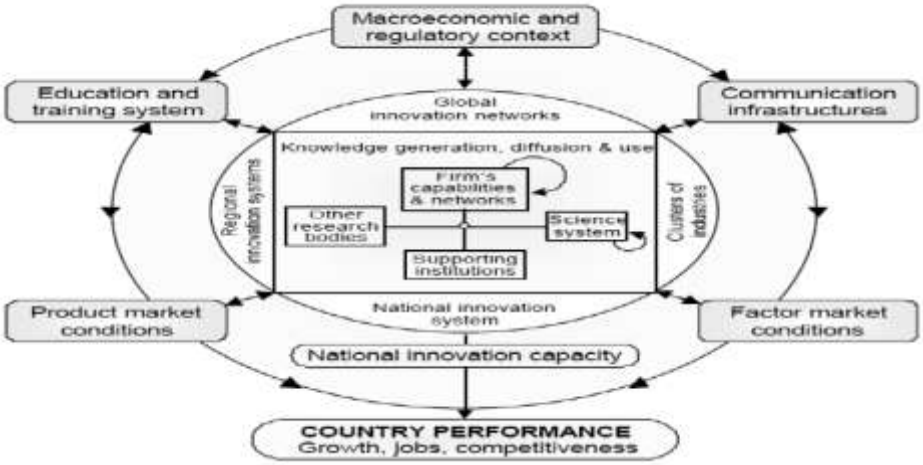


**Figure2.1.** *OECD Framework on managing National Innovation Systems*

## CONCEPTUAL FRAMEWORK

This research adopts a value-based model as a conceptual framework to determine the effect of n innovation incentives on the relatioship between NIS factors and 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.

### 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 linkages in NIS.

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

## RESEARCH METHODOLOGY

### Research Design

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.

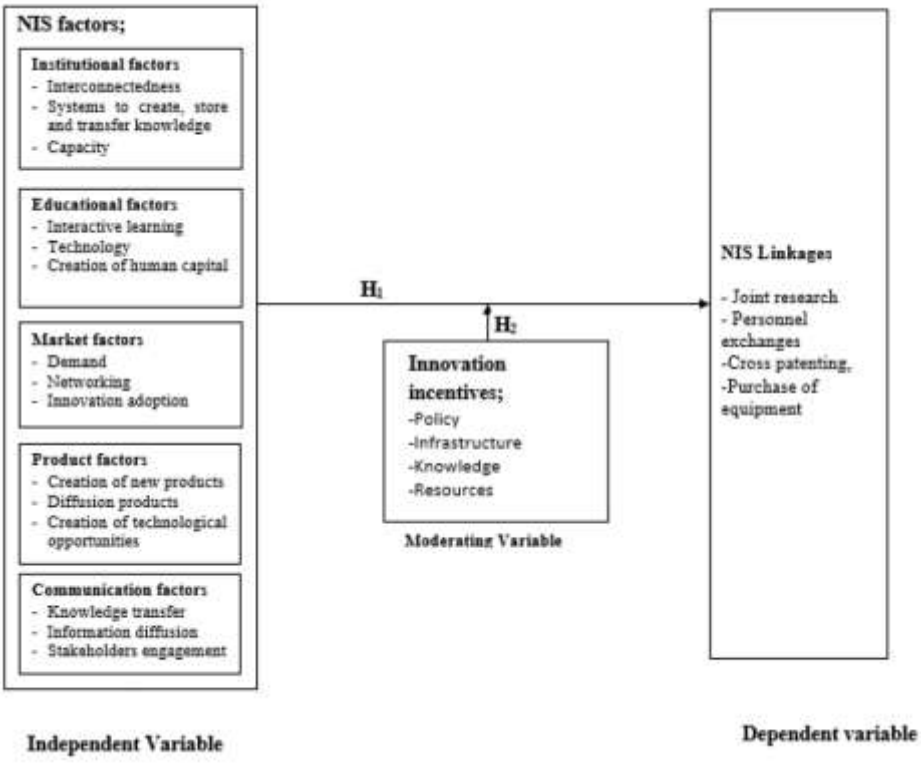


**Figure2.2.** *Conceptual model (Source: Author,2018)*

**Table3.1.** *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** |

## Target Population

The population of the study was 112 innovation-based institutions in Kenya. These were distributed as shown in the table 3.1 below Purposive sampling was adopted for this research. Kothari (2004) supports the selection of particular units that constitute a section of the population which represents the universe. Oates (2006) concurs and further asserts that purposive sampling is likely to produce valuable data that meet the aim of the research. Therefore, in this research, participants were selected from a list of active Microsoft outlook email users. This targeted mostly leaders and employees in ICT departments and innovation sections in these institutions.

## 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). 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.

## Reliability

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.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. 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).

## Validity

Construct validity was ensured by reviewing what other studies on NIS have done. Unbiased questions were added to the instrument to ascertain content validity.

## 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. For this study, regression analysis was the preferred choice with the aim of establishing the relationship between and among the research variables. 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 preding NIS linkages was presented by the model as follows:

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

Where Y is the dependent variable (NIS linkages) and is a linear function of, $X_1$,$X_2$, $X_3$,.....$X_n$ plus $\varepsilon_1$;

$\alpha$ is the regression constant or intercept.

$\beta_{1\text{-}n}$ are the regression coefficients or change induced in Y;

$\varepsilon_1$ 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.

## Moderating Effects

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.

The moderating effect was tested as follows:

$$Y = \alpha + \beta 1X1 + \beta 2X2 + \varepsilon \ldots\ldots\ldots\ldots\ldots \quad (1)$$

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.

$$Y = \alpha + \beta 1X1 + \beta 12(X1X2) + \varepsilon \ldots\ldots\ldots\ldots \quad (II)$$

Where ($\beta$=Co-efficient, Y = NIS linkages, $\alpha$ = intercept/constant, $\varepsilon$ = error term, X1 = NIS Factors, X2 =innovation incentives).

# RESULTS

## Descriptive Statistical Analysis of Key Indicators

The key indicators in this study were national innovation system factors, Innovation incentives, Innovative culture and NIS 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:

## National Innovation System (Nis) Factors

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 4.1 below:

From Table 4.1, 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

**Table 4.1.** *Descriptive Statistics of NIS*

| | 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 |

## Innovation Incentives

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:

**Table4.12.** *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

## NIS Linkages

The statements on each of the factors were responded on and average was taken to represent each factor to describe NIS linkages .These were then presented in the table 4.3 below:

**Table4.3:** Descriptive Statistics of NIS 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 4.3, 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 linkages.

## Test of Hypotheses and Interpretation of the Study Objectives

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 moderating effects of innovation incentives on NIS factors and NIS 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.SEM path analysis was displayed in figure 4.1 below

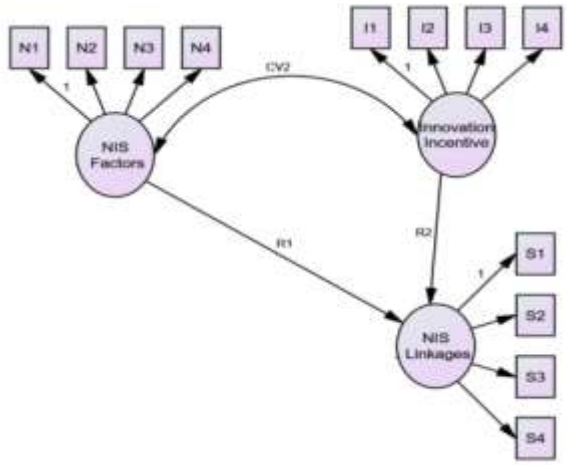


**Figure4.1.** *Path analysis (Source: Author, 2018)*

The items in Figure 4.1 are described as shown in the table below indicating each item in the diagram as per the study. These items are sub-components of NIS factors, innovative culture, innovation incentives and NIS linkages.

**Table4.4.** *Labels of Path Analysis*

| Item | Label |
|---|---|
| N1 | Institutional factors |
| N2 | Educational factors |
| N3 | Market and product factors |
| N4 | Communication factors |
| I1 | Policies |
| I2 | Infrustructures |
| I3 | Knowledge |
| I4 | Resources |
| S1 | Joint Research |
| S2 | Personnel Exchanges |
| S3 | Cross patenting |
| S4 | Purchase equipment |
| CV1 | Covariance between NIS & Innovation incentive |
| R1 | Regression weight of NIS on Linkages |
| R2 | Regression weight of innovation incentives on Linkages |

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

The effect of NIS factors on the linkages of the National Innovation System in Kenya was studied using multiple regression analysis.This relationship was also tested by using the null hypotheses which was stated as H01: NIS factors have no significant effect on the linkages in the NIS. The hypothesis was tested with the results computed using ANOVA and the outcomes shown in the table 4.4 below:

**Table4.5.** *ANOVA table of NIS Factors*

| Model | Sumof 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 4.4, 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 and thus conclude that NIS factors have significant effect on the linkages in the NIS.The variation in the model were explained based on the model summary table as shown below:

**Table4.5.** *Model Summary of NIS Factors*

| Model | R | R2 | Adjusted R2 | Std.Error of estimates | F-change | Sig.F- change |
|---|---|---|---|---|---|---|
| 1 | .614 | .377 | .330 | .729 | 8.102 | 0.001 |

From the Table 4.5, R=0.614. This indicates that there exists a strong positive relationship between NIS factors and NIS 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 linkages of the National

Innovation System to the larger population in general. The relationship between NIS factors and NIS linkages was further analyzed and the results were displayed in the table 4.6 below:

**Table4.6.** *Effects of NIS factors on 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 |

From the Table 4.6, institutional factors have a negative significant effect at p-value <0.05. This indicates that NIS linkages strengthens if institutional factors reduce hence giving a negative effect which is significant. Effect of NIS factors on 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(Linkages in the National Innovation System in Kenya) .Hence the null hypothesis was rejected.

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

The influence of innovation incentives on the relationship between NIS factors and linkages in the National Innovation System in Kenya was determined using stepwise multiple linear regression analysis. First, the effect of NIS factors on 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 linkages, second step tested the influence of innovation incentives on NIS linkages and the third step tested the effect of interaction between NIS factors and innovation incentives on NIS linkages. The influence of interation term is displayed below:

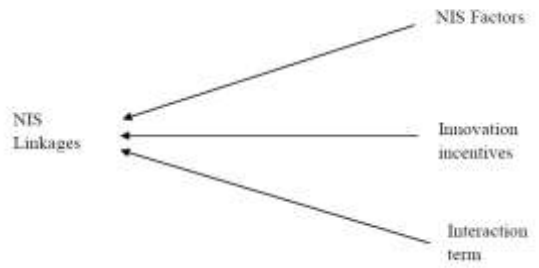


**Figure4.2.** *Influence of Interaction term (Source: Author, 2018)*

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

**Table4.7.** *Regression results depicting moderating effect of innovation incentives on the relationship between NIS factors and NIS 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 |

- Dependent Variable: Nis Linkages
- Predictors in the Model: (Constant), National Innovation System (NIS)factors
- Predictors in the Model: (Constant), National Innovation System (NIS)factors, Innovation Incentives

The findings of step one, two and three are shown in table 4.7 above. The findings of step one indicates that NIS factors (B=.806,t=6.180,p<0.05) has a positive significant inflect on NIS linkages.

The model has R=0.591, which indicates that there exists a strong positive relationship between NIS factors on NIS 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 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 linkages. R=0.603, this indicates that there exists a strong positive relationship of innovation incentives and NIS factors on NIS linkages.

Using adjusted $R^2$ =0.345, the model can explain upto 34.5% of the variation when estimating the effects of the NIS 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 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 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 thus accept the null hypothesis (**$H_{02}$**) that states that there is no significant moderating effect of innovation incentives on the relationship between NIS factors and NIS linkages. In conclusion, as established by the study, innovation incentive has no moderating effect on the relationship of the NIS factors and linkages in NIS in Kenyan ICT institutions.

## New Conceptual Framework

Besed from the findings, the study established that there is relationship of NIS factors on NIS 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.

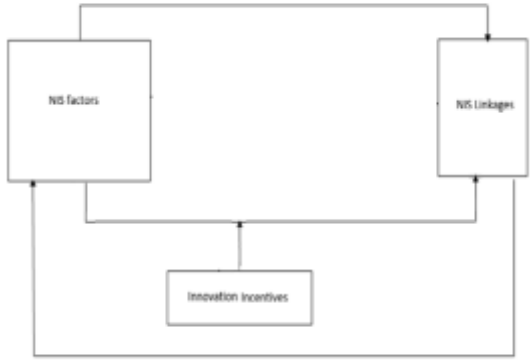


**Figure4.3.** *New conceptual framework (Source: Author, 2018)*

From Figure 4.3 it indicates that there is causality between the NIS factors and Linkages in that they are can be related in any given model by interchanging one to be dependent and the other independent.

## CONCLUSSION

The NIS factors had significant effect on the linkages in NIS for the Kenyan ICT innovation institutions and hence it is a major factor for linkages in NIS in Kenya. Communication as an NIS factor showed positive insignificant effect on the NIS linkages of Kenyan ICT innovation institutions. Hence, this NIS linkage can be still perfectly estimated using NIS factors without communication as a key component in the model.

Using ANOVA table based on F-test, the results were significant at p-value<0.05 and hence there was need to reject the first null hypotheses (H01) which concluded that NIS factors have insignificant effect on the linkages in NIS. There was no partial or full moderating influence of the innovation incentives on the relationship between NIS factors and NIS linkages. Individually, these variables had significant effect on the NIS linkages and increasing either of the variables resulted in an increase in NIS linkages and vice-versa. Therefoe good combination of innovation incentives and NIS factors when studying the factors that influence the NIS linkages in Kenyan ICT innovation institutions

## RECOMMENDATIONS

For more innovation to be realized through NIS, partnership with other stakeholdes should be encouraged in these institutions especially universities that deal mainly 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 linkages of NIS in Kenyan ICT innovation institutions during innovation.

This should be necessarily be monitored by the government since most of these institutions are government entities.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 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

## ACKNOWLEDGMENT

I wish to appreciate the invaluable contributions of my Supervisors, Njihia and Iraki, and the support of the University of Nairobi's School of Business in this ongoing Doctoral research.

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**Citation:** *Hillary Wachinga, Muranga Njihia, Iraki X N, "Moderating Influence of Innovation Incentives on the Relationship between National Innovation System factors and Linkages in Kenyan ICT Innovation Institutions", International Journal of Research in Business Studies and Management", 6(4), 2019, pp.36-50.*