MEASUREMENT OF NATIONAL INNOVATIONS SYSTEMS PERFORMANCE TRENDS IN SUB-SAHARAN AFRICA: A MULTIDIMENSIONAL STUDY

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In the modern economy, national innovation systems (NIS) contribute to a substantial increase in economic development in numerous parts of the world. NIS has been instrumental in integrating most developing countries' economies into the global capitalist system; however, some developing countries lag the innovation capacities to develop their NIS. The inability of the countries in Sub-Saharan Africa to gauge their NIS is problematic and probably risky for the countries' future development. Without proper evaluation and monitoring, it is hard for governments to create policies to advance their NIS to attain their desired economic development objectives. Development experiences of the countries in Sub-Saharan Africa and their insignificant standings in the global exchange of goods and services warrant a comprehensive way to measure and evaluate their NIS. This study ascertained how predictor variables: government effectiveness index (GEI), percentage of public spending on education (PSE) and labor force (LF) influenced the criterion variables: gross domestic product (GDP), gross national income (GNI) and human development index (HDI). The results categorized the countries that are performing soundly or not, and the knowledge from the assessments can aid in improving national policies for future performance of NIS in Sub-Saharan Africa. Likewise, it can help to create an atmosphere of informed decision and evidence-based calculated policymaking through assessment of development models' effectiveness in achieving regional goals. The study of NIS is significant in defining the level of effectiveness, convergence, and progress of nations. The outcomes of the policy ingenuities assumed at the state level can be specified and current strategies can be reformulated.

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TABLE OF CONTENTS

Page

LIST OF TABLES

Page

LIST OF FIGURES

Page

CHAPTER 1

INTRODUCTION

Globally, countries are undergoing rapid and complex changes while transitioning towards knowledge-based economies where innovative activities are foundational to social and economic growth and transformation (Lyasnikov et al., 2014). Anderson et al., (2014) asserted that Innovation includes ideas that are relatively novel, referring to ideas that have been adopted and adapted from other organizations however that are new to the unit of adoption. Anderson et al., (2014) also denoted that Innovation refers to the subsequent stage of implementing ideas toward better procedures, practices, or products. The interconnectedness of technology and information among human resources and institutions are vital to effect, support, and promote innovation to sustain the development of nations and regions (Lyasnikov et al., 2014; Nelson, 1993; OECD, 1997). The United Nations Development Program (UNDP, 1994) defines development as processes that increase society's chance of choice. For example, some individuals would pinpoint the status of education and health as vital factors in meeting basic needs, indicating that education generates knowledge, skills and capabilities making easy individual choices and freedom as a significant factor of development. Economic development is a normal process of change or a quest for economic progress. In the early 1990s, gross national product (GDP) was the only indicator routinely used to achieve a level of development. However, economic growth cannot be the only means to explain development problems because assessing and explaining variations in growth is a significantly more intricate issue. Good governance has significant values for people's freedom and choice and should be an essential scale by which level of development should be judged. There has been an ongoing discussion by NIS researchers on why a system should innovate and the gains associated with upholding

innovation undertakings. Sandberg and Aarikka-Stenroos (2014) asserted that innovation carries significant gains for organizations. Although innovation has excellent yields, it brings numerous threats that could risk the feasibility of an organization. Innovation is a costly and complicated process exposed to various ambiguities such as not having a layout plan to follow to innovate a new product or tackling emerging challenges in the innovation of a new product. Consequently, it is vital to recognize the methods that ease the advancement of innovation to ensure feasible results.

Cozijnsen (2000) emphasized that innovations must be prosperous in that it can drive regulatory improvement, support infrastructural development, and promote entrepreneurship. Globalization, growing competition, profound communal modifications, or incessant industrial signs of progress coerce organizations to innovate to contend and thrive in a complex setting. Since the 1980s, the National Innovation Systems (NIS) concept has gained popularity as a framework for analyzing technological change and growth. NIS and the knowledge-based economy have been the central goal of OECD work in the area of science, technology and industry and they have been keen on providing best practices. NIS is an “indispensable foundation of the long-term economic development of a nation” (Kayal, 2008, p. 74). NIS seeks to understand the interactions between institutions and human capital to facilitate the creation and dissemination of knowledge to the people (Maloney, 2017). NIS strives to adopt diverse types of innovation to increase worth to customers and organizations (Lyasnikov et al., 2014; Nordic Innovation Monitor, 2009). NIS facilitates identifying the indicators participating in the innovation process like government effectiveness, labor force (LF) and the percentage of public spending on education (PSE) within a national framework and highlights relationships between the indicators.

NIS forms a platform for sustainable economic development of the global economy and national economies of which it is comprised (Lyasnikov et al., 2014). The platform for sustainable economic development facilitated by NIS through nations ability to innovate attracts foreign investment and creates valuable businesses that offer products and services that can compete at a global scale. for the long-term. Initially, NIS was utilized to understand and foster innovation and economic development in developed countries. The sustained wealth of industrialized countries depends heavily on their capacity to innovate (Felipe, Kumar & Abdon., 2010). Research has focused on NIS in Finland, Germany (Jenni, 2017), and many developed countries. For example, Japan espoused a NIS, comparatively interventionist and directive in the 1970s and 1980s (Johnson, 1993). The Japanese NIS was interventionist and directive in that the government was directly involved in the path of the innovation system and dictates what happens in the innovation circles. They later changed to facilitation by establishing social innovation clusters such as university-industry partnerships and technologically advanced cities. According to Nishizawa (2007), the Europeans are also noted for using the same facilitation approach, whereas, in the United States, market dynamics are mostly dictated by market forces such as the economic factors that affect price, demand and supply of certain commodities. The approaches used in the developed world led to robust operational infrastructures, effective innovation systems that made them innovative and competitive economically. The developed nations also have appropriate intellectual property policies and effective legal frameworks to support innovation.

Nevertheless, least developed countries and developing countries' ability to increase their people's living standards depends on their ability to absorb, learn, and diffuse technologies (Michie et al., 2004). A country is termed least developed when they are low-income countries

encountering serious fundamental obstacles to sustainable development and are very much susceptible to economic and environmental upsets and have low levels of human assets (UN,2018). According to the United Nations (2018), 33 out of the 47 countries in the list of least developed countries are found in Sub-Saharan Africa. The framework of innovation in developing nations is frequently complicated. A nation is termed as developing when there is uncertainty and political predicaments, joblessness, destitution, distinct societal disparities; imperfect markets, familiar practices, developing economic establishments and regulation, insufficient and inept communal infrastructure, and the economy subject to the whims of the global setting (Uzunidis & Yacoub, 2008). Countries' economies in the developing world are volatile and weak, and their innovation policies are frequently connected to their macroeconomic, diplomatic, functional, and economic setting (Cassiolato et al., 2003). Therefore, knowing the history, functioning, and structure of the least technologically advanced nations is important to understanding their innovation approaches.

More recently, the NIS framework has been used as a technique for understanding causes of the divide in economic development among developed and developing nations (Feinson, 2003). It has also been used as an approach by developing countries to 'catch up' with more economically advanced nations (Watkins et al., 2015). NIS in developing countries was absent from academic literature in the earlier years but has been gaining increasing attention nowadays **(**Watkins et al., 2015). Constructing NIS in developing countries entails building learning capacities constructed among actors and communities (Casadella & Uzunidis, 2017).

One region that has been understudied is Sub-Saharan Africa – the world's slowest growing economic region in 2021. It is projected that the gap between Sub-Saharan Africa and the rest of the world will continue to widen over the next five years (Selassie & Hakobyan,

2021). The current study is needed to help gauge the innovation standing of the Sub-Saharan region for better policy initiatives towards their NIS and create strategies to further solidify academic institutions and promote learning and training that support innovation.

Statement of the Problem

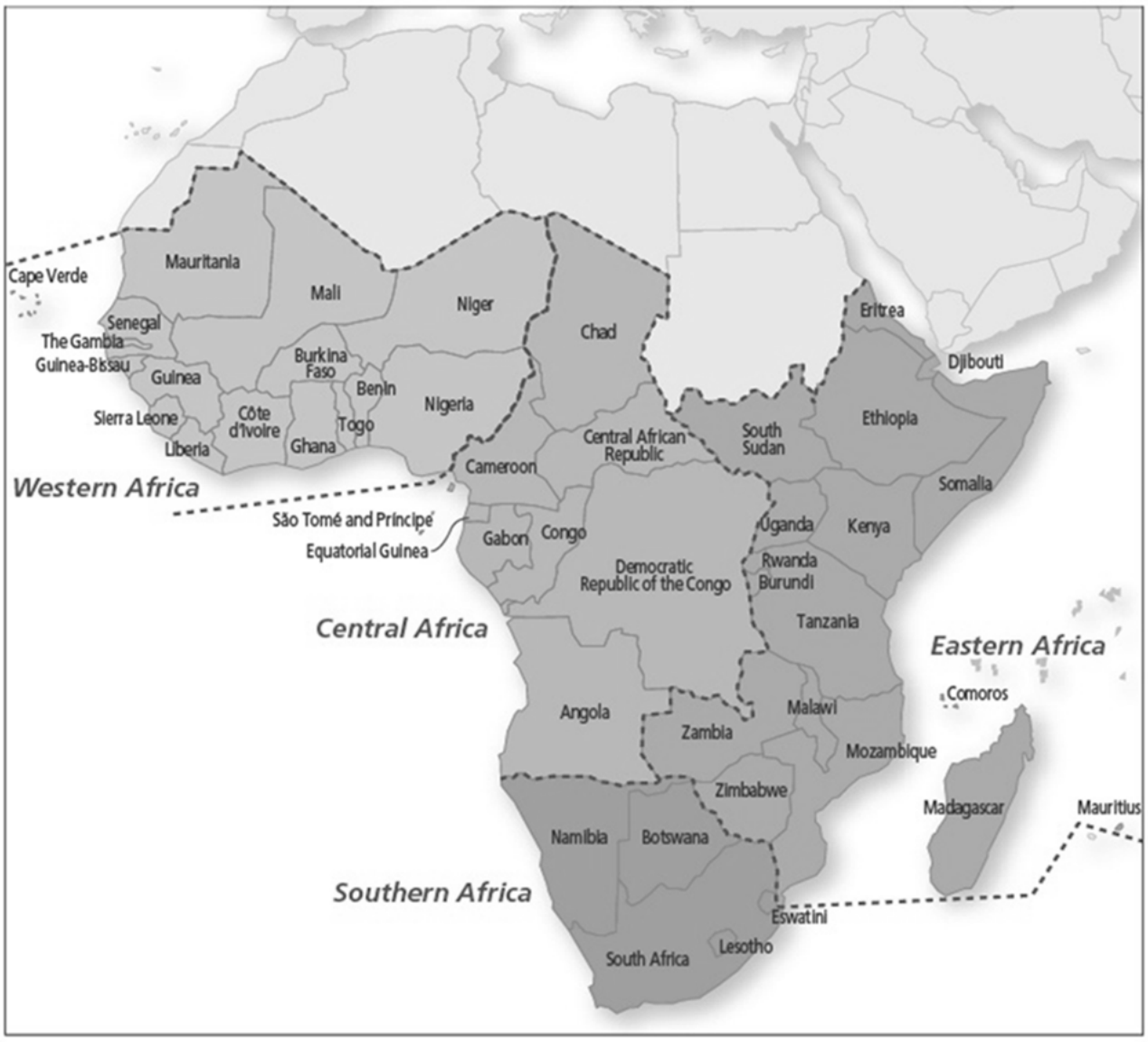
Most Sub-Saharan African countries have been struggling with food security and controlling diseases. There is also the prevalence of poor academic infrastructure with the availability of human capital to teach, train, and conduct research in the region being minimal (Cook et al., 2019). All these problems deter the progress of their NIS and, as a result, perturb wealth creation and prevent the building of a better society. The pandemic caused by COVID-19 creates another layer of challenge for the region's economies, especially with limited access to vaccines that would help curtail the virus. The pandemic has forced over thirty-two million people into extreme poverty, and the region is now experiencing increased debt levels (Selassie & Hakobyan, 2021).

In 2013, the African Union developed Agenda 2063 as a shared framework for inclusive growth and sustainable development. During the African Union government summit in June 2014, the heads of states embraced a 10-year Science, Technology, and Innovation Strategy for Africa (STISA-2024) which is the first decade of African Union Agenda 2063. This 10-year plan is part of a stable society concentrated African Union Agenda 2063 reinforced by science, technology, and innovation as multi-function tools for acquiring the objectives and expanding the sources of growth and sustainability of the economic performance of member states to end poverty in Africa (African Union Commission, 2014).The sole aim of (STISA-2024) is to foster a collective makeover and commercial effectiveness utilizing human resource development, innovation, value accumulation, industrial development, and free enterprise. Out of the 54

countries that converge to discuss the 10-year Science, Technology, and Innovation Strategy for Africa, 47 make up the region of Sub-Saharan Africa (see Figure 1.1). The STISA-2024 strategy was designed to increase and elevate the research establishments such as institutions of higher learning and augment specialized and practical capabilities through robust training and development of the human resources in the region (African Union Commission, 2014).

Figure 1.1

Map of Countries in Sub-Saharan Africa



In 2014, all 47 countries in Sub-Saharan Africa embraced the Science, Technology, and Innovation Strategy for Africa 2024 as the central structure for hastening Africa's evolution to an innovation-led, knowledge-based economy within the overall framework of the African Union (AU) Agenda 2063 (African Union Commission, 2014). The African Union Commission (2014) also espoused resolutions and legislative documents to launch the African Scientific Research and Innovation Council, the African Observatory for Science, Technology, and Innovation, and the Pan-African Intellectual Property Organization. However, the enactment of Agenda 2063 and the Sustainable Development Goals necessitates monitoring and evaluation as mechanisms for building instruments within the structures of the African Union (African Union Commission, 2014). In other words, a dynamic monitoring and evaluation framework was used to determine to what extent the enactment of STISA-2024 can impute impacts in order to know how successful this strategy has been to achieve the goals of the project.

Purpose of the Study

Since the formation of the Science, Technology, and Innovation Strategy for Africa 2024, there has been no concrete framework to reinforce its enactment monitoring and evaluation. Buffel et al., (2017) asserted that the strategy's completion timeline only integrated a concluding assessment at the culmination of 2024. It is imperative to use monitoring and evaluation to measure whether strategic goals were achieved, identify areas that are not performing well, and use the knowledge gained on the assessments to improve performance in the future (Buffel et al., 2017). Data collection, measurement, and evaluation are always issues confronted by most researchers in Sub-Saharan Africa (African Union Commission, 2014).

According to Golichenko (2011), the national innovation system's systematic structural-objective methodology entails three interlocked macroblocks that work together at a similar

level: the commercial milieu, new knowledge, and frequencies for knowledge transfer. Golichenko (2011) explained that to measure these blocks' standing and effectiveness, a national innovation system profile should be created to discover problems in the national innovation system at the macro level. Operationally, there are relationships to the problems from the macro (strategic management), meso (organizational structure, human, financial, and physical resources), and micro (operationalization of resources) levels. Otherwise, it is not possible to explain the macro-outcomes.

Golichenko (2006) highlighted that NIS ascends from government's efforts, industry representation, academia, and the creative atmosphere. Government efforts determine the effectiveness of NIS, while the LF and Human Development Index (HDI) highlight their significance through industry representation, academia, and creative atmosphere. Measuring the innovation systems is expected to provide evidence of the impact that predictor variables like LF, government effectiveness index (GEI), percentage of public spending on education (PSE) have on criterion variables such as GDP, gross national income (GNI) and HDI of Sub-Saharan Africa. This research aims to measure the impact STISA-2024 has on sustainable economic development through evaluation of the NIS of countries in Sub-Saharan Africa using the predictor variables (i.e., GEI, PSE and LF) and the criterion variables (i.e., GDP, GNI and HDI). The primary question guiding this study is: What are the outcomes of measuring/evaluating the performance of Sub-Saharan Africa's NIS 3 years prior to the implementation of STISA-2024 and 7 years after its implementation? To answer the primary research question, the following questions were investigated.

1. How does the implementation of STISA-2024 impact GDP, GNI and HDI in Sub-Saharan Africa as measured in the domains of government effectiveness, labor force and percentage of public spending on education?

2. What are the trends to predict the total performance of the sustainable development of the national innovation systems of Sub-Saharan Africa by the end of 2024?

Theoretical Framework

The study is grounded in the systems theory of innovation. Systems theory is a world view that is grounded on systems inquiry. A system denotes an arrangement of portions linked and combined collectively by a network of affairs (Edquist, 1997). Bertalanffy (1969) asserted that a system is a set of networking components with correlations among them. INCOSE (2006) added that the networking components' set are systematized to acquire a specified objective. Innovation is established by intermingling fundamentals and connections in the fabrication, dispersion, and usage of novel and frugally beneficial information. The inclusion of these fundamentals and associations are either positioned or entrenched inside a nation-state's borders. Carlsson et al., (2002) affirmed that mechanism groups make up systems, affiliations, and characteristics.

Edquist (1997) indicated that NIS comprises key commercial, governmental, societal, structural, institutional, and other dynamics that affect innovation's expansion, dispersion, and usage. In other words, the system is a structure that shapes and intensely affects procedures of interactive learning that lead to innovation. Suitable organizational and policy structures have added substantially in aiding and promoting the activities of the actors in the NIS and hasten the processes of knowledge creation (Schmid & Wang, 2017b; Reiljan & Paltser, 2016b). Corporations interact with numerous establishments such as higher learning institutions, research establishments, financial institutions, governments, merchants, and clienteles in such a process. Borras et al., (2011) explained how the system of innovation framework became vital for policy design and analysis in the milieu of science, technology, and innovation. There is an agreement

among science and policy professionals that the utmost suitable instrument for scrutinizing innovation is the NIS approach (Ghazinoory & Bitaab, 2014).

Utilizing the systems approach to analyze economic and technological change is nothing new (Carlsson et al., 2002). It offers an extensive and supple outline for establishing and understanding case studies and comparative studies. Since NIS comprises a visualization of a country's technical direction, the government envisioned competence, educational, and training capabilities. Systems theory can help stakeholders better understand how various establishments with different actors in various sectors are interconnected and how each contributes to the growth and development of each country within Sub-Saharan Africa and the region (Lall, 2002). The systems theory in this study is pragmatic in the current study because the measures are post-hoc, thus causal connections can be analyzed. This is different from using measures that include uncertainty and prediction where systems theory may be problematic as causal mechanisms cannot be clearly determined.

Background of Sub-Saharan Africa

Sub-Saharan Africa has been registering the most negligible effect and growth than any other region in the world (Ahmad, 2004). Considering per-capita basis and supplemental processes, Sub-Saharan Africa rests among the most impoverished areas in the world. Severe poverty unpretentiously reduces between the last decade of the 20th century and the new millennium's first decade. Regardless, 41% of Sub-Saharan Africans lived below the global poverty mark of $1.90 per day as of 2015, and 21% were malnourished as of 2016 (Cook et al., 2019). According to the World Bank, of the 49 countries in Sub-Saharan Africa (see Table 1.1), only one Sub-Saharan African country qualifies as "high-income" (Seychelles). Six countries are defined as upper-middle-income (Botswana, Equatorial Guinea, Gabon, Mauritius, Namibia, and

South Africa), the rest of the Sub-Saharan African countries are either lower-middle-income or low-income.

Table 1.1

List of Countries in Sub-Saharan Africa

1. Angola	13. Ivory Coast	26. Madagascar	38. Seychelles
2. Benin	14. Djibouti	27. Malawi	39. Sierra Leone
3. Botswana	15. Equatorial Guinea	28. Mali	40. Somalia
4. Burkina Faso	16. Eritrea	29. Mauritania	41. South Africa
5. Burundi	17. Ethiopia	30. Mauritius	42. Sudan
6. Cameroon	18. Gabon	31. Mozambique	43. South Sudan
7. Cape Verde	19. The Gambia	32. Namibia	44. Swaziland
8. Central African Republic	20. Ghana	33. Niger	45. Tanzania
9. Chad	21. Guinea	34. Nigeria	46. Togo
10. Comoros	22. Guinea Bissau	35. Rwanda	47. Uganda
11. Congo (Brazzaville)	23. Kenya	36. Sao Tome and Principe	48. Zambia
12. Democratic Republic of Congo	24. Lesotho	37. Senegal	49. Zimbabwe
	25. Liberia		

(Source: Library of Congress, 2010)

Ahmad (2004) also highlighted that technological development and transfer significantly affect employment, food security, export incomes, raw materials, and capital for advancement. The academic infrastructure, learning, and training are also gravely affected, impacting nation-building and economic development in the region. The education system (tertiary, secondary, and primary) and training are affected because most regions prioritize other sectors of the economy, such as food security and disease control. As a result, innovation that is highly reliant on a knowledge-based society is impacted, and a never-ending cycle of poverty is forever present in most states in the region.

According to the International Monetary Fund (IMF), several Sub-Saharan African countries faced economic impedance in 2014 due to weak global commodity prices and poor

agricultural conditions. The laden economic activities caused the average GDP to drop from 5% in 2013 to 2.7% in 2016, before marginally recuperating to 3.3% in 2017 (Cook et al., 2019). The IMF also projected in October of 2018 that regional growth would increase steadily to 4.5% by 2023 while remarking the substantial difference amongst the countries (Cook et al., 2019). The vast majorities of Sub-Saharan African economies stay homogenous. They are highly dependent on raw or marginally processed commodity exports in the energy, mining, and agricultural sectors. The public debt-to-GDP ratio dropped abruptly in the early 2000s because of the international lenders' intensive debt relief efforts (Cook et al., 2019).

Nonetheless, the number of Sub-Saharan African countries classified as being at high risk of debt distress increased from 8 in 2013 to 18 in 2018. According to the World Bank, Sub-Saharan Africa confronts rising fiscal deficits and weak exchange rates prevalently in commodity-exporting countries. Moreover, financing options suffer marginalization by weak tax collection strategies across the region (Cook et al., 2019). The lack of institutional capacity to facilitate sustainable growth and human development has impoverished most Sub-Saharan African countries. This challenge leads to economic turbulence, poor agricultural conditions, and violent conflict in large regions. Corruption and insecurity have also affected most countries, further hindering socio-economic advancement in most areas.

Many researchers have identified reasons for Sub-Saharan Africa's failure to achieve its sustainable economic development objective. In contrast, others have contended the methods used to measure economic development. Laher (2009) emphasized that Sub-Saharan Africa should decolonize its sustainable economic development effort from Global North hegemony. The African Union Commission (2014) emphasized that a knowledge-based and innovation-led culture is the basis for attaining the socio-economic growth objectives established in the region.

Considering the history of Sub-Saharan Africa, it is important to investigate how the indicators including GEI, PSE, and LF influence GDP, GNI and HDI of the countries in the region. The predictor variables (GEI, PSE, and LF) were selected mirroring the triple helix model and based on their intrinsic value to any nation's national innovation system. The LF plays a huge role in industry, percentage of public spending on education influences academia, and supports research and development, and government effectiveness identifies government's role in NIS. The dependent variables or outcome indicators (i.e., GDP, GNI and HDI) were selected based on how representative they are in determining economic development and on their value as the most sort after outcomes for any thriving economy. GDP, GNI and HDI are all important indicators of economic development and as a result are very important for this study.

Significance of the Study

The significance of measurement and evaluation in supporting Sub-Saharan Africa's quest for sustainable development is to invest in setting a vision and orchestrating a strategy to facilitate that vision (Olve et al., 1999). This study is based on the premise that measurement and evaluation can show the impact of NIS on Sub-Saharan African countries' economic growth and sustainability. Integrating measurement and evaluation as a tool in the system will significantly support Sub-Saharan Africa's quest for sustainable economic growth. It will give policymakers the leverage to resolve issues, as Otley (2003) asserted that what gets measured gets done. The ability to measure and evaluate the impact of the NIS will facilitate identifying sectors of the economy that need attention and how to resolve issues to advance the economy.

Understanding the economic growth in the region will determine the effectiveness of NIS and evaluate its impact on the region's economic growth measures. This research will help the policymakers and researchers know the region's NIS standing to restructure the production

system and general institutional setup to promote physical and intellectual mobility in the region for economic advancement. The study might serve as a basis for understanding and transforming the NIS in Sub-Saharan Africa by better decision initiatives and innovation culture. The academic system and training would be better targeted to complement research in higher educational institutions and create a knowledge-based economy.

Delimitations of the Study

The delimitation of the study involves the selection of the indicators and the technique of analysis used in the study. The indicators were selected from a pool of secondary data variables to facilitate the study. The technique used for the study is also delimited given that it was well thought out to fit the need of the study. The indicators to be used in the study are chosen by the researcher given the fact that other approaches have been used to measure innovation systems and there is none in which the actors of NIS who determine the policies and advance the system are studied.

Key Term Definitions

- *Economic growth*: Economic growth can be characterized as the surge or increase in the inflation-adjusted market value of the commodities and public services generated by an economy during a period (Bureau of Economic Analysis, 2015).
- *Gross domestic product (GDP)*: Gross domestic product is the fiscal measure of the market worth of the basic commodities and services created in a particular moment by nations (Coyle, 2014; Bureau of Economic Analysis, 2015).
- *Knowledge-economy*: This is an economic system in which the production of commodities and public services is based predominantly on knowledge-intensive pursuits that add to technical and scientific innovation development (Karahan, 2006).

- *National innovation system (NIS)*: The national innovation system is the movement of technology and knowledge amongst people, enterprises, and institutions which is important to the innovative procedure on the state level (Freeman, 1997).
- *Sub-Saharan Africa*: This is physically the region of the continent of Africa that is south of the Sahara (Cook et al., 2019), and comprises of 49 countries.
- *Sustainable development*: This is a coordinating theory for convening human development objectives while also maintaining the capability of natural systems to deliver the natural resources and ecosystem services on which the economy and the population rely (Bolis et al., 2014).
- *Systems theory*: Systems theory is the interdisciplinary examination of systems, i.e., interconnected groups of organized, symbiotic components that can be natural or manufactured (Edquist, 1997).

Summary

Chapter 1 gives an overview of NIS and what it entails highlighting the significance of measuring NIS to support policymakers to implement better strategies for advancing the economic development of their respective countries. The chapter points out the numerous problems faced by the countries in Sub-Saharan Africa stemming from dependence on aid, fragile economies, and disease. A coherent measurement technique to gauge the NIS of Sub-Saharan Africa and monitor the performance trend of these nations is needed to determine the current and desired development in the region. The problem statement, the purpose of the study, and research questions are detailed. The background of the Sub-Saharan African region is also examined in detail, and comprehensive information is given about the framework of the study.

The significance of the study is also pointed out, highlighting that it will help advance the NIS of the region. The delimitations of the study were also mentioned.

CHAPTER 2

LITERATURE REVIEW

This chapter reviews the relevant literature related to national innovation system (NIS). Innovation research is explored at the initial stage of the literature review, and further delimiting of NIS is done to give an overview of what it entails. The variables that impact NIS are also discussed, highlighting how they are used as a standard for measuring NIS in least developed and developing economies. An overview of the dynamics of NIS is also explored. The need to measure NIS is highlighted, and the problems associated with measuring NIS are elaborated. The chapter also highlights different approaches used to measure NIS and the multidimensional approach proposed for this study. The study also emphasizes advanced global innovation systems and the significance of the knowledge-based economy in NIS development. The problems encountered in measuring NIS and possible measures to remedy NIS measures are also included.

The groundwork of all scholarly research procedures regardless of discipline is the mixture of analysis and existing practice (Feddes & Gallucci, 2015). This literature review is a compilation of available topic articles that comprise statements, theories, statistics, and evidence published from a specific point of view to attain or express those perspectives on the topic's nature and how it should be scrutinized, and effective evaluation of the study papers concerned (Templier & Paré, 2015). The literature review in this study comprises a framework, description, and significant assessment of previous or current impediment in researches and acknowledges new research concerns and fostering research questions available data (Boell & Cecez-Kecmanovic, 2015). Various databases were utilized for theory building, specifically concentrating on scholarly peer-reviewed journals. A wide range of databases were employed to

have wider access to more literature and more expressive abstracts that will balance the theoretical foundation. Academic and periodic journals were used, and the articles exploited included theoretical and empirical articles that lined up with the research topic. The articles selected for the study range from 1980 to 2022 and were attained utilizing the keywords: *innovation, economic development, national innovation system, knowledge-based economy,* and *leadership*. The search generated a wide range of publications about NIS and those found relevant were selected. The collection and review of these articles were limited to scrutinizing theories, practices and policies. Although the articles discussed NIS descriptively, there was no specific study that was directed on studying the region of Sub-Saharan Africa as a group in relation to NIS as this study seeks to do. Critical analysis of the literature was reviewed and synthesized by fitting in concepts to build new prototypes and viewpoints about the subject and Synthesis through conveying together current thoughts by way of new ideas to create fresh, new methods of thinking about the topic (Torraco, 2005).

National Innovation Systems Research Framework

Schumpeter (1939, 1942), the inventor of the current usage of the word innovation, asserted that it is a procedure whereby a business conveys new technology into the economy. Schumpeter (1939, 1942) also attaches novel technology to economic progression by emphasizing a fault in customary neoclassical economic theory, which rests on the supposition of perfect competition. Nonetheless, the OECD innovation manual (2005) defined Innovation as a new knowledge, system, procedure, or scheme that generates a sophisticated level of performance for assuming operators. It has four extensive types, mainly product, process, marketing, and organizational innovations. Product innovation entails realizing a new or improved goods and services; process innovation involves notable alterations in the

manufacturing and distribution process; marketing innovations signify a change in the design and packaging of products, while organizational innovations apply to new organizational techniques (OECD, 2005). The theory of NIS arose during the latter part of the 1980s and the early 1990s. Fagerberg and Srholec (2008) highlighted that NIS plays a key role in achieving economic security and developing the economy's competitiveness through the interactive relationship between the government and business sectors. A highly developed knowledge management system plays an essential role in supporting NIS (Chu et al., 2014). NIS presents foresights that create flexibility to eliminate numerous deficiencies and blind spots of the neoclassical mainstream, and sufficiently reveals the innovation methods and their fundamental dynamics (Golichenko, 2016), and it is vital to measure its performance trends to advance its cause.

Silva et al., (2011) identified that the varieties and stages of innovation diverge within organizations and are determined mostly by an enormous and intricate set of variables. Variables such as organizational level, industry-level, and economy-level factors can equally arouse and limit innovation practice. For example, successful innovation can increase business value when new products are introduced, and profits gained. On the other hand, profits can also be limited to a few businesses and as a result increase wealth inequality. Innovation is considered a significant dynamic force for institutions' development and persistence (Baumol, 2002; Schumpeter, 1939). Vossen (1998) pointed out that orthodoxly the scope of innovation principally falls into the range of new product development or technology management. Researchers predominantly carry out such studies in the milieu of larger organizations. However, the scope of innovation has broadened recently, and discourse concerning innovation has become a significant academic subject of inquiry.

According to Edquist (1997), innovation can also be named as technological innovations,

organizational innovations, and institutional innovations. North (1990) elaborated further on the subject, highlighting that organizational innovation entails political, economic, social, and educational organizations. However, North (1990) also highlighted that institutional innovation involves markets and practices, customs, prescribed rules, and common laws controlling dealings and exchanges amid entities and clusters. Production-focused research and development (R&D) involves procedure and product innovation to advance countries' capability to meet production quality benchmarks locally and internationally at a competitive price and profit. There is quite a bit of research from academia partnered with UNESCO, government organizations, and others that cover large-scale, advanced research topics and complexity. In fact, most of the research done under the auspices of large international organizations is conducted by academic researchers. For example, much of the research on renewable energy in the US was conducted by academic researchers contracted through the US government:

Simultaneously, the governmental organizations have a specific part in planning and implementing strategies to make national innovation systems advanced, vigorous, and maintainable (Lundvall, 1997). Essentially, innovation can be progressive or far-reaching (Lundvall, 1992) like in the case of Apple and the practice of creative destruction or Blackberry and their single innovation strategy. Edquist (1997) emphasized that innovations are new inventions of financial implication with countless iterations of innovation involved in developing and disseminating knowledge.

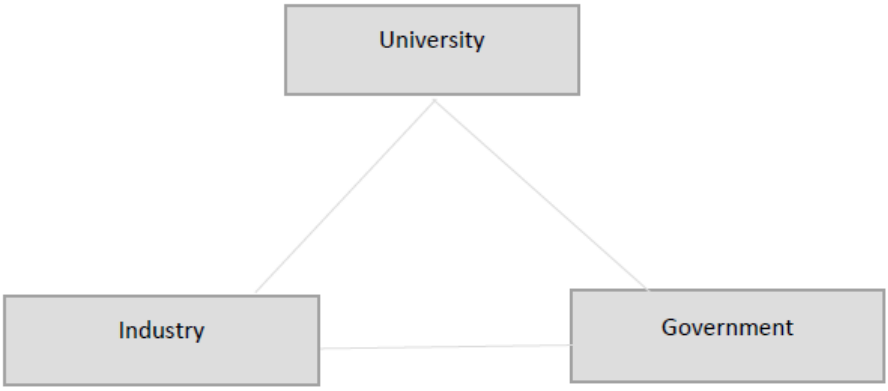
Innovation is a multidimensional concept that comprises diverse meanings and explanations from the viewpoint of various fields, some of them co-exist in developing disciplines like innovation studies (Fagerberg & Verspagen, 2009), even though others are considered "outsiders" (Edwards-Schachter & Wallace, 2017). Edwards-Schachter (2018)

emphasized that despite the numerous forms of literature available, it is hard to give a comprehensive definition of innovation and clearly describe its nature. To understand this, it is important to focus particular attention on innovation's personal, organizational, technological, and environmental frameworks. Despite the complexity of the innovation concept, comprehension of the innovation concept in the domain appears to be nevertheless progressing (Balzat & Hanusch, 2004; Edquist, 1997; Fagerberg, 2005). West and Bogers (2014) highlighted that less research attention was conducted on the impact of organizations' competencies and culture. This is important for the proposed research project, because culture is central to nations' ability to integrate innovation.

NIS stimulates the structures of innovation pursuits among the key players in the knowledge economy, including the government, business sector, and higher learning institutions whose interaction process falls within the presumed triple helix model (Lawton & Leydesdorff, 2012a). The triple helix model (Etzkowitz & Leydesdorff, 1995; Lawton & Leydesdorff, 2012a) was inspired by the Sábato and Botana triangle (1968) and can be a useful explanatory theory for understanding innovation systems. Among the typologies regarding the actors of NIS, the university, industry, and government make up the triple helix model (see Figure 2.1). According to Etzkowitz and de Mello (2003) universities, industries and government interact in a knowledge-based economy to contribute to innovation activity. The university's role is to oversee research and commercializing research outputs, and teaching and training people; industry's task is to transform thoughts and innovations; while government's responsibility is to formalize strategies and offer funding (Datta & Saad, 2011). The university, industry, and government constitute a system united for the purpose of innovation. The best way to measure the NIS is to study the actors involved in the system as emphasized in the triple helix model.

Figure 2.1

Typology Detailing Three NIS Actors



Moreover, the triple helix model added nearly to comprehending the complementarities of the critical proxies of a network of innovation from communal policy and knowledge management viewpoints (Ranga & Etzkowitz, 2013). For example, Ireland is a country that has assumed a national innovation system and realized dramatic economic growth since joining the European Union. The Irish model of the National Innovation System was dependent on foreign direct investment and export-led development. They gave higher learning institutions priority as part of supporting the development of corporate talent in the software industry. The expansion of software companies all over Dublin's place ascended partially due to the technological specialists graduating from adjacent institutions and the zone's appeal to such individuals. According to Hertog and Remoe (2001), the Galway cluster in Ireland experience is dominated by Digital Equipment Corporation, which supports job searchers and the development of new firms. The Irish government also financed absorptive human and physical capital capacity, predominantly in computing, communications, and national substructure (Andreosso-O'Callaghan & Lenihan, 2006).

Pavitt's taxonomy added to a range of grounds within innovation research (Archibugi,

2001), comprising structural performance and commercial procedure mapping at the business level. Taxonomies are intended to categorize phenomena with the objective of maximizing the disparity between groups. Pavitt intended the taxonomy to depict the performance of innovating firms to predict their activities and to propose a framework for policy analysis. The main influence of taxonomy is the belief that there is no one-size-fits-all model for establishing and comprehending invention and scientific modification policies. Rakas and Hain (2016), in their research advanced the utmost all-inclusive study on the diverse methods of systems of innovation. Rakas and Hain (2016) mentioned that the different methods of innovation originated from the ground-breaking studies of Freeman (1987), Lundvall (1992), and Nelson (1993). The different methods of innovation entail disruptive innovation, incremental innovation, sustaining innovation and radical innovation. Disruptive innovations are innovations of new technology or business models that disrupt the existing market. Incremental innovation is a gradual continuous improvement of existing products and services. Sustaining innovation is significantly improving a product that aims to sustain its position in the market. Radical innovation involves technological breakthroughs that transform industries and create new markets. These methods vary by systematic and theoretical emphasis, basics and scopes highlighted, and scheme limitations and examination components. The most frequently used analysis units for these innovations are regional, sectoral, technological, business, and social systems of innovation and production. Golichenko (2016) asserted that assessing the results of innovation would help create knowledge; therefore, researchers should test outcomes when researching procedures and dynamics of innovation. The indicators, which act as the study's variables, that are included in this study are GEI, PSE, and LF, GDP, HDI and GNI. The independent variables (i.e., GEI, PSE, and LF) were chosen mirroring the triple helix model and based on their intrinsic value to any

nation's national innovation system. The dependent variables (i.e., GDP, GNI and HDI) were selected based on their value as the most sort after outcomes for any thriving economy. Testing variables such as GEI, PSE, and LF revealed their impact on GDP, HDI and GNI as applied in this multidimensional quantitative study.

Why Measure Performance Trends in National Innovation Systems

The reason for using measuring and evaluation techniques (or methods) within a society is predominantly to inform, inspire, and govern all parties involved, but exclusively to assess the past, present, and future outcomes of an organization (Ax, Johansson, & Kullvén, 2002). Governments cannot underestimate the significance of monitoring and evaluation because, as Kaplan and Atkinson (1998) pointed out it is vital in any system to control the process, set performance objectives, measure actual performance, compare performance and the goals, and, if essential, act in response to the variance. Atkinson et al., (1995) viewed performance measurement as inseparable from the control system, a group of techniques utilized to keep the business in trajectory and accomplish identical objectives. Organizational performance can be measured both financially and non-financially. This study's approach considered both, even though financial performance measurements are traditionally the widespread approach (Kaplan & Atkinson, 1998). Kaplan and Norton (2001) explained that focusing on monetary measures alone would lead the organizations to doing the wrong things by focusing only on past actions and promoting short-term behavior, sacrificing long-term value creation for short-term performance. According to Bhimani and Langfield-Smith (2007), some scholars call for balancing financial and non-financial information to support the strategic innovation process. Performance of the variables GDP, GNI and HDI are a great way to measure innovation, because these performance outcome variables are usually impacted when innovation is going in the right

direction or otherwise. Performance outcome measures are employed to reveal the degree to which a fundamental function, objective, occupation, innovation, or service has impacted its intended audience or variables. The performance measures are generally constructed around the objective or outcome of the function, purpose, service, manufactured goods, or activity it is meant to provide or satisfy.

Problems of Measuring National Innovation Systems

The current literature review revealed that different methods have been employed to advance the academic needs of the NIS concept. However, these academic foundations are insufficient to ensure the emergence of a complete methodology for studying NIS. There is disagreement among researchers about a specific method for studying the NIS. For example, Lundvall (2007) emphasized that learning the NIS needs must be grounded on the micro's macro-level change. On the contrary, existing research methods are more fixated on macro-level establishments and a minor degree on entrepreneurs functioning at the micro-level (Hekkert et al., 2007). Also, national monopoly vs. private firm economic productivity at a larger scope beyond entrepreneurship at the meso or macro level. Micro is the individual or primary level of the economy, while meso is the intermediate or community level and macro is the advance or global economy. Often, there are conflicts between individualistic, large private company behaviors for profit that conflict with national priorities. These can often explain a failed component of larger national and regional efforts than if one examines outcomes in aggregate (e.g., environmental policy improvement, labor improvements, education, etc.).

Edquist (2006) underscored that an innovation system is a distinct unit devoid of splitting out the sub-processes and their actors when moving to a macro-level. At the macro level, the products are extended from a national to a global level. According to Fagerberg (2006), knowing

how knowledge and innovation function at the institutional level is difficult and requires appropriate theoretical and practical inquiry. Selected research highlighted that the methodology is frequently excessively expressive (Fagerber & Srholec, 2008; Guan & Chen, 2012; Yoon & Hyun, 2009) and under no circumstances ensures an authentic illustration of the necessary strategic processes in the NIS (Lorentzen, 2009).

Published studies on the NIS research approach revealed several complications and inadequacies present in national innovation systems (Carlsson & Jacobsson, 1997; Edquist et al., 1998; Johnson & Gregersen, 1994; Malerba & Orsenigo, 1997; Smith, 2000) such as infrastructural and institutional failures of NIS. In addition, researchers Edquist (2006), Hekkert et al. (2007), and Wieczorek & Hekkert (2012) sought to determine dynamic roles of NIS where failure to undertake the innovation processes indicates the failure of national innovation systems are noteworthy. In other words, organizations within the NIS who fail to produce products and services effectively impact the region and nation in a negative way thereby affecting the performance of the NIS. It also provides opportunities for competitors from other regions and nations to take up this gap.

Some past studies have also focused on communications research and the advancement and procedures of technological design at the phase of distinct manufacturing regions (Van Looy et al., 2006) and state (Choung & Hwang, 2000; Sun & Liu, 2010). To date, despite strongly valued discernments arising across the history of the expansion of the idea of national innovation systems, there is no crosscutting exploration of the running of NIS. Edquist (2006) emphasized that the limitations such as the lack of a standard approach to study national innovation systems, and no underlying interactive aspects to generate or learn the essentials of NIS make it challenging to utilize countless theoretical forethoughts of the national innovation systems in

practice. As a result, there is no approach to regulating any equitably comprehensive set of connected elements because this part of the economy is a complex adaptive system. No one standard can be used to evaluate NIS because each case involves different conditions, variables, and context that ensure an adverse impact on the growth of the method or to advance public policies designed to eradicate these elements (Edquist, 2011).

Miettinen (2013) articulated that the national innovation systems approach is ill-linked to systematic and optimistic thinking. Lorentzen (2009) stated that education in national innovation systems is frequently engrossed in industrialized nations' problems. They usually do not propose instituting a national innovation system in developing countries (Albuquerque, 2007; Lundvall, 2007). The difficulty of gauging specific vital national innovation system procedures like collaborative training remains unresolved. So far, no system of indicators creates the possibility to sufficiently illustrate the inputs and outputs of the innovation system's processes and the usefulness of these procedures and methods. The fact is that NIS is a complex adaptive system and how one innovative system is bounded will vary compared to others. The national innovation system's systematic structural-objective methodology entails three interlocked macroblocks that work together at a similar level: the commercial milieu, new knowledge, and frequencies for knowledge transfer.

Sustainability in National Innovation Systems

Sustainable development is a novel concept that began on civilization's radar in the 1980s, urged by the publication of the World Commission on Economic Development's (WCED) seminal Brundtland Report (Bolis et al., 2014). The Brundtland Report expressed sustainable development as "development that meets the current needs without compromising future generations' ability to meet their own needs" (WCED, 1987, 31). Osburg (2013)

highlighted that sustainable development stresses innovative business solutions beyond the customary intent to make the most profits. Karns (2011) identified that a novel business idea that goes past the philosophy of fast cash and revenue expansion in favor of new approaches to environment and development is an instant requirement. For example, all nations should resort to clean energy to reduce the carbon footprints on our planet. Nonetheless, the economic growth, agricultural expansion, and fast increasing populations of developing countries require much more energy. Currently, the ordinary individual in an industrialized market economy utilizes more than 80 times as much energy as someone in sub-Saharan Africa (UNIDO, 2009).

Table 2.1

Millennium Development Goals

#	Description
1	End poverty in all its forms everywhere.
2	End hunger, achieve food security and improved nutrition, and promote sustainable agriculture.
3	Ensure healthy lives and promote well-being for all at all ages.
4	Ensure inclusive and equitable quality education, and promote lifelong learning opportunities for all.
5	Achieve gender equality and empower all women and girls.
6	Ensure availability and sustainable management of water and sanitation for all.
7	Ensure access to affordable, reliable, sustainable and modern energy for all.
8	Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.
9	Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation.
10	Reduce inequality within and among countries.
11	Make cities and human settlements inclusive, safe, resilient and sustainable
12	Ensure sustainable consumption and production patterns.
13	Take urgent action to combat climate change and its impacts.*
14	Conserve and sustainably use the oceans, seas and marine resources for sustainable development.
15	Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.

(table continues)

#	Description
16	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels.
17	Strengthen the means of implementation and revitalize the global partnership for sustainable development.

In its quest to stir up the world's nations enroute for this novel comprehension of growth, the United Nations (UN) established development goals to unite the international community on the road to mutual developing goals (Table 2.1; United Nations 2017). The initiated plans of the Millennium Development Goals (MDGs) have been reviewed lately and rechristened as the Sustainable Development Goals (SDGs) to realize the objectives in the year 2030 (Kwon & Kim 2014). These development goals go beyond social institutions and include collective socio-economic imminent paths such as eradicating poverty and hunger, as a result, are also familiar stories (O'Neill et al., 2015). Social-political institutions have been making the most of descriptions to validate their interests (O'Neill et al., 2015) and, as a result, are among the fundamental tools essential to the culture. In the case of validating their interests, social institutions made available the groundwork for sustainability. Sustainability gives rise to the advent of a novel methodology to economic growth grounded on the quest for cohesive social, environmental, and economic prosperity (Drexhage & Murphy, 2010).

The Millennium Development Goals are worthy of making the world better, because the goals are designed to alleviate poverty and improve the lives of all people globally. Still, they do not proliferate the notion of enabling already disadvantaged Sub-Saharan Africa to develop in terms of socio-economic advancement (Mutasa & Paterson, 2015). Instead, narratives such as Sub-Saharan Africa lagging behind the rest of the world are in motion to propagate the indication of Sub-Saharan Africa as a failure (Easterly, 2009, 26). Sustainable development is a theory to eliminate inequalities and is inseparable from political power disparities (Meadowcroft, 2007).

The Millennium Development Goals target developing countries by placing obligations like using clean energy and reducing the carbon footprints on the planet, accordingly, lacking an all-inclusive method in applying a universal sustainability approach because industrialized nations are not doing the same. The demand for the universal sustainability approach has resulted in the soliciting of an identical universal collaboration of developed nations in the proliferation of the idea that Africa is a Millennium Development Goal failure (Easterly, 2009). The fact is that most of the countries in Sub-Saharan Africa serve as sources of raw material for industrialized nations and have not innovative as necessary. Such negative narratives distinguishingly destabilize Sub-Saharan Africa's advancement and highlight inadequacies in their governance systems. The developed countries disregard essential disparities propagated by advanced nations and establishments hindering Sub-Saharan Africa's growth (Mutasa 2015; Nhamo 2009).

Nhamo (2016) comprehensively examined the current affairs of Sub-Saharan Africa concerning the modern global sustainability agenda and highlighted specific significant disparities among the emerging and advanced nations. Nhamo (2016) elaborated those industrialized nation-states are the utmost pollutants of the environment in creating carbon footprints on our planet; however, they believe that the less industrialized nations should compensate the more for the pollution by using clean energy which requires knowledge to produce. For example, energy usage is higher in the industrialized nations than in Sub-Saharan Africa. Nhamo (2016) also stressed the incapability of Sub-Saharan Africa to hold more advanced countries responsible and even the colonial legacy in the African setting keeps Sub-Saharan Africa as a raw material supplier to the developed nations. The pro-climate narratives can cause more poverty for Sub-Saharan Africa (Amusan & Olutola, 2017). The fact is most if not all Sub-Saharan African countries depend on Aid from the Advanced nations and global

organizations to sustain their economies. Aid which comes in the form of loans usually has conditionalities such as implementing environmentally friendly policies and following certain guidelines for environmental sustainability as dictated by the advanced nations.

Advanced Global Innovation Systems

Globalization is correlated with an advancement gap between the developing and developed nations, which increased drastically without providing developing nations with improvements to their LF's scientific competence. As a result, developing countries must espouse or implement a scientific advancement policy through cohesive leadership and NIS. Globally, nations have been enacting policies and establishing institutions geared towards facilitating innovation. Young (2007) reiterated that some governments even instituted local development agencies and science and technology parks to facilitate a technology development regime to reinforce and uphold their innovation lead.

NIS comprises a visualization of the direction a nation should take technologically, the techniques, and the determination to allot funds as desirable for innovation (Lall, 2002). According to Young (2007), the most advanced nations have been spending enormously on cutting-edge research in biotechnology, aerospace, and nanotechnology directed at institutions of higher learning also pointing out that these studies are often wholly or partially subsidized by federal or state governments. In the United States, innovation research bureaus and agencies supporting economic development such as the US Economic Development Administration (EDA) which is under the US Department of Commerce have multiplied, typically nurturing economic development through innovation. The United States Congress has played a significant role in progressing innovation and competitiveness for a robust innovation system. For example, the Congress initiated and supported the NIS and propagated the National Innovation Act-

Commerce Provisions, revealing that commercial, learning, and governmental leaders approve the significance of the nation's sustained development (https://www.congress.gov/bill/109th-congress/senate-bill/2390). The National Innovation Act--Commerce Provisions identified areas that need more research investment including physical sciences and inducements for organizations in a national setting to augment innovative pursuit intensity. Developing nations should emulate the same sense of direction like the advanced nations to ameliorate their NIS.

Likewise, the European Union formulated innovation policies and systems at the state, regional, and local levels. Multinational organizations like the European Union (EU) have been influential in supporting and ensuring the pursuit by help and facilitate the harmonization of innovation industries amongst member nations through government funding of research and development. The European Union has spent an estimated 3 billion euros, respectively, for information technologies, biotechnology, and nanotechnology (European Communities, 2006) to achieve stability and regional prosperity by promoting an economy that works for the people.

Nations like Finland, Holland, and Sweden have been dedicated campaigners and experts of the National Innovation System. After utilizing interventionist strategies such as increasing spending on public goods like education, research and development, public transportation, healthcare and funding innovation projects directly to support economic development. Finland has shifted to a facilitation and support approach through alliance development. Their National Technology Agency guided the enactment of state policy (Nauwelaers & Reid, 2002). Finland was able to shift from an economy determined by enormous resource investing in knowledge and innovation based. The cluster approach they used gave them an edge in terms of Information and Communication Technologies. The cluster approach is dependent on the geographical nearness of a significant size of market obliged high-tech businesses in other words a group of businesses

doing similar innovation located at a specific area such as software companies or companies that deal in computer hardware. Finland's ability to strengthen its higher learning institutions garnered the circumstance for robust scientific and applied research. It boosted the works of national businesses while also enticing foreign companies to the country. Hertog and Remoe (2001) asserted that Finland is among the most advanced nations globally due to mobilizing government, industry, higher learning institutions, and human resources to lead an innovation system.

The nations in Asia have also been developing strategies to foster Innovation. Asian developed countries such as South Korea, Japan, and Taiwan, corporations and regional/local innovation play a more active role (Lee, 2003; Kiso, 2007; Matthews, 2001; Kitagawa, 2005) likewise Singapore. Singapore improved its research and higher learning institutions, national organizations, transportation, and communications infrastructure to align with its overall innovation strategy (McKendrick et al., 2000).

Knowledge-based Economy and National Innovation Systems

Innovation characteristically comprises the knowledge management and exploitation subsystem and the knowledge production and transmission subsystem (Mayer et al., 2016) relative to the NIS. Higher education institutions deliberate as the initiator of innovation societies (Athey et al., 2008). Kadlec and Blažek (2015) highlighted that collaboration among businesses and higher education institutions, or research organizations can help support innovation and academia and can lead to improved societal and fiscal growth

Capello and Lenzi (2014) elaborated on the relevance of knowledge and innovation as drivers of local economic growth. McCann and Simonen (2005) emphasized the role of geography in the advancement of innovation. According to Cohen et al., (2000), the dynamics of

knowledge and geographical awareness of fiscal affairs result from exploitation of intellectual assets. However, Asheim and Gertler (2005) asserted that innovative undertakings and economic topographies that measure up to the adeptness and usefulness of knowledge links are fundamental to growth.

Innovation defines “how products are produced, innovations are created, and learning processes flow in the system” (Lundvall et al., 2002, p. 220). Attaining the objectives of an NIS requires states to employ an innovative approach to oversee the innovation process. Another important feature of the national innovation system is its structure, which controls manufacturing design and the line of expertise for success. Moreover, the organizational innovation process relies on their precise knowledge base (Asheim & Gertler, 2005). Countries can also make considerable expansions by supervising the knowledge effects and encouraging collaboration within the innovation system through research funding. Rather than adopting the existing ad-hoc approach to technology and information transfer, governments should establish more operational structures such as higher education and research institutions and techniques to secure society’s knowledge (Nada, 2012). Knowledge and innovation produce significant optimistic externalities where the social return rate is often nearly three times higher than the private return rate.

Cohen et al., (2000) indicated that knowledge and spatial attentiveness to financial affairs originate from academic resources. Innovative undertakings and the economic characteristics that correspond to knowledge associations’ competence and efficiency are vital to growth (Asheim & Gertler 2005). Karahan (2006) stated that the term “knowledge-based economy” for an emerging economy emerges from a broader acknowledgment of knowledge and technology in economic growth. Knowledge be used to transform a resource-based economy into a knowledge-based economy and advance innovation immensely. In a knowledge-based economy, knowledge

plays a vital role in wealth creation. Asheim & Gertler (2005) asserted that innovative undertakings and the economic characteristics that correspond to the competence and efficiency of knowledge associations are critical to growth.

Significant knowledge utilized in new businesses and spin-off establishments is sporadically designed based on entirely novel discoveries or products. The link between the universities, industries, and other relevant set-ups is vital and more recurrent than the other form of the knowledge base. The contributions and productions of codified knowledge are more frequent than tacit knowledge. Regardless, all sorts of learning expertise are incorporated and required in the development of knowledge establishment and innovation (Johnson and Lundvall, 2001).

The active social systems with established belief systems lead to vital roles in organizations and gathering knowledge creation developments (Malmberg & Power, 2005, p.425), for example the role played by women in innovation could be determined by the culture of the environment in which they live. Lorenzen (2005) discoursed this subject through knowledge, contiguity, and harmonization leading to economic value. Carley (2003) asserted that we should regard NIS in multi-modal and multi-plex footings of a matrix of people, knowledge possessions, proceedings, and responsibilities. Technological change causing activities and practical knowledge are strategic effects on fiscal keenness. According to Asheim and Coenen (2004), codified knowledge is more frequent in innovation systems due to the following reasons:

1. Knowledge contributions frequently rely on assessments of prevailing studies.
2. Knowledge generation focuses on the use of scientific ideologies and approaches.
3. Knowledge procedures are more strictly structured, and results are inclined to have a green light in reports, electronic archives, or patent portrayals.

Most emerging states seek to increase innovation to grow their economies (African Union

Summit, 2007). According to Nelson and Phelps (1966), within the debate concerning the institutions or technology roots of economic growth, NIS have become especially important in national policy since 1980 (European Commission 2004). Bartels and Lederer (2009) highlighted that pragmatic comprehension of NIS in industrial and emerging market economies significantly affects unindustrialized nations. Gurak (2009) asserted that humans produce knowledge and apply it to specific areas to augment living standards, highlighting the significance of human capital in knowledge production. Learning is necessary to generate economic growth in NIS. Knowledge creation supports the delivery of goods or bestows services responding to the public's valuable essentials and needs

Different Approaches for Measuring Performance Trends in NIS

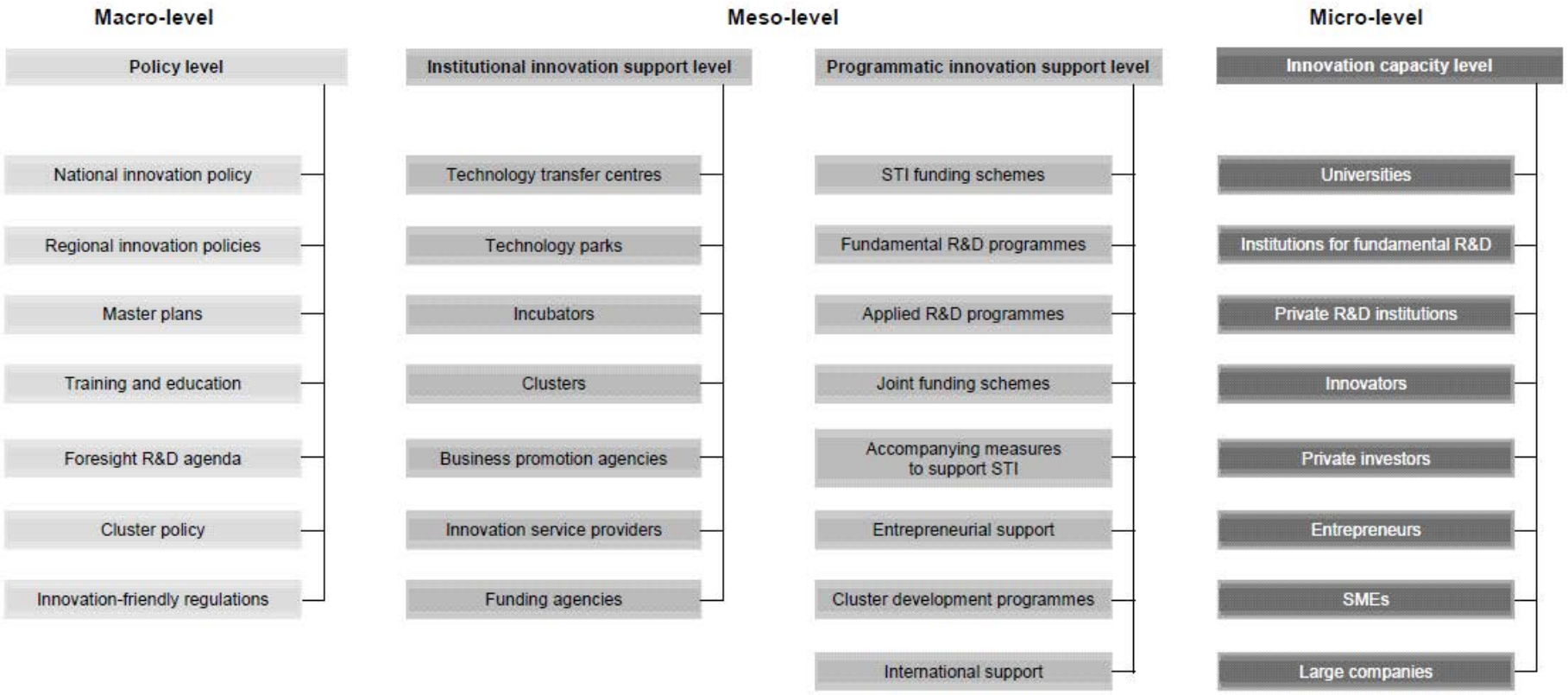
During the era in which innovation policy is very significant, policymakers are endorsing third-generation transformative innovation policy acknowledging the significance of confronting communal difficulties (Schot & Steinmueller, 2018). This section provides details on different methods for measuring performance trends in NIS.

Analysis of National Innovation Systems

Firstly, the analysis of national innovation systems (ANIS) concept was invented by the Institute for Innovation and Technology invention in Berlin (IIT, 2012a). The ANIS approach is grounded on the hypothesis that 30 determinants of NIS (see Figure 2.2) generally sway an innovation system. It affords an indicator-based valuation of these determinants, known to reveal the innovation system (Seidel et al., 2013). Seidel et al. (2013) argued that the developing world's policymakers are searching for explanations of their innovation systems and flawless proposals for augmenting enactments, rather than seeking systematic prototypes of the innovation systems' functionality or for refined, statistically based performance indicators.

Figure 2.2

The 30 Determinants of an Innovation System



Source: Institute for Innovation and Technology, Berlin (2012).

Policymakers focus more on the realistic valuation of the economic environment per reference to innovation to improve their innovation systems' performance. Seidel et al. (2013) emphasized that 30 determinants fundamentally influence NIS, and each determinant reflects a trait of the innovation system. The determinants have a three-level hierarchy as follows:

i. The micro-level, also known as the innovation policy level, offers foremost performers support in the innovation system such as firms, higher education institutions, governments, and R&D establishments.

ii. The meso level, also referred to as the Institutional Innovation Support Level and Innovation Program Support Level, can be well-thought-out as an imperative transitional instrument to translate policy choices into a procedure. Predominantly, clusters, technology transfer centers, innovation service providers, and funding agencies are linked with the Meso level.

iii. The macro-level or the innovation capacity level is a national policy level such as decrees, guidelines, principal strategies, training, and teaching. Thus, the 30 determinants have dissemination and portrayal in Figure 2.2.

National Innovative Capacity

Another validated way of evaluating cross-country comparisons of innovation performance has been presented by Furman et al., (2002) with the theory of "national innovative capacity." This concept is centered on the theoretical concepts of the endogenous growth model (Romer, 1990), the concept of international competitiveness as established by Porter (1990), and the NIS approach. National innovative capacity is defined as the ability of a country to produce and commercialize a flow of innovative technology over the long term on the strength of a nation's common innovation infrastructure, the environment for innovation in a nation's industrial clusters, and the strength of linkages between these two (Balzat & Hanusch, 2003). With the national innovation capacity approach, the researchers separately use several variables to evaluate infrastructure, cluster conditions, and linkages.

Porter and Stern (2002) used the national innovative capacity model on 75 nations and

observed findings to produce a rating of the innovation capacities of the countries examined. Lawson and Samson (2001) indicated that innovation capacity could unceasingly convert knowledge and thoughts into novel produces, processes, and methods for the advantage of an establishment and its participants. Consequently, innovation competency denotes the aptitude to incorporate limited resources to instigate and achieve innovation. According to Gaynor (2002), innovation capacity is an organized system of unique possible prospects, examining whether they are appropriate to use for the establishment's planned administration. Nada (2012) mentioned that functional innovation capability rests on seven dimensions: (1) Innovation Strategy, (2) Innovation Process (3) Leadership and Culture, (4) Collaboration and Partnering and (5) Business and Technology, (6) Innovative organization, and (7) learning.

Suarez-Villa (1990) presented the concept of National Innovation Capacity to measure innovation and the probability for innovation in a nation. Suarez-Villa (1990) outlined it as a country's capability as a political and economic body to generate and commercialize the movement of innovation technology over the long term. However, National Innovative Capacity frequently reflects the institutional capability to withstand Innovation (Hu & Mathews, 2008; Huang & Shih, 2009). According to Suarez-Villa (1990), one of the strongest indications of innovation performance is the proportion of copyrights issued by the US Patent and Trademarks Office (USPTO). As a result, the National Innovation Capacity depends on three broad elements as stated by (Furman et al., 2002): (i) Common innovation infrastructure, (ii) Cluster-specific environment for innovation, and (iii) Linkage quality. These fundamentals are deliberated on henceforth.

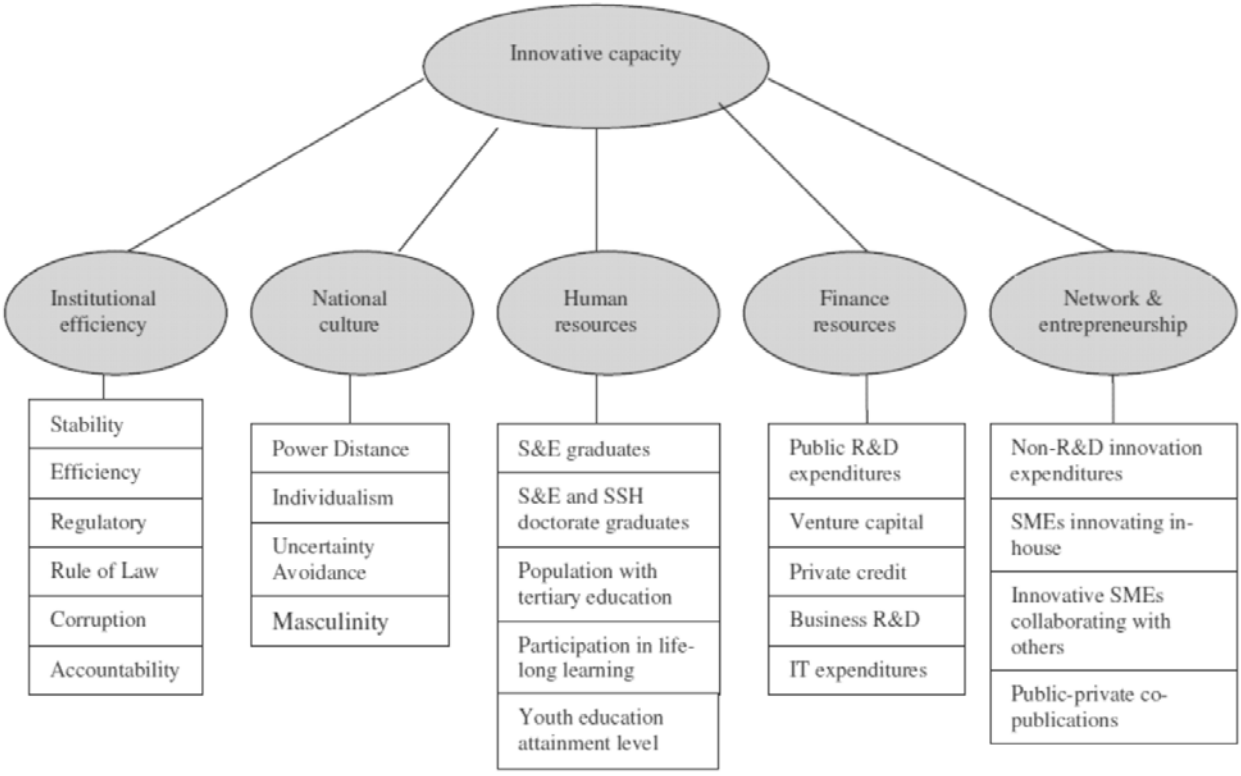
The collective innovation substructure of a state is a clique of vital investments and strategies that enable innovative undertakings. This clique comprises social and economic

wealth, industrial superiority, and available methods connected to creative action. For measuring a state's innovation public policy, three processes surface:

1. The efficiency of intellectual property protection.
2. The capacity of a nation to maintain its engineering innovation experts.
3. The magnitude and obtainability of R&D tax credits for the private sector.

Figure 2.3

The Determinants of Innovative Capacity



Source: Natário, Couto, Teresa, Tiago, & Braga (2011).

Even though the collective innovation substructure gives the overall setting for innovation, the invention in due course depends on establishments where innovation is industrialized and commercialized. Therefore, innovation activities usually occur in clusters. Innovation capability has been gradually accepted as the main limit and answer for a financial system at the middle-income level to sustain economic growth (Lavopa & Szirmai, 2018).

Superiority and burden assess the cluster-specific environment for innovation, starting with domestic consumers, the existence of merchants of specific research and training, and the pervasiveness and depth of clusters. Figure 2.3 shows the determinants of innovation capacity.

On the contrary, the associations' power affects the collective Innovation Substructure's function to interpret Innovation's probability into detailed, innovative productions in a country's industrialized cluster. The relationship between the Collective Innovation Substructure and a nation's industrialized group is give-and-take, meaning clusters can nourish the Collective Innovation Substructure and profit from it. Two indicators appraise the excellence of relations concerning the main two blocs. Firstly, the general excellence of scientific research institutions is the percentage of R&D completed by academia and the forte of venture capital markets. Second, Natário et al., (2011) suggested five stages, portrayed in Figure 2.3, to pinpoint and categorize the determinants of innovative national capacity: institutional efficiency, national culture, human resources, financial resources, and network and entrepreneurship.

Other Approaches of Measuring Performance Trends in NIS

Liu and White (2001) presented a descriptive model of the NIS conceptual framework, which is meant to depict the structure and performance of NIS. Their framework is built on five different activities of innovation processes which are research, production, "end-use (customers of the product or process outputs)," "linkage," and "education" (Liu & White, 2001, p. 1094).

Chang and Shih (2005) also introduced a model to study the structure and depth of a nation's innovation system based on previous work by the OECD (1999). The model comprises six components – R&D expenditure, R&D performance, technology policy, human capital development, technology transfer, and the climate for entrepreneurial behavior. According to Balzat and Hanusch (2003), the approach used by Chang and Shih (2005) is intended to assess

the fundamental facts of a NIS. To describe the functioning of a system, Chang and Shih (2005) utilized four fundamental groups of indicators: formal and informal cooperation in R&D, measures of the dissemination of innovations, and finally, the mobility of the national workforce.

Nasierowski and Arcelus (1999, 2000) presented a model in which nations are logically grouped in terms of technological abilities and are associated based on a method of structural equations comprising inputs, outputs, and moderators. Cluster analysis techniques were used to categorize the countries into two groups covering technological leaders. The other group encompasses developing nations that depend on technological progress primarily from the import of innovations from developed. Nasierowski and Arcelus (1999, 2000) used factor analysis methods to evaluate the nations and then rank them corresponding to their technological forte. Nasierowski and Arcelus (2003) also developed a data envelopment analysis-based model comprising two inputs, two moderators, and three output variables to research the effectiveness of NIS. The rudimentary notion inspiring the efficacy measurement by Nasierowski and Arcelus (2003) is to observe NIS as a secluded segment of the whole economy.

Examples of international indexes include The European Innovation Scoreboard (EIS) and the Global Innovation Index (GII). Developed countries primarily use the European Innovation Scoreboard (EIS) and the global innovation index (GII) to evaluate their innovation systems. The European Innovation Scoreboard (EIS) is a scoreboard used annually to measure the fortes and flaws of research and innovation systems in Europe. In 2012, the European Innovation Scoreboard (EIS) measured member countries' performance concerning research and Innovation. The assessment depends on 25 indicators joined in three pillars: enablers, fixed undertakings, innovators, and special fiscal effects as productions. The enabler are any indicators that support innovation, while fixed undertakings are the innovations that are engaged in at a

particular time. Innovators make innovations happen and special fiscal effects are the changes in the spending and revenue behavior of the government to influence innovation to stimulate the economy.

The global innovation Index (GII) is an annual international classification of nations corresponding to their capability and accomplishment in Innovation. It is more comprehensive than the European Innovation Scoreboard because it involves more indicators and countries. This index's rationale is to assess nations' innovation groundwork procedures and notify administrations, industries, and entities with the intention of complete utilization of innovation.

Fundamentals of GEI, PSE, LF, GDP, GNI and HDI in NIS

Balzat and Hanusch (2003) identified a gap in the literature, indicating that a distinct and more precise combination of the NIS approach with economic growth, as well as the link with GDP, is still lacking. Though the connection between technical change, GDP, and economic growth has long been explored because of diverse patterns of economic growth, new theories of innovation like that of NIS have consequently not been linked with economic growth and GDP analytically. The constructs explored in this study are labor force, percentage of public spending on education, government effectiveness as predictor variables and GDP, GNI and HDI as criterion or outcome variables. These constructs are significant in measuring the performance trends in NIS. Yindong and Xinxin (2013), emphasizing the important role of governments in enacting NIS, highlighted that stewardship behavior focuses on the ethical responsibilities of governments to promote society and underlines concerns about the future.

Magalhaes (2014) offered empirical evidence to indicate that government effectiveness results in quality policymaking and execution. Leaders who concentrate on ethical principles are anxious for the long-term outcomes of their choices and stimulate citizens and help develop,

encourage, and support the groundwork necessary for innovation (Nunn & Avella, 2015). Nga and Shamuganathan (2010) indicated that effective governments consciously consider the effect of their decisions on the socio-economic and environmental ecosystem by initiating innovative solutions to communal problems. Effective governments help uncover groundbreaking ways to augment social, environmental, and economic problems with the sole aim of creating durable social value and promoting the advancement of humankind through responsible innovation (Nga & Shamuganathan 2010). Effective governments can encourage citizens motivated by prosocial actions that seek to benefit others and are more prone to concentrate on new ideas as they identify to solve issues for citizens within and outside the country (Grant et al., 2011).

The goal of creating and expanding NIS is to improve economic and human development. Economic and human development can be achieved when the dynamics of production, transfer, and diffusion of technology in the economy are activated because the technological buildup is the ultimate component that plays a vital part in diverse stages of growth (Schumpeter, 1934; Romer, 1990). Therefore, the construction of a technology-intensive infrastructure is deemed the material career of innovation within the system, coupled with suitable institutional and policy structures that contribute meaningfully to easing and inspiring the actions of the indicators within the NIS and fast-tracking the mechanisms of knowledge creation (Schmid & Wang, 2017b; Reiljan & Paltser, 2016b). Furthermore, the superior established knowledge management mechanisms perform a crucial part in facilitating NIS (Chu et al., 2014).

Research has shown that an economy's absorptive capacity "depends heavily upon the level of education and training" (Mytelka, 2001, p. 2). According to Dahlman and Nelson (1995), a key input of NIS is a technical human capital base capable of evaluating and planning

on technology issues that involves a highly established educational system that puts the required foundation at all stages. They argued that human capital investments must be aimed at the university and primary/secondary levels of education. The university level generates "qualified personnel who can monitor technological and other trends, assess their relevance to the prospects for the country and individual firms, and help to develop a strategy for reacting to and taking advantage of trends" (Dahlman & Nelson, 1995, p. 97). The primary/secondary level is an essential factor required "to hasten the diffusion and adoption of new technologies, to make local adaptations and improvements on the shop floor, and more generally to increase the awareness and ability to take advantage of technological opportunities" (Dahlman & Nelson, 1995, p. 97). The development of the human capital will root "for strong scientific, engineering, and socio-economic capabilities as a basis for policymaking, especially in sectors undergoing radical change" (Mytelka, 2001, p. 3).

Some studies have addressed the connection between specific variables within the NIS, for example, investigating the relationship between Research and Development expenditure and economic growth (Inekwe, 2015a). A nation cannot access economic growth without due diligence to evolutionary economics, which deals with learning procedures that generally change the economy. NIS performs a crucial role in accomplishing economic wellbeing and improving the economy's effectiveness through the collaborative connection between the industry and the government, generally (Fagerberg & Srholec, 2008).

The nature of the fundamental correlation among actors inside the NIS establishes the outcomes that NIS generates on the economic and societal levels. Fagerberg and Srholec (2008), who examined the influence of NIS on economic development, argued that innovation and the economic dimension play a significant role in the economic development process in emerging

nations. Castellacci and Natera (2013) also contended that economic freedom and institutional structure are vital components in the advancement of NIS and a significant element in defining their developing impact.

Global Leadership

Turner et al., (2019) asserted that to operate globally, it is necessary to have the ability to comprehend the complexities that correspond with globalization. Globalization has been increasing drastically and this warrants an increasing talent pool of leaders (Black and Morrison, 2014). Leadership is an important factor that determines the ability of organizations to innovate and plays an important role in controlling the impact of NIS on nations. Waite (2018) emphasized that leaders seek to support innovation and are also compelled to act conscientiously to attain economic, social and environmental outcomes. Azapagic (2003) asserted that leadership is one of the important factors for organizations to internalize the concern for sustainability. Broberg and Krull (2010) asserted that in an ever more vigorously competitive atmosphere, new leadership approaches are necessary in which organizations demand more responsibility. Bird et al. (2010) defined global leadership as the process of persuading people to accomplish a universal objective in a global community.

Turner et al. (2019) emphasized that in the global market, it is necessary for organizations to account for local leadership far exceeding the organization's leadership. They also highlight the importance of explaining any effect or impact that the planned strategy could have on the local people or culture. Global leaders comprehend the significance of building their organizations' leadership potential for future success, as emphasized by Canwell et al., (2015) that the development of leadership pipeline should be a top priority for organizations. According to Kets de Vries and Korotov (2010), global leaders recognize the necessity to deep dive into

new ideas, methods, and processes that assist partners develop the attributes necessary for success. The advancement of NIS as a result will depend on the skills of global leaders with their understanding of the global environment. Kets de Vries (2007) emphasized that a leader's strength comes from their skill to motivate people to follow in constructive and socially responsible ways. Kets de Vries (2007) pointed out that the dynamic changes in the global atmosphere which comprises the significance of national and corporate cultures and higher education levels necessitates global leaders to have strong skills and methods to effectively perform their roles.

CHAPTER 3

METHODOLOGY

This chapter provides details on the research methodology employed in the study. Detailed information is given about the quantitative approach of the study by explaining how secondary data was obtained, the statistical techniques used, variables involved, and data analysis procedures.

Research Design

When selecting a paradigm for a study, it is essential to consider what amounts to knowledge within the world (Cooksey & McDonald, 2011). Pinpointing the research proposal in a specific paradigm entails the research being endorsed and directed by the selected paradigm's suppositions, standards, and ideals. Choosing the appropriate paradigm necessitates that one understands what these elements represent. Scotland (2012) elaborated on ontology, a branch of philosophy associated with the nature of reality, what exists, and what can be known. From the definition of reality, we draw assumptions about how it operates (epistemology) and call this knowledge. From these, we believe there are methodologies that allow us to explore and better describe phenomena. (Arp, et al, 2015), to be confident that something is logical or factual and capable of measuring the essence of the phenomenon under study.

As a result, the provision of a definitional ontology contextualized by a domain ontology is necessary because the suppositions support familiarizing one's thought process about the research problem, its implications, and approaching it to add to the solution. Ontology in this study is indispensable to a paradigm because it helps explain the effects that establish innovation systems and the world as labelled (Scott & Usher, 2004). This study utilized quantitative research methodology to examine the impact of innovative systems on sustainable development

in Sub-Saharan Africa. Countries create innovative systems for their economic growth.

The concept of national innovation systems stresses that technology and information flow among people, enterprises, and institutions is key to an innovative process (Edquist, 1997). It contains the interactions between the actors needed to turn an idea into a process, product, or surface on the market. For example, the interaction between government, industry and academia has given a lot of progress in the advancement of the internet and technology in general. There are determinants for understanding innovations that are also particularly popular among policymakers and innovation researchers globally (IIT, 2012a). The indicators are the actors or determinants that can impact a NIS (IIT, 2012a). As previously mentioned, the indicators or study variables are GEI, PSE, LF, GDP, GNI and HDI. The independent variables were chosen mirroring the triple helix model and based on their intrinsic value to any nation's national innovation system. The dependent variables (i.e., GDP, GNI and HDI) were selected based on their value as the most sort after outcomes for any thriving economy and how representative they are in determining economic development.

The choice of a particular research design primarily depends on the nature of the problem being addressed, individual experiences of the researcher, the audience for whom the investigation is a concern, and ease of access to participants (Alston & Bowles, 2018; Guetterman, 2015). Quantitative research that compares potential impacts of innovation systems' individual elements on the expected outcomes to certain performances that would necessitate the investigators to isolate possible components assumed to be instrumental and subsequently gather data to examine connections or relationships (Creswell, 2003). According to Bryman (2016), quantitative research involves measurement, establishing relationships, generalization, and replication.

According to Edquist (2005), empirical studies are rarely conducted on regional innovation systems with aggregate data at the local and national level for most countries. The investigation employed a multidimensional quantitative research design to examine the relationships between the predictor variables: GEI, PSE, and LF, and the criterion variables: GDP, GNI and HDI. The implementation of STISA-2024 to promote innovation and economic development will likely impact a change in the NIS of the region if the GEI, PSE and LF are effectively managed. This will likely impact the outcome variable such as GDP, GNI and HDI creating some development in the economy.

Data Collection

In this quantitative study, the variables are derived from a pool of secondary data from the Global Economy website (https://www.theglobaleconomy.com/download-data.php) and the World Bank. Secondary data are data already collected by an initial source for a primary purpose that are used to conduct research on other important questions (Johnston & Johnston, 2017). The years to be evaluated are 2010 and 2020 to observe the changes of NIS basically because STISA-2024 was implemented in 2014 and data is available up to the year 2020. The research captured the period before implementing STISA-2024 and the period after its implementation up to the year 2020. This data provides a practical option for researchers who may have limited time and resources. Secondary analysis uses similar fundamental investigation rules such as choosing a suitable data set to explore response shift; fundamentals of data sets and their analysis preparation; management of missing data; approving that the data is appropriate and meets the standards and expectations of the designated response shift detection technique; model fit assessment; understanding outcomes of effect sizes; and relating results across methods as research using primary data and has steps to be observed just as any research approach (Johnston

& Johnston, 2017). Therefore, secondary data for this study does not require an IRB to conduct the study. The data sets on the website cover over 300 indicators for over 200 countries. All the countries that have complete data of the selected variables in Sub-Saharan Africa were studied and the variables that directly impact national innovation systems were selected for this research.

In past studies, researchers have evaluated diverse measurements of NIS and explored the association between these measures and economic growth (Edquist, 1997; Desai et al., 2002; Fagerberg & Verspagen, 2002; Archibugi & Coco, 2004; Fagerberg & Srholec, 2008; Filippetti & Peyrache, 2011; Castellacci & Natera, 2015). Nevertheless, in this study, researcher utilized independent variables GEI, PSE and LF to correlate the specific changes made to the system under NIS to specific measures of economic growth such as GDP, GNI, and HDI. However, some papers highlight both technology clubs which are gatherings of passionate technology savvy individuals for the purpose of innovation and NIS (Castellacci, 2008, 2011; Castellacci & Archibugi, 2008). Alnafrah and Elena (2018) also examined the impact of NIS indicators on GDP per capita in Russia. The results of their studies indicated that the current attempts of the Russian government to support innovation pursuits and the shift in the direction towards a knowledge-based economy started to be beneficial and influence the living standards of the Russian people by boosting their stake of GDP. Even though there are studies that point out a different picture of the same country, they found that the GDP numbers were misleading because the benefits were not diffused to the whole population and were instead only captured by the wealthiest members of the country because of how their economic system is designed (carnegiemoscow.org).

The following studies (Edquist, 1997; Desai et al., 2002; Fagerberg & Verspagen, 2002; Archibugi & Coco, 2004; Fagerberg & Srholec, 2008; Filippetti & Peyrache, 2011; Castellacci &

Natera, 2015). have measured NIS using numerous variables to capture the different aspects of the economy. Like most previous studies, the research methods for this study were selected based on the variables that produced vastly consistent and binding scores. The predictor variables: GEI, PSE, and LF, and criterion variables: GDP, GNI, and HDI were selected for this study. The predictor variables of the study measured the outcome of the systemic change such as the economic development of the region of Sub-Saharan Africa and were selected based on the significance of these variables in the NIS environment, and the criterion variables were selected based on the outcomes observed in the NIS to indicate success or failure in the economy. New indicators are emerging that are more comprehensive, multidimensional, and unique in their approach to events in an economy's growth and development (Potter et al., 2018). For example, indicators such as Green GDP and genuine progress indicator (GPI) are beyond the scope of this study due to lack of data to include them in the study but should be researched in the future.

Multidimensional Quantitative Approach

Policymakers in Sub-Saharan Africa are adopting the third-generation transformational innovation policy in this era of substantial innovation policy, emphasizing the importance of resolving communal difficulties as poor information infrastructure and the difficulty in adjusting innovation systems course as reflected by path dependencies (Schot & Steinmueller, 2018). This is problematic because it hinders information flow to facilitate innovation. The goal of creating and expanding the NIS is to improve the intensity of economic and human development (Alnafrah & Elena, 2018). Alnafrah and Elena (2018) pointed out that the dynamic forces of production, transfer, and diffusion of technology in the economy must be actuated because the technological buildup is the underlying component that performs a crucial function in various stages of development. In addition, the formation of a technology-intensive infrastructure is

considered the significant mover of innovation endeavors in the system (Alnafrah & Elena 2018). The dynamic forces of production, transfer, and diffusion of technology fundamentals are significant for the development of the NIS, together with the suitable institutional and strategy structures that add meaningfully to enabling and inspiring the activities of the performers within the NIS and hastening the instruments of knowledge formation (Schmid & Wang, 2017b; Reiljan & Paltser, 2016b) by facilitating learning.

The analysis of NIS in this research is based on three main dimensions: (1) the innovation dimension, (2) the economic dimension, and (3) the institutional dimension, as previously done by Alnafrah and Elena (2018). The analysis of these three dimensions of NIS were instrumental in comprehending the mechanisms of links between actors within the system and the possible impact of these dimensions on the standard of living of Sub-Saharan Africans. This showed the standing of the economic development of the countries involved in the study. In addition, studies have addressed the associations among the NIS and macroeconomic indicators by researching the association between specific variables within the NIS, like investigating the relationship between R&D expenditure and economic growth (Inekwe, 2015a; Akcali & Sismanoglu, 2015).

In the same vein, this multidimensional approach seeks to measure the NIS based on the relationship between the predictor variables (i.e., GEI, PSE, and LF) and criterion variables (i.e., GDP, GNI, and HDI). The analysis utilized a multidimensional quantitative research design to assess the connections between the predictor variables: GEI, PSE, and LF, and the criterion variables: GDP, GNI, and HDI. The researcher used canonical correlation analysis and linear regression analysis of the predictor and criterion variables to reveal results of technology innovation's influence on sustainable development in Sub-Saharan Africa.

Data Analysis

This study utilized canonical correlation analysis and linear regression analysis of the dependent and independent variables to reveal the impacts of innovation on sustainable development in Sub-Saharan Africa. Data collected from the years 2010 and 2020 was used as a sample to measure the NIS of specific countries with complete data sets in the region of Sub-Saharan Africa. Despite the statistical limitations found in past studies of NIS, this study elaborated on and described a series of proposed variables that recorded the unparalleled vital connections linked to innovation systems.

Canonical Correlation Analysis

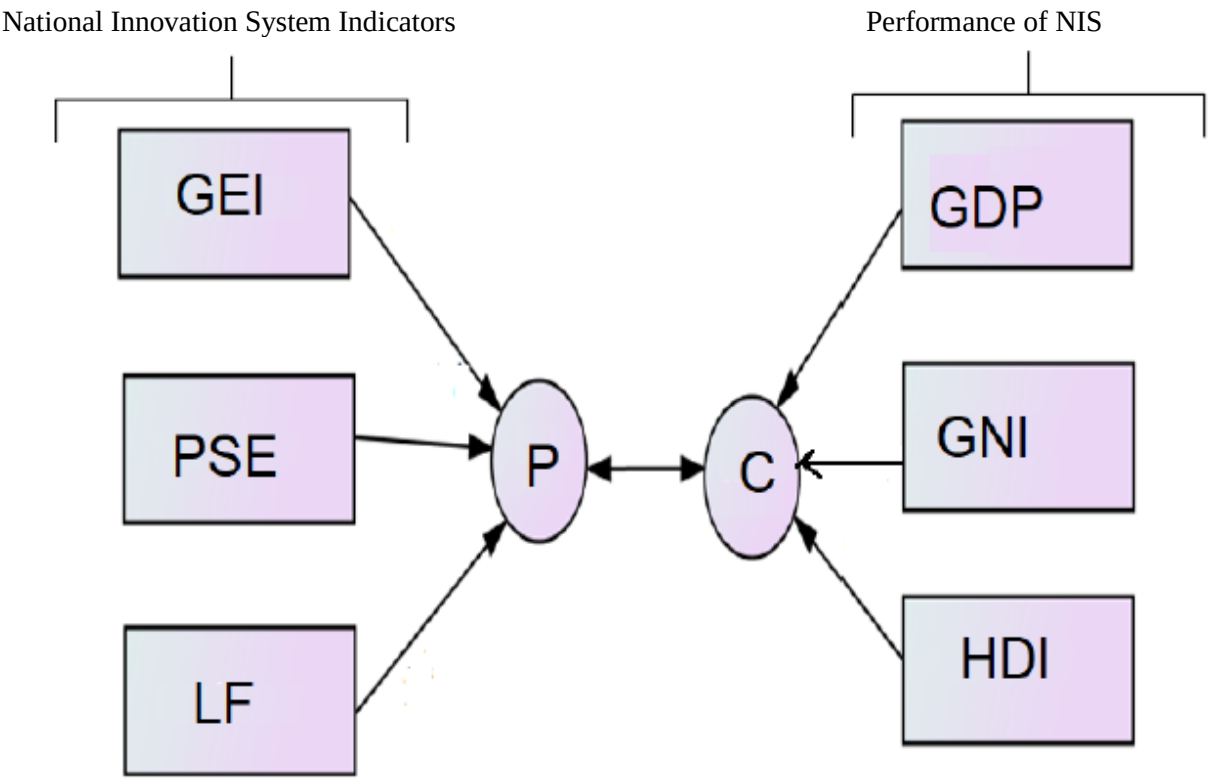
Correlational research explores the interactions between predictor variables and criterion variables. It can be assessed using univariate, bivariate, or multivariate statistical analysis techniques as suitable for the number of criterion variables considered (Rosenthal & Rosnow, 2008). According to Anderson (1992), Hotelling (1935; 1936) initially proposed canonical correlation analysis (CCA) as a simplification of Pearson's product moment correlation coefficients. Canonical correlation analysis was initially introduced as a common viewpoint on previous multivariate methods consisting of multivariate analysis of variance and multivariate multiple regression as indicated by Baggaley (1981) and Thompson (1991). Exclusively, Knapp (1978) showed that "virtually all of the commonly encountered parametric tests of significance can be treated as special cases of canonical correlation analysis" (p. 410).

The first analysis of this research followed the analysis approach recommended by Sherry and Henson (2005). They proposed initially observing the significance of the general model and then assessing the significant functions from smallest to largest. Finally, the authors suggested that the canonical correlation analysis should end with the interpretation of standardized

canonical coefficients and structure coefficients, and then the findings should be summarized. The reason canonical correlation analysis was chosen for this study is that it gives the researcher the chance to examine relations among predictor and criterion variables and to test for different connections in these variables without performing numerous analyses (Hair et al., 2009; Sherry & Henson, 2005). Canonical correlation analysis also gives the clearest technique for analyzing this data given the several connections between variables and the researcher's desire to examine the impact among the variables (Rosenthal & Rosnow, 1991; Salkind, 2004).

Figure 3.1

Components of a Canonical Function



Canonical correlations analysis is utilized to identify and assess the association between two sets of variables. In this research there are three variables which are independent variables (i.e., GEI, PSE, and LF) and three dependent variables (i.e., GDP, GNI and HDI) (see Figure

3.1). The correlations between the three independent and three dependent variables are explored in this study. The three independent variables on the left are considered as one canonical variable and the dependent variables on the right are considered as one canonical variable. SPSS was run to find out the correlations between the dependent canonical variable and the independent canonical variable which is known as canonical correlations. The system found multiple canonical correlations between these canonical variables. The number of canonical correlations were decided based on the minimum number of variables based on the independent variable set and the dependent variable set. The least number of variables among the set are taken as the number of canonical correlations. In this case both independent variables and dependent variables equally indicate that three canonical correlations are created.

Canonical correlation analysis embodies the bivariate correlation between the two canonical variates in a canonical function. Knapp (1978) presented a comprehensive demonstration of canonical correlation analysis indicating the essence of understanding matrix algebra and understanding eigenvalues and eigenvectors. According to Knapp (1978), the initial phase in a canonical correlation analysis is calculating a correlation matrix of the variables in the model. A symmetric matrix of diminished rank equivalent to the number of variables in the smallest of the two sets is then derived from the intervariable correlation matrix, and *canonical correlation coefficients* (*Rc*) are measured.

Exclusively, eigenvalues are calculated for the matrix, with each eigenvalue equal to a squared canonical correlation coefficient (Bartlett, 1948). A canonical variate is constructed for every set of variables, one for the independent variables and one for the dependent variables. A canonical function is then created, increasing the correlational coefficient among the two variates (Hardle & Simar, 2015). A new canonical function is made for each variable in the lesser of the

two sets of variables which explains a distinct correlation present amongst the variables and is separate from the other canonical functions (Hair et al., 2009; Sherry & Henson, 2005). The functions which notably explain the relations among the initial variables are maintained for analysis (Sherry & Henson, 2005).

The two sets of variables were compared when the canonical variables were defined, analysis was undertaken by observing the correlations amid the canonical variables. Subsequently this correlation which is measured between canonical variables is basically called its canonical correlation. Concentrating on a dependence relationship, the two datasets were modelled in a regression-like way, and data set y as a function of data set z was analyzed.

Linear Regression Analysis

Kumari and Yadav (2018) mentioned that the general concept of regression is to analyze and check if a set of predictor variables do a good job in predicting an outcome (dependent) variable and, which variables are important predictors of the outcome variable. The use of linear regression helps to make predictions and determine if they are unbiased and precise. When making predictions about important research it is always better to make sound predictions. Linear regression could be utilized to make predictions and is a vital part of the statistical output after a model is fit. The coefficients explain the relationship amongst individual independent (predictive) variables and the dependent (criterion) variable(s). Nevertheless, values can also be entered for the independent variables into the equation to predict the mean value of the dependent variable. In utilizing regression to make predictions we predict the meaning of the dependent variable given specific values of the independent variables. For our example, we used three independent variables to predict each of the three-dependent variables. Predictions in the regression framework are more demanding. Data needed to be collected for the relevant

variables, the model was formulated, and there was the need to evaluate how fittingly the model fits the data. The universal technique for using regression to make good predictions is to research the subject area so you can build on the work of others. This research helps with the subsequent steps:

a. Gather data for the appropriate variables.
b. Identify and measure your regression model.
c. Use model to make predictions if it satisfactorily fits the data.

Prejudice in a statistical model reveals that the predictions are analytically too high or too low. Precision signifies how near the predictions are to the studied values. In utilizing regression for predictions, the objective is to generate correct predictions that are close to the original values. After collecting the data and running it through SPSS, it was determined if the relationship between the variables is statistically significant. The correlations and relationships between the variables are essential when utilizing the value of one variable to predict the value of a different variable.

Measuring how good the model fits the observed data requires a different goodness-of-fit measure, which is the predicted R-squared. The predicted R-squared assesses how clearly the model predicts the value of new interpretations. SPSS computes it by successively eliminating each examination, fitting the model, and establishing how well the model predicts the eliminated observations. When predicted R-squared is much lower than the regular R-squared, you know that your regression model doesn't predict new observations as well as it fits the current dataset.

Predictor Variables

The predictor variables that predict economic development are GEI, PSE, and the LF and data from 2010 and 2020 were used respectively. Details on each variable are provided next.

Labor Force

The LF refers to the total number of people who are currently employed and the number of people who are unemployed and looking for work. The labor force does not incorporate individuals not working and not looking for employment, for instance, retirees (Katz & Krueger, 2019). Individuals who would like to be employed but are not ready to work are also not considered part of the LF. In short, the workforce comprises people who either have a job or are keenly pursuing one. In times of economic recession, the LF decreases as people become increasingly pessimistic about their chances of working during the recession. Redundancies and retrenchment usually deter applicants from applying even though they may be eager to work (Katz & Krueger, 2019). There is a relationship between the LF and innovation because a more developed technological base allows the LF to learn and be more skilled. LF is important in this study because a skilled labor force leads to self-reinforcing patterns in the behavior of countries. A greater quantity of well productive laborers produces a greater volume of productivity and generates an exceptional innovation possibility.

Government Effectiveness

Thorough understandings of the accomplishment of nations could be measured utilizing the ratings of the GEI. The score for the GEI spans from -2.5 to 2.5, indicating a strong rating and providing a year-on-year evaluation of nations (TheGlobalEconomy.com, 2020). GEI incorporates the “perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government’s commitment to such policies” (Kaufmann et al., 2008). Sacks and Levi (2010) emphasized that all things being equal, the more efficient the country’s government, the greater the degree of public benefits.

GEI is the assessment of the value of output and how good policy accomplishes anticipated goals (Kim & Voorhees, 2011). Considering that state establishments perform a universal function in promoting innovation pursuits (Pezeshkan2016a), GEI has been instrumental in helping NIS by prioritizing the activation of official fundamentals of applied and technological activities as vital components of economic development and increasing the effectiveness of industrial projects (Alnafrah & Mouselli, 2017). Determining government effectiveness necessitates the application of the stakeholders' thoughts, making it a comparative theory to evaluate.

Government effectiveness has been described as an intuitively clear concept (O'dwyer & Ziblatt, 2006) but has been contested and described as difficult to measure (Linz & Stepan, 1978) as cited by Gasiorowski (1996). Several researchers linked with the World Bank have been associated with conceptualizing and measuring government effectiveness (Kaufmann et al., 1999). Magalhaes (2014) provided empirical evidence to suggest that government effectiveness results in quality policymaking and implementation on which NIS is dependent for advancement. Therefore, government effectiveness is a crucial performance indicator for African economies in enhancing the condition of their nations. The government oversees all policies in respect to science and technology, and political actions directed towards NIS advancement. The government has control over governing apparatuses, laws on property rights, patent systems, antitrust legislation, taxes on innovative firms. It is apparent that the state is efficient in establishing the circumstances necessary to generate public-private dealings and make more capabilities of innovation and research. The State is significant because it can also perform the role of negotiating trade agreements and facilitate investments. For instance, in Sub-Saharan Africa, the motivations of innovation policies illustrate a double purpose (UNCTAD, 2015b):

mutually to inspire businesses' capability for technological captivation for the aim of increasing their ability to produce knowledge, nonetheless, similarly, to generate systems for the diverse technological vicissitudes, public markets to achieve growth goals.

Percentage of Public Spending on Education

According to OECD (2022), the percentage of public expenditure on education is very vital for comparing education expenditure between countries in relation to their economies. They also highlighted that a high percentage of public spending on education suggests a high priority for education and the likelihood of increasing revenue for funding public projects. Government expenditure on education is the total percentage of GDP which is calculated by dividing total government expenditure for all levels of education by the GDP and multiplying by 100.

Criterion Variables

The criterion variables for this study are GDP, GNI and HDI. Details on each variable are provided next.

Gross National Income

According to OECD (2022) Gross national income (GNI) is defined as gross domestic product, combined with net receipts from abroad of compensation of employees, property income and net taxes minus grants on production. Remunerations of workers' receivable from overseas are the income earned by residents who basically reside inside the economic region but work abroad such as those working around border areas of two countries or for people who live and work abroad for short periods and whose center of economic interest remains are homebased.

GDP

GDP was in the 1940s defined as the overall value of all the goods and services a country produces; it also determines an economy's size is in terms of material wealth (Coyle, 2014; Bureau of Economic Analysis, 2015). According to the Bureau of Economic Analysis (2015), GDP has become the standard for measuring the economy of a nation. The main idea of assessing and adding up all goods and services a country produces in an economy started in the US in 1930 but became more prominent in the era of the Second World War. Affiliated governments wanted to know the number of weapons their economies could produce without collapsing, and as a result, GDP was created to plan armament production. GDP was later developed as a primary way of measuring economic success and annual growth for nations. GDP per capita, which means the total GDP of a country divided by all the people who live in that country, also emerged from comparing the success of different economies across different countries (Bureau of Economic Analysis, 2015).

Human Development Index

The human development theory stresses developing human capabilities and how individuals utilize their skills to function in the environment and choose between alternatives in all aspects of their lives (UNDP, 2018a). HDI is among the more complicated indicators because of the degree of human capability and excellence of living and is a combination of three factors:

1. Universal quality of living, articulated by the probable length of lifespan.
2. Knowledge, assessed by a mixture of the literacy rate of the adult population weighted by 2/3 significance and the entire matriculation rate in primary, secondary, and higher education weighted by 1/3 of the character, and
3. Standard of living or financial gains articulated by production, that is, GDP in terms of purchasing power parity in US dollars.

Evaluating the whole range of factors in HDI measures development in accomplishing

several facets of human development (Republicki zavod za razvoj, 2007). HDI is a broadly quoted statistic generally applied as a gauge of welfare in numerous nations (King & Roy, 2008). Ferjan (2014) started a modern method of thinking about development stemming from the report published in 1990, “People are the real wealth of nations.” HDI is a very important indicator because a country that does not promote human development will not be able to sustain a NIS. the shortage of competent workforce restricts the implementation and dissemination of latest technology, identifying a human resource limitation that inhibits the production of a nation and its capability to innovate (Murphy & Topel, 2016; Pargianas, 2016).

Conclusion

Measuring the NIS of the countries in Sub-Saharan Africa will help these countries make better decisions regarding policymaking and investing in the right domain to improve their economy and NIS. Various approaches have been used to measure advanced national innovation systems. However, for the developing nations, it has been hard to use the same research techniques to measure the NIS especially in Sub-Saharan Africa. Using this secondary data approach with the relevant indicators will help to easily measure the NIS and enact strategies to advance their system.

CHAPTER 4

RESULTS

The purpose of this research is to measure the impact of STISA-2024 on sustainable economic development through the assessment of the NIS of the countries in Sub-Saharan Africa. A quantitative multidimensional research design was utilized to effectively measure the performance of Sub-Saharan Africa's NIS over a 10-year period, starting from the year 2010 (3 years before the implementation of STISA-2024) through to the year 2020 (7 years after the implementation of STISA-2024). Out of the 49 countries in Sub-Saharan Africa 32 were included in the data analysis because of access to the complete dataset that is relevant to this research. The study examined and ascertained how predictor variables: GEI, PSE and LF influenced the criterion variables: GDP, GNI and HDI. The initial stage of the study involved conducting a canonical correlations analysis comparing data of predictor variables and criterion variables, and a linear regression analysis. The canonical correlation analysis was conducted to predict the impact of the implementation of STISA 2024 on the dependent variables GDP, GNI and HDI using the independent variables GEI, PSE and LF. Canonical correlations analysis was conducted to answer Research Question 1: How does the implementation of STISA-2024 impact GDP, GNI and HDI in Sub-Saharan Africa as measured in the domains of GEI, PSE and LF?

Research Question 1: Canonical Correlation Analysis

Canonical correlations analysis was applied to distinguish and evaluate the association among two sets of variables. In this investigation, there are three independent variables (i.e., GEI, PSE and LF) and three dependent variables (i.e., GDP, GNI and HDI). The correlations among the three independent and three dependent variables are investigated in this research as shown in Table 4.1.

Table 4.1

Canonical Correlations Settings

	Values
Set 1 Variables	GEI PSE LF
Set 2 Variables	GDP GNI HDI
Centered Dataset	None
Scoring Syntax	None
Correlations Used for Scoring	3

The three independent variables on Set 1 as shown in Table 4.1 are considered as one canonical variable and the dependent variables on Set 2 are considered as one canonical variable. SPSS was used to determine the correlations among the dependent canonical variable and the independent canonical variable which is known as canonical correlations. The system found multiple canonical correlations between the independent and dependent canonical variables in this study. The number of canonical correlations were decided based on the minimum number of variables (the independent variable set and the dependent variable set). The minimum number of variables between the sets were taken as the number of canonical correlations. In this case, both independent variables and dependent variables are equally indicating that three canonical correlations were created. In conducting canonical correlations, it is important to do coefficients test for the presence of general relationships among two sets of variables and the significance test in canonical correlation is utilized to carry out the significance test of all the sources of the linear association among the two canonical variables.

The null hypothesis for wilks test is that the correlations in the current and following rows are zero. Since the significant value was less than 0.05, the hypothesis was rejected. This means we got a correlation which is not zero and is more than zero. In this study, the correlation .814 on the canonical correlations shown in Table 4.2 is significant at .000 and was examined,

and the correlation .669 is mutually significant at .000 and was recognized. On the other hand, .083 was insignificant at .537 and was not part of the results evaluated in this study to check the correlations of the independent and dependent variables.

Table 4.2

Canonical Correlations

	Correlation	Eigen value	Wilks Statistic	F	Num df	Denom D.F.	Sig.
1	.814	1.963	.185	14.333	9.000	129.139	.000
2	.669	.808	.549	9.435	4.000	108.000	.000
3	.083	.007	.993	.385	1.000	55.000	.537

Table 4.3

Canonical Correlation, Eigen Value and Proportions

Canonical correlation	Eigen value	Proportion	Percentage
1	1.963	0.70662347	70.66%
2	0.808	0.290856731	29.09%
3	0.007	0.002519798	0.25%
Total	2.778		

Table 4.3 shows the Eigen value proportion of Model 1 to Model 3. The eigenvalue and eigenvectors presented the canonical correlation and corresponding canonical predictor and criterion variables. The initial canonical variables are extremely crucial because the subsequent correlation is the maximum correlation among others as the correlation coefficients are attained in descending order. To rephrase it, the first canonical correlation is the greatest, the second canonical correlation is the second greatest and so on. In this study, the first canonical correlations are referred to as Model 1, and the second as Model 2, and the third as Model 3. The percentage is calculated by dividing the Eigen value of the model to total sum of Eigen value

multiplied by 100:

$$E/\Sigma E \times 100 = P$$

For example, the first model is 1.963/2.778x100 = 70.66% as shown in Table 4.3.

Once canonical correlation analysis is conducted, several functions are extracted like the initial function which is the lower data set that has a high correlation and contributes much to the variation and the others follow with low contributions. For example, in this study the first model shows a variance of 70.66% which comprises of the lower data sets and reveals a greater percentage of the countries involved in the study while the second model shows a variance of 29.09% which shows the higher data and contributes moderately to the study while the final model reveals a 0.25% variance which is very small and insignificant and was rejected in this study. The first model comprises 70.66% of the data of countries in Sub-Saharan Africa, while the second model comprises 29.09% of the data and the third model comprises only 0.25% of the data. This means that only 70.66% of the data is explained by the first model, and 29.09% of the data is explained by the second model, however the third model explains a minimal 0.25% of the data in Sub-Saharan Africa. After explaining the variance of the data sets, the canonical loadings on Table 4.4 explain the loading impact of the dependent variables on the independent variables.

Table 4.4

Set 1 Canonical Loadings

Variable	1	2	3
GEI	.006	.987	-.158
PSE	.140	.155	-.978
LF	-.994	-.072	.076

Table 4.4 shows the Set 1 canonical loadings of the independent variables: GEI, PSE and LF. The canonical loadings highlight that GEI for Model 1 was at .006 which is a low positive

loading. However, GEI for Model 2 was at a high positive .987, while for third model GEI was a -.158. PSE was at .140 in the first model, and .155 in the second model, however, in the third model it was -.978. LF showed a -994 in Model 1, a -.072 in Model 2 and a .076 in Model 3. These models were corresponded with the canonical loadings of the outcome variables in Table 4.5.

Table 4.5

Set 2 Canonical Loadings

Variable	1	2	3
GDP	-.936	.302	.182
GNI	.031	.965	.262
HDI	-.022	.969	-.245

Table 4.5 shows the Set 2 canonical loadings of the dependent variables: GDP, GNI, and HDI. These dependent or outcome variables canonical loadings together with the independent variables canonical loadings gave a clear prediction of the current situation in Sub-Saharan Africa. GDP for Model 1 was at -.936 which is very low, for Model 2 it is at a fair .302 and for Model 3 it is at a .182. Independent variable GNI was at .031 for Model 1, a highly positive .965 for Model 2 and a positive .262 for Model 3. HDI for Model 1 was at a -.022, while Model 2 was at a .969 which is high and Model 3 is at a -.245. Table 4.6 explains the proportion of variance of the independent and dependent variables in the study.

For the first model, the total variance of the predictor variables is 33.6% (.336x100 = 33.6%) and the total variance of the criterion variables is 29.2%. (.292x100 = 29.2%). The variance came from Table 4.6 which was .336 for the first set of predictor variables and .292 for second set of criterion variables for the first model analyzed. In the second model, the variance proportion explained shows .335 (.335x100 = 33.5%) for predictor variables and .654 (.654x100

= 65.4%) for criterion variable and the third model shows a .329 (.329x100 = 32.9%) for the predictor variables and .054 (.054x100 = 5.4%) for the criterion variables.

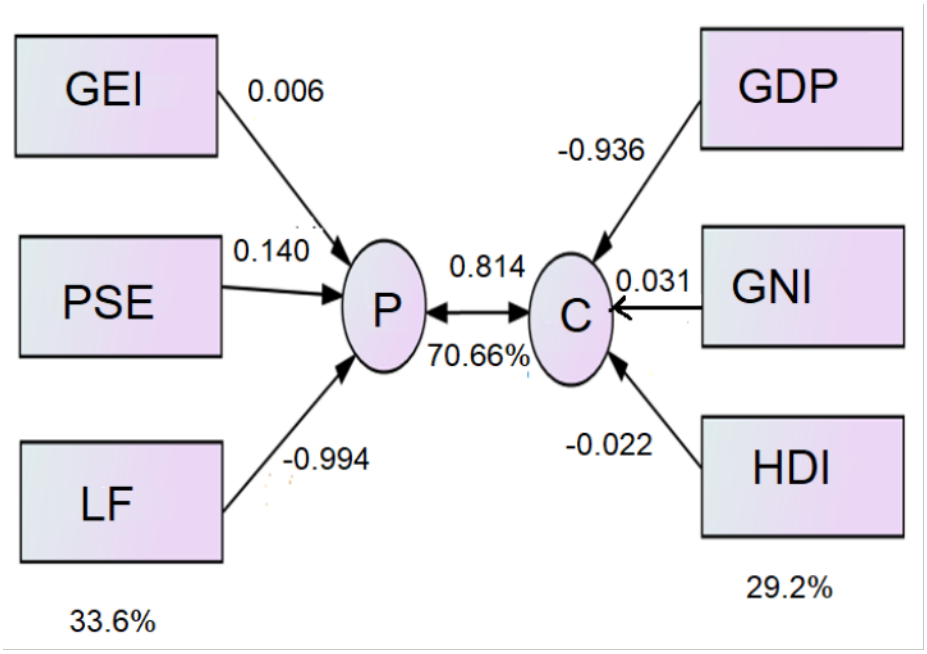
Table 4.6

Proportions of Variance Explained

Canonical Variable	Set 1 by Self	Set 1 by Set 2	Set 2 by Self	Set 2 by Set 1
1	.336	.223	.292	.194
2	.335	.150	.654	.292
3	.329	.002	.054	.000

Figure 4.1

Canonical Correlation Analysis Model 1



In Figure 4.1 the first set of variables on the left of the models are the independent variables GEI, PSE and LF and on the right are the dependent variables GDP, GNI and HDI. In Figure 4.1, the group of variables on the left are called predictor (P) variables and the variables on the right side are the criterion (C) variables. Canonical correlations analysis is utilized in this

study to find the relationship between the predictor variables and criterion variables in a manner that the correlation among the predictor and criterion variables is maximized. Clearly, there are numerous linear patterns of variables, however the objective is to only choose the linear functions that communicate the correlations among the predictor and the criterion variables the best. The linear functions that communicate the correlations among the two sets of variables are called the canonical variables. The correlations among parallel sets of canonical variables are known as canonical correlations. The fundamental concept underlying canonical correlation analysis is to find a linear combination of the predictor variables which has the maximum correlation with linear combination of the criterion variables (Becker, Chambers, & Wilks, 1998).

The variance explained in Model 1 between the independent and dependent variables is 70.66%, and it was calculated using the eigen value in Table 4.4. The importance of the variance is to show what percentage of the data was analyzed in the model and as a result facilitated the canonical correlation predictions. The first correlation is .814 which is the correlation between the predictor and criterion variables as shown in Model 1 (Figure 4.1). The .814 indicates that there is a positive and significant correlation between the variables under study. The canonical loadings for the predictor variables are 0.006 (GEI), 0.140 (PSE), and -0.994 (LF) (Set 1), and those of the criterion variables are -0.936 (GDP), 0.031 (GNI), and -0.022 (HDI) (Set 2). For 70.66% of the countries under study their GEI, PSE and LF are weak and did not impact their GDP meaningfully. The results indicate that the NIS of these countries are weak because the independent variables that are supposed to advance innovation don’t have the capacity to do so.

In the first model it shows that when GEI increased by 0.006, GDP reduced by -0.936. It also shows that when GEI increases by 0.006 GNI increases by 0.031 while the HDI reduces by -

0.022. The model also reveals that when PSE increases by 0.140, GDP reduced by -0.936. It also shows that when the same variable increases by 0.140 GNI increases by 0.031 while the HDI diminishes by -0.022. However, it also reveals that when LF decreases by -0.994 GDP decreases by -0.936, GNI increases by 0.031 and HDI decreases by -0.022. Model 1 revealed the weakness of the governments analyzed and highlighted an ineffective LF in which innovation is minimal resulting in a GDP of -0.936. The low GNI at 0.031 shows how labor is poorly rewarded in the countries studied and the negative HDI of -0.022 indicates that much is not done to train a LF capable of innovating meaningfully. The negative LF of -0.994 highlights the high unemployment rate in the countries studied under this model. PSE at 0.140 revealed that less is spent on education and training highlighting the low investment in education further revealing why STISA-2024 is not performing as it should in advancing innovation in the region.

Model 1 in Figure 4.1 reveals a weak private sector in Sub-Saharan Africa where the governments are very dominant even though GEI is at a low 0.006. GEI at 0.006 affects GDP (-0.994) and HDI (-0.022) negatively and has minimal positive impact on GNI (0.031). PSE was also at a minimal positive at 0.140 and impacted GDP and HDI negatively and have a minimal positive effect on the GNI of Sub-Saharan Africa. The PSE in the region is very low hence the low performance of the variable in having any impact on GDP. The LF in Sub-Saharan Africa was at a -0.936 impact mainly because of the high unemployment rate in the region. The LF has impacted GDP and HDI negatively and the poor performance or impact could be linked to a high unemployment rate among the youth. Although LF impacted GNI positively, it was at a minimal 0.031 which could be attributed to the self-employed Sub-Saharan Africans such as those in farming. The weakness of all the three variables that are needed for economic progress are either at a minimal low or negative, revealing the reason why there is no major innovation in the

region. The results reveal that the independent variables used to measure the impact of the implementation of STISA 2024 on the NIS of Sub-Saharan Africa through the domains of the dependent or outcome variables GDP, GNI and HDI have very minimal impact.

The variance explained in Model 2 is 29.09% which is the subjective sum of the variables in the analysis. In the second row of Table 4.2, the correlation shows .667 which is the correlation between the predictor and criterion variables. The canonical loadings for the predictor variables are 0.987 (GEI), 0.155 (PSE), and -0.072 (LF) (Set 1), and those of the criterion variables are 0.302 (GDP), 0.965 (GNI), and 0.969 (HDI) (Set 2).

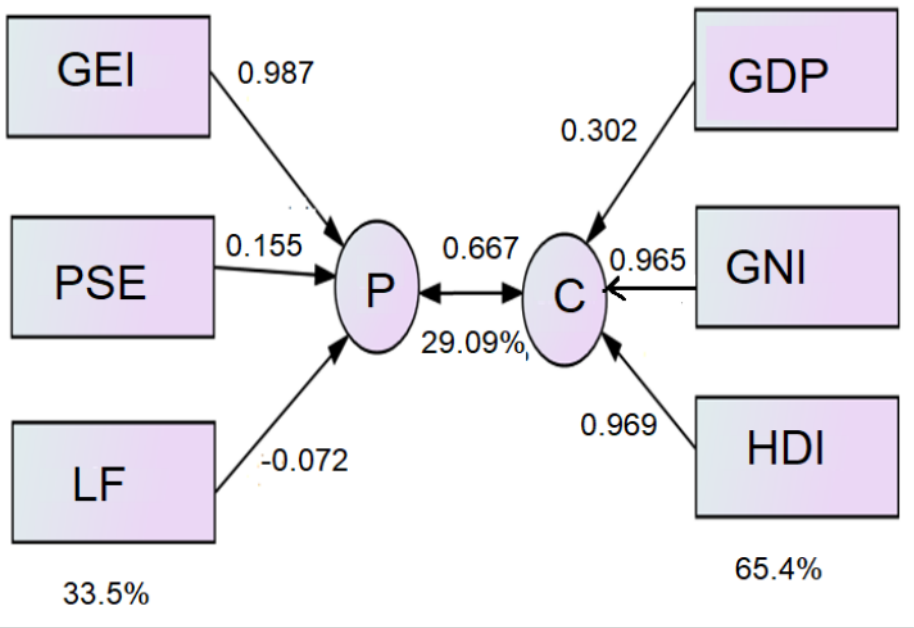
Model 2 shows that when GEI increases by 0.987, GDP increases by 0.302. It also shows that when GEI increases by 0.987 GNI increases by 0.965 and HDI increases by 0.969. The model also reveals that when the PSE increases by 0.155, GDP also increases by 0.302. It also shows that when the same variable increases by 0.155, GNI increases by 0.965 and HDI also increases by 0.969. However, it also reveals that when LF decreases by -0.072 GDP increases by 0.302, GNI and HDI both increase by 0.965 and 0.969 respectively. The countries studied in Model 2 have very effective GEI pointing out the importance of government in the advancement of the nations' economies. GDP is way better in the economies in which the GEI (0.302) are higher and GNI was also at a high 0.965 revealing that the workers in these economies are highly rewarded. PSE at 0.155 is indicative of a low investment in education and training, however these countries have a high HDI at 0.969 showing a more engaged and highly effective workforce. Unemployment is lower in these nations, and they end up enjoying a better standard of living in comparison to the nations in Model 1.

Model 2 reveals a highly effective GEI canonical loading of 0.987, a positive but weak PSE at a loading of 0.155 and a weak and ineffective LF at -0.072. The results of Model 2

reiterate the dominance of the governments as the most effectual variable in Sub-Saharan Africa. The results show a monopoly of power by governments in Sub-Saharan Africa and a feeble private sector not innovative enough due to a frail LF. Even though GEI was at a significant 0.987, its impact on GDP was at a low positive at 0.302. However, Model 2 shows GEI impacting GNI and HDI significantly at 0.965 and 0.969 respectively. PSE at 0.155 also impacts GDP positively at 0.302 as GEI impact both GNI and HDI were highly positive at 0.965 and 0.969 separately. The only independent variable that is negative in this model is LF at -0.072 which reveals the neglected LF in Sub-Saharan Africa and the lack of a strong private sector to reduce unemployment.

Figure 4.2

Canonical Correlation Analysis Model 2

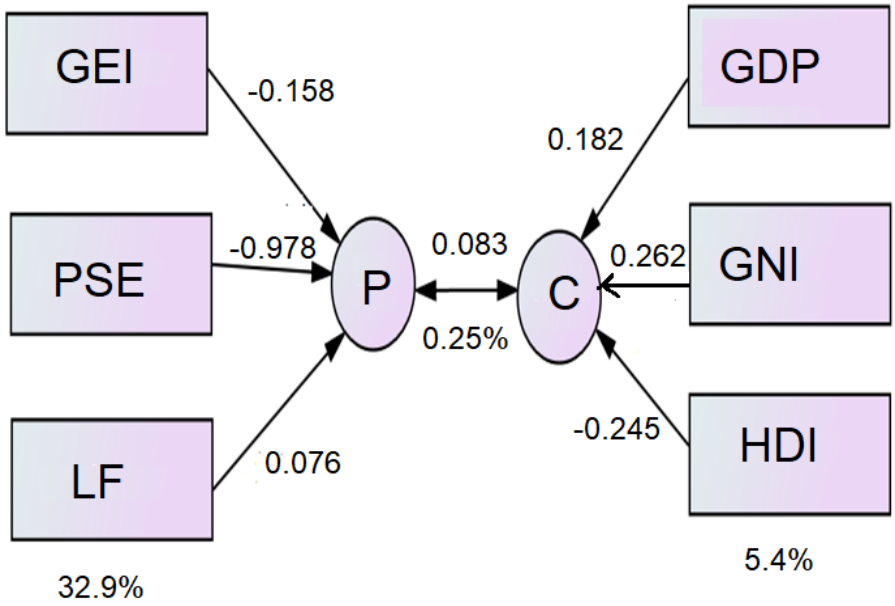


Model 3 shows an explained variance of 0.25% which is very small meaning it has a very small effect size and was rejected as a result. In the last row of Table 4.2, the third correlation is .083 which is the correlation between the predictor and criterion variables. The canonical loadings for the predictor variables are -0.158 (GEI), -0.978 (PSE), and 0.076 (LF) (Set 1), and

those of the criterion variables are 0.182 (GDP), 0.262 (GNI), and -0.245 (HDI) (Set 2).

Figure 4.3

Canonical Correlation Analysis Model 3



Model 3 revealed that when GEI decreases by -0.158, GDP increases by 0.182. It also shows that when GEI decreases by -0.158, GNI increases by 0.262 while the HDI reduces by -0.245. The model also reveals that when PSE decreases by -0.978, GDP increases by 0.182. It also shows that when the same variable decreases by -0.978 GNI increases by 0.262 while the HDI diminishes by -0.245. However, it also reveals that when LF increases by 0.076, GDP increases by 0.182, GNI also increases by 0.262 and HDI decreases by -0.245.

Model 3 is indicative of a failed state in which GEI is at a -.0158, yet GDP is positive at 0.182. GNI is also positive at 0.262 is indicative of clandestine activities such as drug trafficking and other illegal activities taking place in the economy. LF at 0.076 reveals that a small percentage of the population are engaged. The PSE in Model 3 is -0.978 which shows that not much is spent to develop the skills of the people or for educational advancement. HDI at -0.245 revealed that there are less skilled people in the state yet the GDP and GNI are positive. Less

than 1% of the data (0.25%) revealed such a state indicating it is only one nation in the region with such characteristics.

Research Question 2: Linear Regression Analysis

The linear regression revealed the trend of the dependent variables when analyzed individually with the independent variables. The findings from question two demonstrated the trend the dependent variables are taking by doing a linear regression of each dependent variable separately with all the independent variables. Linear regression was the statistical technique used to answer Research Question 2:

- What are the trends to predict the total performance of the sustainable development of NIS of Sub-Saharan Africa by the end of 2024?
    - What relationship does GEI, PSE and LF have with GDP?
    - What relationship does GEI, PSE and LF have with GNI?
    - What relationship does GEI, PSE and LF have with HDI?

In this study, the predictor variables were initially applied against each criterion variable in the first phase and in the second phase each predictor variable is ran against each criterion variables independently to gain more insight of the impact of each on the criterion variables. In this linear regression, scores on one variable or sets of variables are predicted from the scores of a second variable or sets of variables. The variables predicted are termed the criterion variables and are stated as Y (Kumari & Yadav, 2018). The variables on which the prediction is based are called the predictor variables and are denoted as X (Kumari & Yadav, 2018). When only one predictor variable is involved, the method is named simple regression. In simple linear regression, the predictions of Y when plotted as a function of X form a straight line. Linear regression consists of finding the best-fitting straight line through the points. The best-fitting line is called a regression line.

What Relationship Does GEI, PSE and LF Have with GDP?

Table 4.7 shows how the linear combination of GEI, PSE and LF maximize the correlation with GDP. R^2 represents the proportion of the variance for a dependent variable that is explained by an independent variable. $R^2 = 0.520$, which is written in percentage as 52.0% (i.e., 0.520 x 100 = 52.0%) indicates that 52% of the variance for a dependent variable is explained by the independent variables. At 49.5%, adjusted R^2 is less than the value for R^2, which was 52.0%, because it corrects for the positive bias in order to provide a value that would be expected in the GDP. Adjusted R^2 is also an estimate of the effect size, which is at 49.5%, and is indicative of a medium effect size, according to Cohen's (1988) classification. All the variables were entered and the impact of the predictor variables (GEI, PSE and LF) on GDP accounts for 52.0% of the variation of GDP concentration with adjusted $R^2 = 49.5\%$, a medium size effect according to Cohen (1988).

Table 4.7

Linear Regression of Impact of GEI, PSE and LF on GDP

Model	*R*	R^2	Adj R^2	Std. Error of the Estimate
1	.721[a]	.520	.495	59.26125

a. Predictors: (Constant), Labor force, million people, Government effectiveness index (-2.5 weak; 2.5 strong), Public spending on education, percent of public spending

The null hypothesis is that there is no significant difference between the base model and the final model and since the Sig value is less than 0.05, the null hypothesis is rejected. The conclusion is that there is a significant difference between the base model and the final model – which means that the model is good and that GEI, PSE, and LF seems to be impacting the gross domestic product of Sub-Saharan African countries.

The regression model is statistically significant, F (3, 59) = 21.27, $p < .0005$. It is

statistically significant because $p < .05$. A statistically significant result also indicates that there is a statistically significant linear relationship. This is reported in Table 4.8 as: F (3, 59) = 21.27, $p < .0005$. The breakdown of the formula is as follows:

Table 4.8

ANOVA[a] of Impact of GEI, PSE and LF on GDP

	Sum of Squares	*df*	Mean Square	*F*	Sig.
Regression	224116.648	3	74705.549	21.272	.000[b]
Residual	207201.858	59	3511.896		
Total	431318.505	62			

a. Dependent Variable: Gross Domestic Product, billions of U.S. dollars. b. Predictors: (Constant), Labor force, million people, Government effectiveness index (-2.5 weak; 2.5 strong), Public spending on education, percent of public spending.

In Table 4.8,

- F denotes that we are comparing to an F-distribution (F-test)
- df = 3 indicates the regression (aka model) degrees of freedom
- df = 59 indicates the residual (aka error) degrees of freedom
- F = 21.27 indicates the obtained value of the F-statistic (obtained F-value).
- Sig is $p < .0005$ which indicates the probability of obtaining the observed F-value if the null hypothesis is true.

The 3-predictor variable statistically significantly predicted impact on GDP, F (3, 59) = 21.27, $p < .001$. Table 4.9 explains the coefficients of the impact of GEI, PSE and LF on GDP in Sub-Saharan Africa. The first linear regression entails the impact GEI, PSE, and LF have on GDP. The linear regression analysis shows that GEI was at .009 which is significant in GDP. If GEI increases by one unit, then GDP increases by 0.261 units. GEI was at 35.139 and it indicates that it did have an impact on GDP. PSE was at .252 which is not significant in impacting GDP which means that every unit of PSE added decreases GDP by -.112. PSE in Sub-Saharan Africa

is not strong and does not have any positive impact on GDP. LF at .000 is significant in GDP, and the regression analysis shows that if LF increases by one unit, GDP increases by 0.678 units which indicates that LF is more effective than GEI and PSE and has more impact on GDP. The results revealed that GEI and LF have a significant impact on GDP in the region of Sub-Saharan Africa, but not PSE.

Table 4.9

Explaining Coefficients of Impact of GEI, PSE and LF on GDP

	Unstd Coeff		Stand Coeff Beta	*t*	Sig.
	B	Std. Error			
(Constant)	42.131	28.861		1.460	.150
Government effectiveness index (-2.5 weak; 2.5 strong)	35.139	13.022	.261	2.699	.009
Public spending on education, percent of public spending	-1.623	1.402	-.112	-1.157	.252
Labor force, million people	5.655	.756	.678	7.480	.000

Dependent variable: Gross Domestic Product, billions of U.S. dollars

The regression variable plots below show all the countries in Sub-Saharan Africa. After running the linear regression on SPSS, a regression variable plot was created to illustrate the relation of each independent (Predictive) variable and respective dependent (Criterion) variables. Partial regression plots or added variable plots were used with the main objective of scrutinizing the relationship of the dependent variable and independent variables restrictive of the other independent variables.

In linear regression, scores on one variable are predicted from the scores on a second variable. The variable predicted is termed the criterion variable and is stated as Y. The variable on which the prediction is based is called the predictor variable and is denoted as X. When only one predictor variable is involved, the method is named simple regression. In simple linear

regression, the predictions of Y when plotted as a function of X form a straight line. Linear regression consists of finding the best-fitting straight line through the points. The best-fitting line is called a regression line. The regression variable plots below in Figures 4.4, 4.5, and 4.6 show the relationship of independent variable GDP and dependent variables GEI, PSE and LF of countries in Sub-Saharan Africa.

Figure 4.4 shows the relationship between GEI and GDP of the countries in Sub-Saharan Africa. The plot shows that when GEI increases, GDP also increases. The plot also revealed the GEI of all the countries that are doing well economically in Sub-Saharan Africa. Countries such as Mauritius, Cape Verde, Botswana, South Africa, Seychelles, Rwanda, Namibia have a positive GEI. Nevertheless, most of the countries in Sub-Saharan Africa have a negative GEI and low GDP. Nigeria is the only outlier among the countries with a negative GEI that has a high GDP of more than $360 billion in 2010 and over 430 billion in 2020. The case of Nigeria is indicative of a country with resources, yet the government and its institutions are ineffective and weak. Among the countries with a positive GEI, South Africa is the outlier with a GDP of more than $417 billion in 2010 to a $335 billion in 2020 indicating a drop in the GDP of South Africa. The negative GEI of most countries in the region has resulted in the increase of poverty and failure to implement meaningful NIS in the region. Most of the countries upholding STISA-2024 do not have the required funding and effective coordination to implement and monitor the strategy in their countries.

Figure 4.4 shows that GEI in 2010 and 2020 are the same for most of the countries in Sub-Saharan Africa. Nigeria which is an outlier with the highest GDP in Sub-Saharan Africa had a negative GEI at -1.17 in 2010 and -1.03 in 2020. South Africa which was at a positive GEI of .39 2010 GEI of .30 in 2020 an increase which is very minimal to impact GDP positively. The

plot shows that Rwanda's GEI was at -.05 in 2010 and increased to a positive .34 in 2020 which is very impressive. Mauritius also saw a GEI of .087 in both 2010 and 2020, which is one of the highest in the region which validates why GEI is significant because Mauritius is one the most economically advanced countries in Sub-Saharan Africa. Seychelles is also another country that has seen significant increase in their GEI from .20 in 2010 to .51 in 2020 highlighting why Seychelles is one of the high-income countries in Sub-Saharan Africa. Cape Verde had a -.02 GEI in 2010 and increased to a .25 in 2020 which has seen the country's GDP increase significant from $1.66 to $1.70 billion in 2020. Among the countries that have a positive GEI, Botswana saw a reduction of their GEI from .45 in 2010 to .26 in 2020. Namibia which was at a .07 in 2010 and a .05 in 2020 which is a slight reduction. All the other countries in the region were at a negative GEI from 2010 to 2020.

The relationship between PSE and GDP showed that when public spending on education decreases, GDP also decreases. Countries like Sierra Leone, Benin, Namibia, Senegal and Ghana spend a good percentage on education, but the GDP of these countries are very small for any meaningful impact to be noticed. South Africa is the outlier again with a high GDP and a very decent PSE of 18.04% in 2010 and 19.53% in 2020. Figure 4.5 reveals that Seychelles PSE in 2010 was 10.86% and in 2020 it reduced to 9.17% yet it is one of the economies that are doing well in the region. Most of the countries in Sub-Saharan Africa did not see any change in the amount spent on education from 2010 to 2020, which ascertains the reason why PSE could not impact GDP significantly in a positive way.

Most of the countries in Sub-Saharan Africa have a huge LF and there is a presence of high unemployment in these countries. South Africa has one of the highest GDP in the region and is right above the LF mark of 20 million. South Africa and Nigeria are the two outliers in

terms of GDP, yet Nigeria is at around 55 million in terms of LF employment which is very low given Nigeria's huge population. Ethiopia is another outlier with a GDP of around $110 billion and a LF around 54 million people. Ethiopia has seen a huge increase in their LF from 35 million in 2010 to 54 million in 2020 which highlights a 35% increase in the LF within a decade. Democratic republic of Congo also saw an increase of its LF from 24 million in 2010 to 31 million in 2020 as shown in Figure 4.6. The same trend of LF increase could be noted for most of the other countries in Sub-Saharan Africa even though there have not been any huge increases in their GDP, in fact some of the countries such as South Africa has seen a decrease in their GDP. The result indicates that there have not been any meaningful inventions in the NIS of Sub-Saharan African countries to impact GDP through the LF. The linear regression model shown in Table 4.10 shows the impact of GEI, PSE and LF on GNI.

Table 4.10

Linear Regression of Impact of GEI, PSE and LF on GNI

Model	R	R^2	Adj R^2	Std. Error of the Estimate
1	.647[a]	.419	.387	3440.92926

a. Predictors: (Constant), Labor force, million people, Government effectiveness index (-2.5 weak; 2.5 strong), Public spending on education, percent of public spending.

Figure 4.4

Linear Regression Relationship GEI and GDP

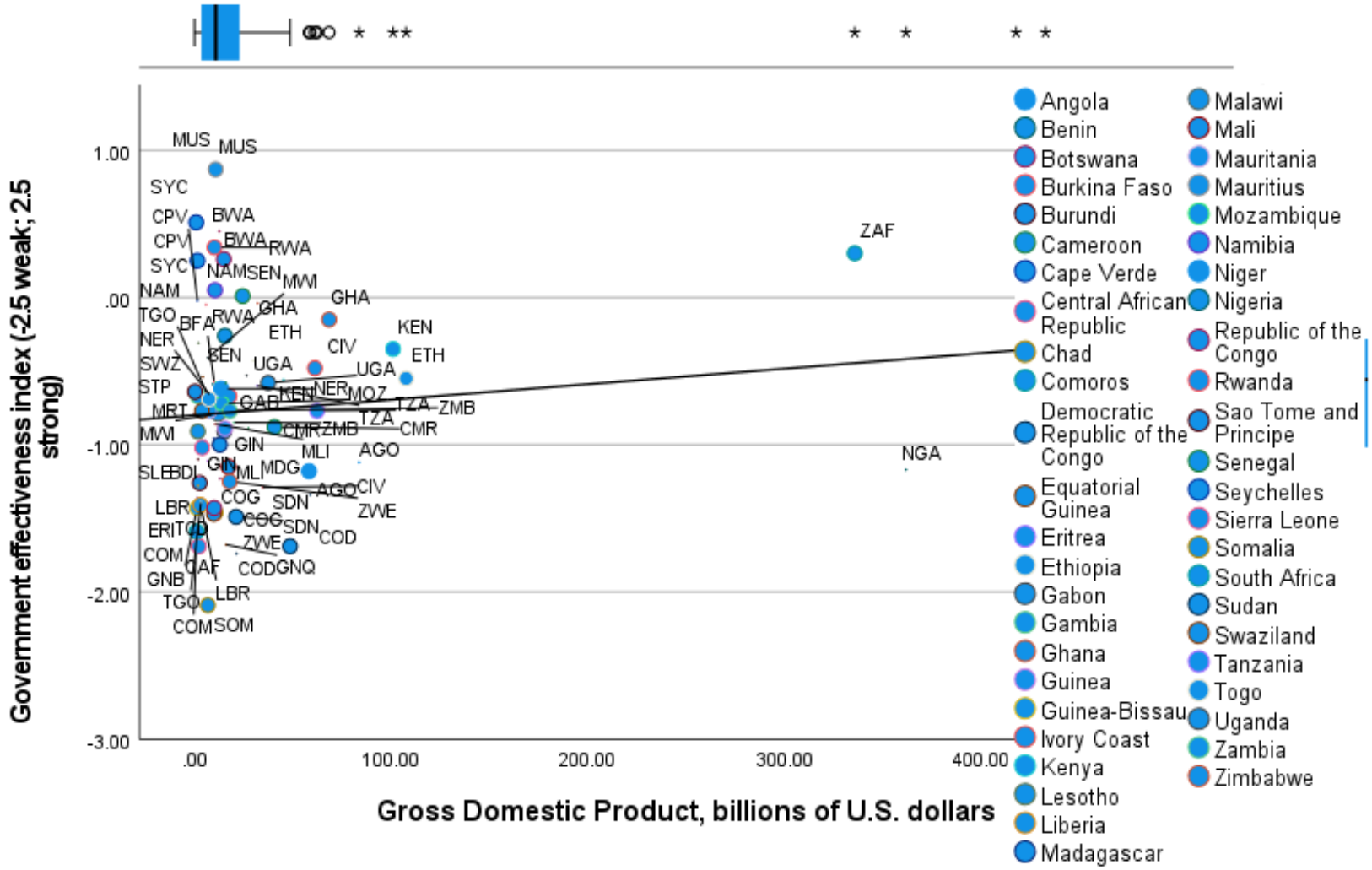


Figure 4.5

Linear Regression Relationship PSE and GDP

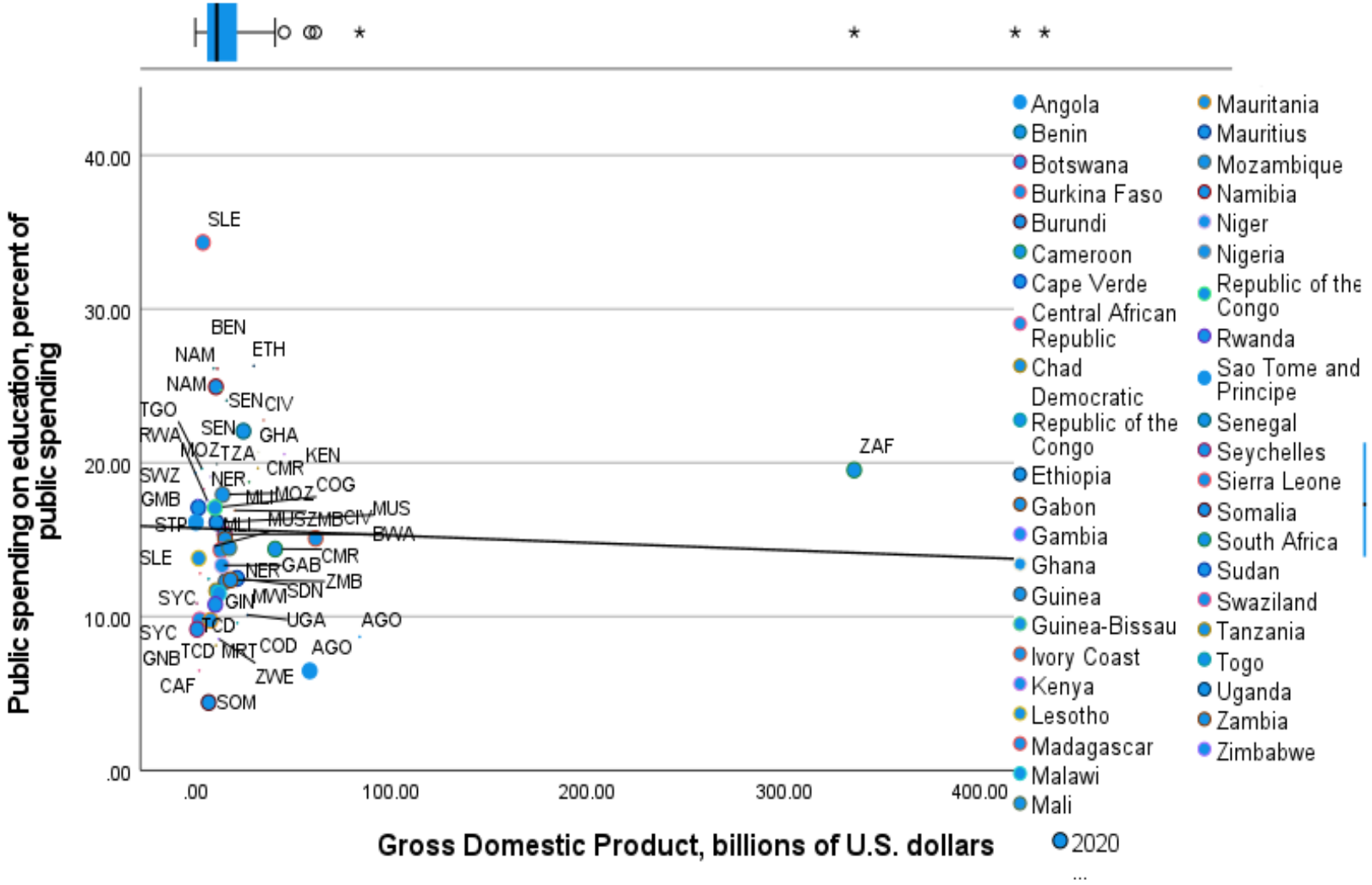
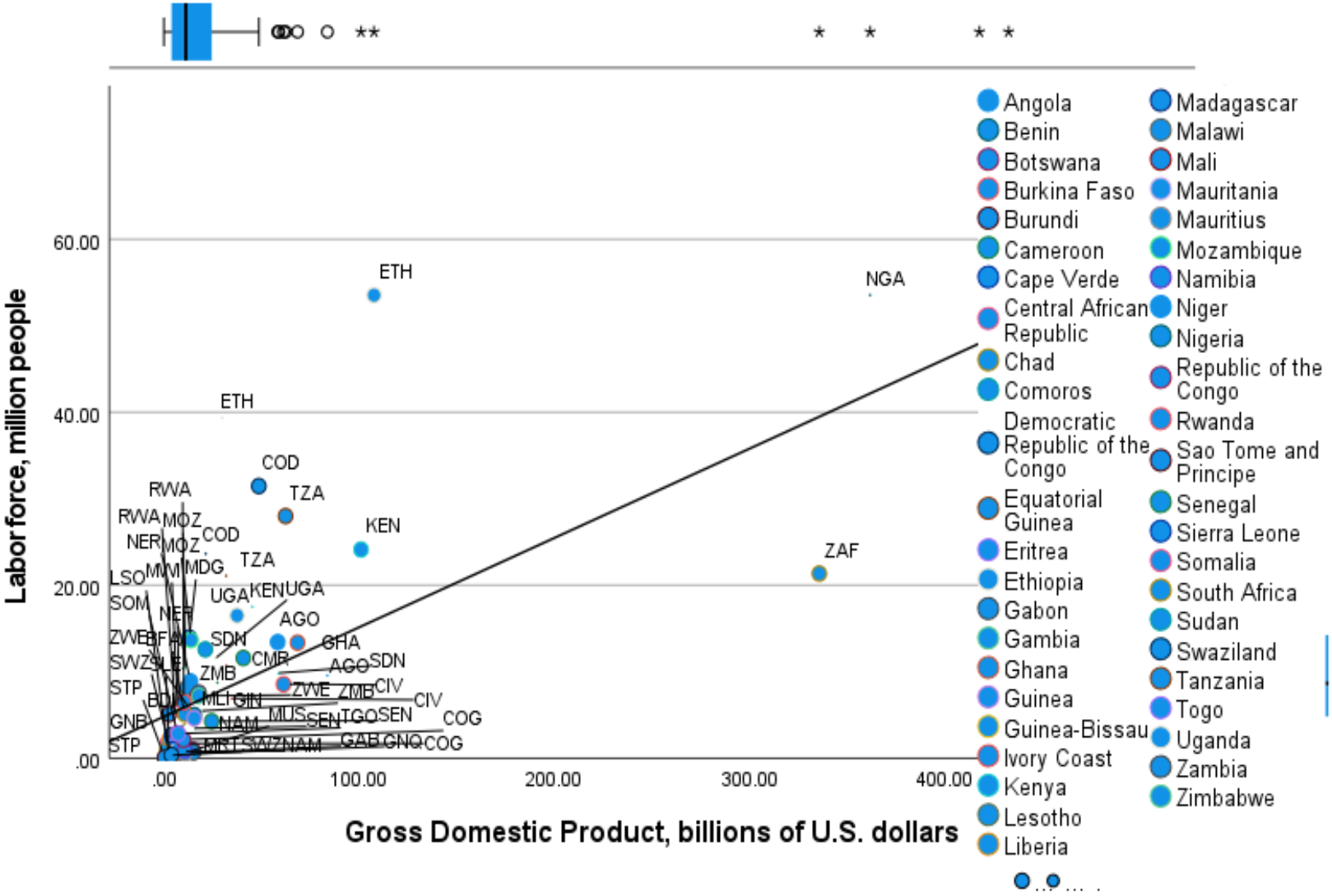


Figure 4.6

Linear Regression Relationship LF and GDP



What Relationship Does GEI, PSE and LF Have with GNI?

R^2 represents the proportion of the variance for a dependent variable that is explained by an independent variable. $R^2 = 0.419$, which as a percentage is 41.9% (i.e., 0.419 x 100 = 41.9%). 41.9% of variance for a dependent variable is explained by the independent variables. At 38.7%, adjusted R^2 is less than the value for R^2, which was 41.9%, because it corrects for the positive bias in order to provide a value that would be expected in the GNI. Adjusted R^2 is also an estimate of the effect size, which at 38.7%, is indicative of a medium effect size, according to Cohen's (1988) classification. All the regression variables were entered and the impact of the predictor variables GEI, PSE, and LF on GNI accounts for 41.9% of variation of GNI concentration with adjusted $R^2 = 38.7\%$, a medium size effect according to Cohen (1988). Table 4.11 reveals the ANOVA of impact of GEI, PSE and LF on GNI in Sub-Saharan Africa.

Table 4.11

ANOVA[a] of Impact of GEI, PSE and LF on GNI

	Sum of Squares	*df*	Mean Square	*F*	Sig.
Regression	477263491.962	3	159087830.654	13.436	.000[b]
Residual	663039672.491	56	11839994.152		
Total	1140303164.452	59			

a. Dependent Variable: Gross Domestic Product, billions of U.S. dollars. b. Predictors: (Constant), Labor force, million people, Government effectiveness index (-2.5 weak; 2.5 strong), Public spending on education, percent of public spending

The null hypothesis is that there is no significant difference between base model and the final model since the Sig value is less than 0.05, the null hypothesis is rejected. The conclusion is that there is a significant difference between the base model and the final model – which means that the model is good and that LF, GEI, and PSE seem to be impacting the GNI.

The ANOVA was significant at .000 and the regression model is statistically significant, F (3, 56) = 13.436, $p < .0005$. It is statistically significant because $p < .05$. A statistically

significant result also indicates that there is a statistically significant linear relationship. This is reported from Table 4.11 as: F (3, 56) = 13.436, $p < .0005$. Table 4.12 shows the coefficients of the impact of GEI, PSE and LF on GNI in Sub-Saharan Africa.

Table 4.12

Coefficients of Impact of GEI, PSE and LF on GNI

	Unstd Coeff		Stand Coeff Beta	*t*	Sig.
	B	Std. Error			
(Constant)	9617.472	1751.045		5.492	.000
Government effectiveness index (-2.5 weak; 2.5 strong)	4735.237	757.326	.682	6.253	.000
Public spending on education, percent of public spending	-115.650	85.378	-.151	-1.355	.181
Labor force, million people	-22.798	49.320	-.048	-.462	.646

Dependent Variable: Gross National Income in Dollars

The following linear regression involves the influence GEI, PSE, and LF has on GNI. The predictor variable GEI is significant at .000. When GEI increases by one unit, GNI increases by .682 units. The variables PSE and LF are at .181 and .646 respectively, indicating that they are both insignificant and have no impact on GNI. GEI is the only variable effective due to its significance at .000 highlighting that it is the only independent variable having an impact on GNI. The dominance of the government on income distribution in Sub-Saharan Africa reveals how the governments in the region are trying to do it all with minimal private sector involvement or empowerment. The regression variable plots below in Figures 4.7, 4.8, and 4.9 show the relationship of independent variable GNI and dependent variables GEI, PSE and LF of countries in Sub-Saharan Africa.

The relation in Figure 4.7 shows that when government effectiveness increases gross national income increases too. The countries with positive government effectiveness index and

highest per capita income in Sub-Saharan Africa are Mauritius, Seychelles, Botswana, South Africa and Namibia. These countries have GNI (Per Capita) of $10,000 or higher. Some of the other countries that make $10,000 or more and have a negative GEI are Gabon at around $14,000 and Equatorial Guinea around at $13,000. A small fraction of the 49 Sub-Saharan African countries have a positive GEI while most of the countries are in the negative.

The GNI of most of the countries in Sub-Saharan Africa did not change much from the year 2010 to 2020. Countries such as Mauritius, Equatorial Guinea, Gabon, Botswana, and South Africa are the outliers and have seen changes in their GNI either positively or negatively. Equatorial Guinea has seen the most decrease in its GNI from $20,000 in 2010 to around 13,000 in 2020 due to ineffective governing. The GEI for Equatorial Guinea was -1.68 in 2010 and -1.47 in 2020 which highlights that the country would have done way better if their GEI was positive. Mauritius as shown in Figure 4.7 had a GNI of around $17,000 in 2010 and an increase to a little above $21,000 in 2020 which is a positive increase. Gabon which is one the outliers with a negative GEI of -.77 in 2010 had a GNI of around $12,000 in the same year, even though the country's GEI decreased to a -.91 in 2020, it has seen a slight increase in its GNI to a little above $13,000 in the same year. Botswana's GNI in 2010 was above $12,000 and it increased to above $14,000 in 2020. South Africa another outlier had a GNI of above $13,000 in 2010 which reduced to $12,700 in 2020. Seychelles which are one of the high-income countries in Sub-Saharan Africa had a GNI of $18,000 in 2010 which has increased to above $25,000 in 2020.

The horizontal line indicates that PSE does not impact GNI. The line is horizontal because the amount of PSE is very minimal and the reason the teachers in this part of the world make less money from teaching. The lack of incentives causes most educated Sub-Saharan Africans to choose other more lucrative professions than the teaching profession. Sierra Leone is

an outlier in Figure 4.8 because their PSE is high at above 30% yet their income per capita is among the lowest in Sub-Saharan Africa. The Sub-Saharan African countries that spend more than 20 percent of their GNI on education are also very few, even the wealthy nations like South Africa, Gabon, Botswana, Seychelles, and Mauritius spend less than 20% of their GNI on education.

PSE in Sub-Saharan Africa has not seen many changes from 2010 to 2020. The only country that spends more than 30% on PSE is Sierra Leone which is among the poorest countries in the region. Sierra Leone increased PSE from 12% in 2010 to 34% in 2020 which will likely improve the country's academic system in the long run and hopefully improve their NIS. Namibia had the highest PSE in 2010 at 26% but it reduced by 2% to 24% in 2020. Republic of Congo and Senegal both spent above 24% in 2010 yet both countries have seen a decline in PSE in 2020 with Senegal spending 22% and Republic of Congo spending 17%. PSE does not impact GNI in any meaningful way in Sub-Saharan Africa because the countries have not been investing much in research and development to support innovation.

The data analyzed show that when LF decreases income increases. The outliers on the above graph are Nigeria, Ethiopia and South Africa. Nigeria has the biggest GDP in Sub-Saharan Africa, however the per capita income in Nigeria is below $2500 due to the country's huge population and LF. Ethiopia also has a huge population and LF and as a result the income per capita is very low at $650. On the other hand, South Africa has a lower population than both Nigeria and Ethiopia with a LF of around 22 million people, as a result their per capita income is high at above $12000. Resource rich countries like Equatorial Guinea see a very slim LF with a high per capita income at above $13,000. From the graph we can also see that most of the countries in Sub-Saharan Africa share similar features as shown in Figure 4.9.

Figure 4.7

Linear Regression Relationship GEI and GNI

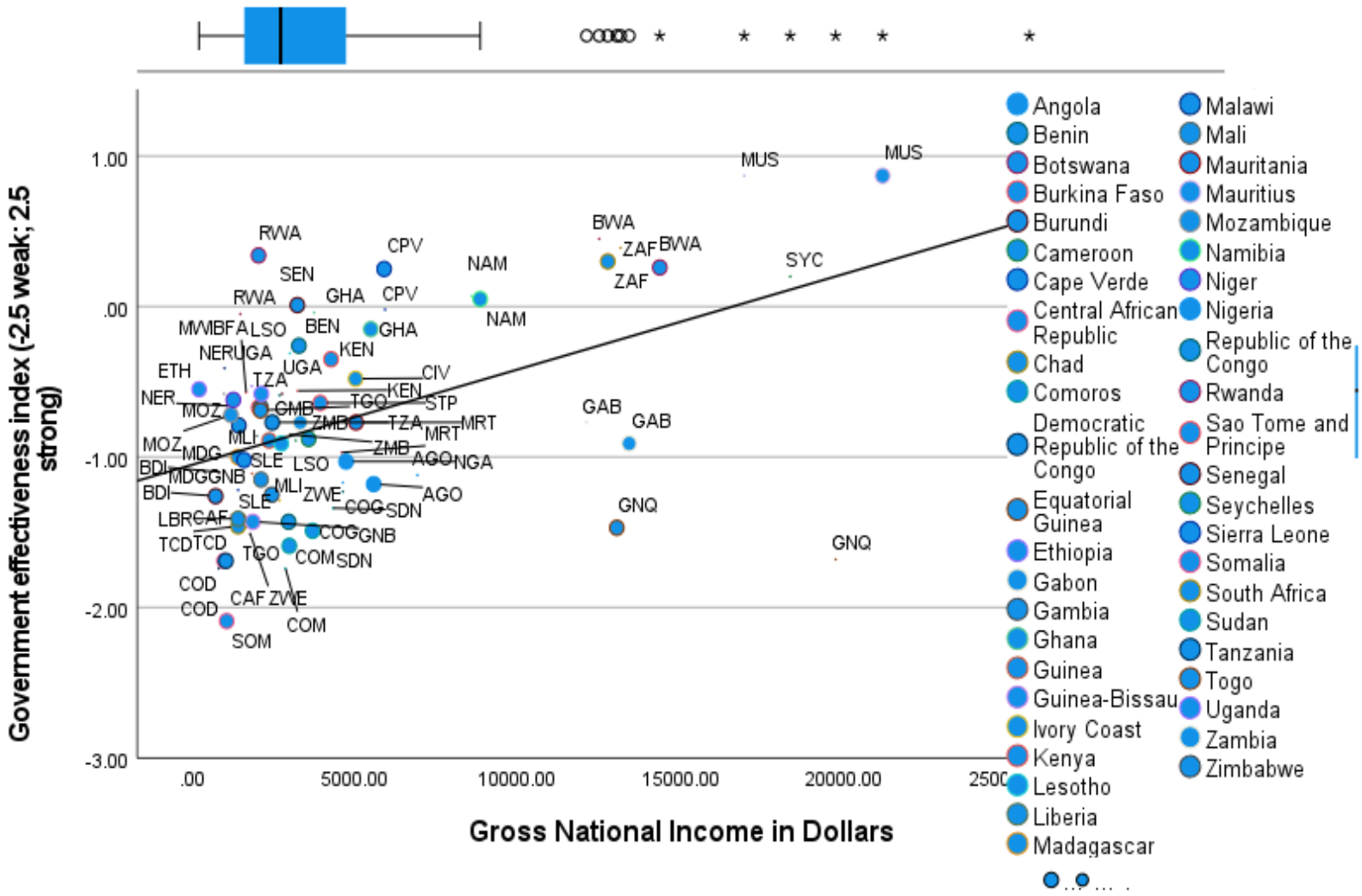


Figure 4.8

Linear Regression Relationship PSE and GNI

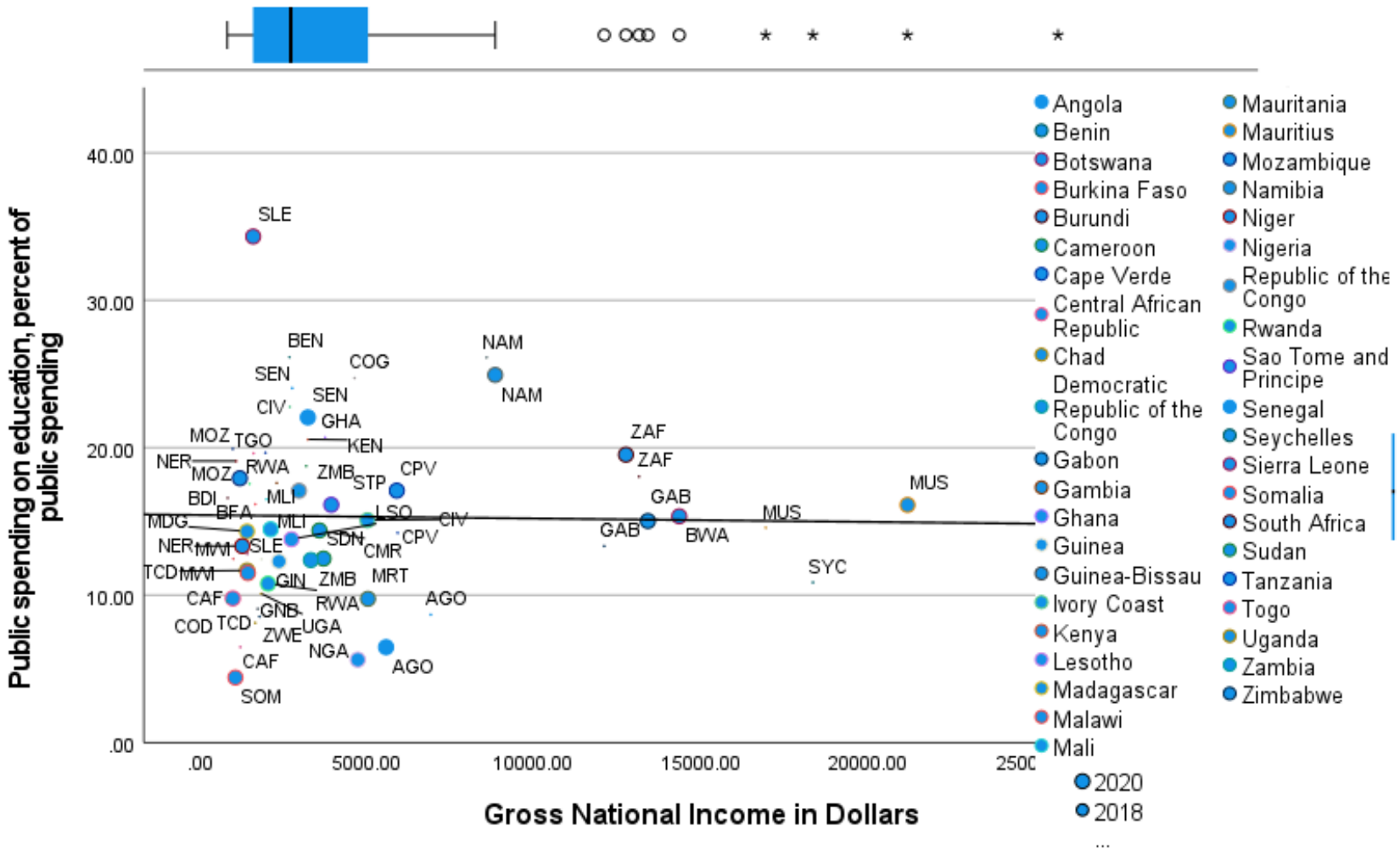
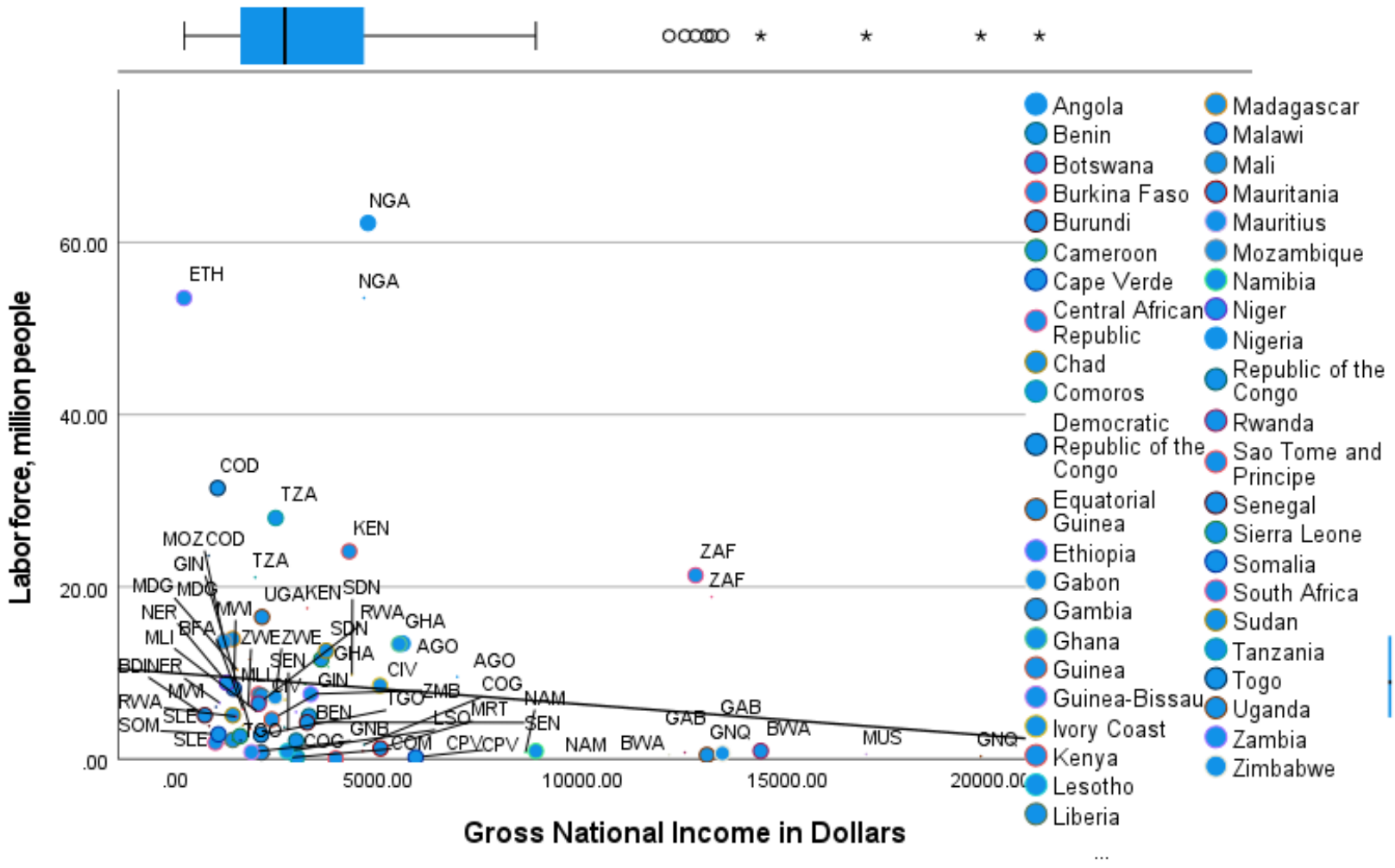


Figure 4.9

Linear Regression Relationship LF and GNI



The LF in many of the countries in Sub-Saharan Africa has been increasing steadily over the years and it has been the region's worst nightmare. Nigeria and Ethiopia have the biggest LF in Sub-Saharan Africa. In 2010 the LF in Nigeria was 53.53 million people but it increased drastically to 62.2 million people in 2020. Ethiopia had a 39.3 million in 2010 and it also increased immensely to 53.5 in 2020. The weak NIS in the region has been affecting the LF, mostly the youths who resort to clandestine immigration. The linear regression of the impact of GEI, PSE and LF on HDI will help the relationship these independent variables have on the dependent variable HDI.

What Relationship Do GEI, PSE and LF Have with HDI?

In Table 4.13, R^2 represents the proportion of the variance for a dependent variable that is explained by an independent variable. Because $R^2 = 0.411$, 41.1% of variance for a dependent variable is explained by the independent variables. At 38.1%, adjusted R^2 is less than the value for R^2, which was 41.1%, because it corrects for the positive bias in order to provide a value that would be expected in the HDI. Adjusted R^2 is also an estimate of the effect size, which at 38.1%, is indicative of a medium effect size, according to Cohen's (1988) classification. All regression variables were entered and the impact the predictor variables (GEI, PSE and LF) have on HDI accounts for 41.1% of the variation of HDI concentration with adjusted $R^2 = 38.1\%$, a medium size effect according to Cohen (1988).

Table 4.13

Linear Regression of Impact of GEI, PSE and LF on HDI

Model	R	R^2	Adj R^2	Std. Error of the Estimate
1	.641[a]	.411	.381	.08299

a. Predictors: (Constant), Labor force, million people, Government effectiveness index (-2.5 weak; 2.5 strong), Public spending on education, percent of public spending.

Table 4.14

ANOVA of Impact of GEI, PSE and LF on HDI

	Sum of Squares	*df*	Mean Square	*F*	Sig.
Regression	.279	3	.093	13.489	.000[b]
Residual	.399	58	.007		
Total	.678	61			

a. Dependent Variable: Human Development Index (0 - 1) b. Predictors: (Constant), Labor force, million people, Government effectiveness index (-2.5 weak; 2.5 strong), Public spending on education, percent of public spending

The null hypothesis is that there is no significant difference between base model and the final model since the Sig value is less than 0.05, the null hypothesis was rejected. The conclusion is that there is a significant difference between the base model and the final model – which means that the model is good and that GEI, PSE, and LF seem to be impacting the HDI.

The third regression model is also statistically significant, F (3, 58) = 13.489, $p < .0005$. It is statistically significant because $p < .05$. A statistically significant result also indicates that there is a statistically significant linear relationship. This is reported in Table 4.14 as: F (3, 58) = 13.489, $p < .0005$. Table 4.15 shows the coefficients of the impact of GEI, PSE and LF on HDI.

Table 4.15

Coefficients of Impact of GEI, PSE and LF on HDI

	Unstd Coeff		Stand Coeff Beta	*t*	Sig.
	B	Std. Error			
(Constant)	.636	.041		15.619	.000
Government effectiveness index (-2.5 weak; 2.5 strong)	.117	.019	.664	6.262	.000
Public spending on education, percent of public spending	-.002	.002	-.126	-1.180	.243
Labor force, million people	-.001	.001	-.056	-.554	.582

Dependent Variable: Human Development Index (0 - 1)

In this linear regression the set of predictive variables (i.e., GEI, PSE, and LF) are utilized to determine if they are effective in predicting the HDI of the countries in Sub-Saharan Africa. The linear regression shows GEI to be very effective in predicting HDI because it is statistically significant at .000. One unit increase in GEI increased HDI by .664. PSE was insignificant at .243 and LF was also insignificant at .582. The results indicated that the only independent variable impacting the outcome variable HDI is GEI, and it could be attributed to the governments of Sub-Saharan Africa been responsible for and driving every sector of the economy. The other two independent variables (PSE and LF) were insignificant according to the regression analysis meaning that PSE is minimal, and the unemployment is widespread causing a weak LF. The regression variable plots below in Figures 4.10, 4.11, and 4.12 show the relationship of independent variable HDI and dependent variables GEI, PSE and LF of countries in Sub-Saharan Africa.

Figure 4.10 shows the relationship between GEI and HDI. When GEI increases HDI increases too. The countries with the highest GEI also have the highest HDI, countries such as Mauritius, Seychelles, Botswana, and South Africa are among the countries with the highest GEI, and HDI. Mauritius HDI in 2010 was .75 and it increased to .80 in 2020, while Seychelles had a HDI of .76 in 2010 and it increased to .80 in 2020. Gabon's HDI in 2010 was a .66 and it increased to .70 in 2010. Some of the poorer countries that have seen some improvement in their HDI are The Gambia and Cape Verde. The Gambia had a HDI of .44 in 2010 and it increased to .50 in 2020 while Cape Verde was at .63 in 2010 it increased to .67 in 2020. Equatorial Guinea which is one of the high-income countries in the region saw a 1-point increase in their HDI from .58 in 2010 to .59 2010. The HDI in Sub-Saharan Africa is developing steadily but not enough for the much-needed NIS in the region and STISA-2024 is not doing much to improve the NIS.

One of the most fascinating facts of this linear regression is that PSE is a horizontal line as revealed in Figure 4.11 indicating that it does not have any impact on the HDI of Sub-Saharan Africa. PSE is very minimal and does not impact the HDI as it should. For meaningful and serious innovation to take place in any economy, the HDI must be high. The PSE even for the wealthy Sub-Saharan African countries is low, indicating that there is minimal human development, and that the wealth is coming from natural resources and not the NIS of those countries let alone a strategy like STISA-2024 whose impact is not noticed in any of the countries in Sub-Saharan Africa.

The linear regression reveals that the relationship between LF and HDI in Sub-Saharan Africa is that when LF decreases, HDI also decreases. Nigeria and Ethiopia have the highest LF as shown in Figure 4.12, while Mauritius has the highest HDI in Sub-Saharan Africa together with Seychelles. The countries saw a great increase in their LF and HDI includes Democratic Republic of Congo, Tanzania, Kenya and South Africa. Democratic Republic of Congo's LF was 23.6 million people in 2010 and it increased to 31.4 in 2020. Tanzania and Kenya had a LF of 21.1 and 17.5 million people in 2010 respectively which increased to 28 million and 24.1 million people respectively. South Africa's LF in 2010 was at 18.8 million people and has increased to 21.3 in 2020. Many of the other countries have seen a slight increase in their LF and HDI, even though there are not readily available jobs for the youth population.

Figure 4.10

Linear Regression Relationship GEI and HDI

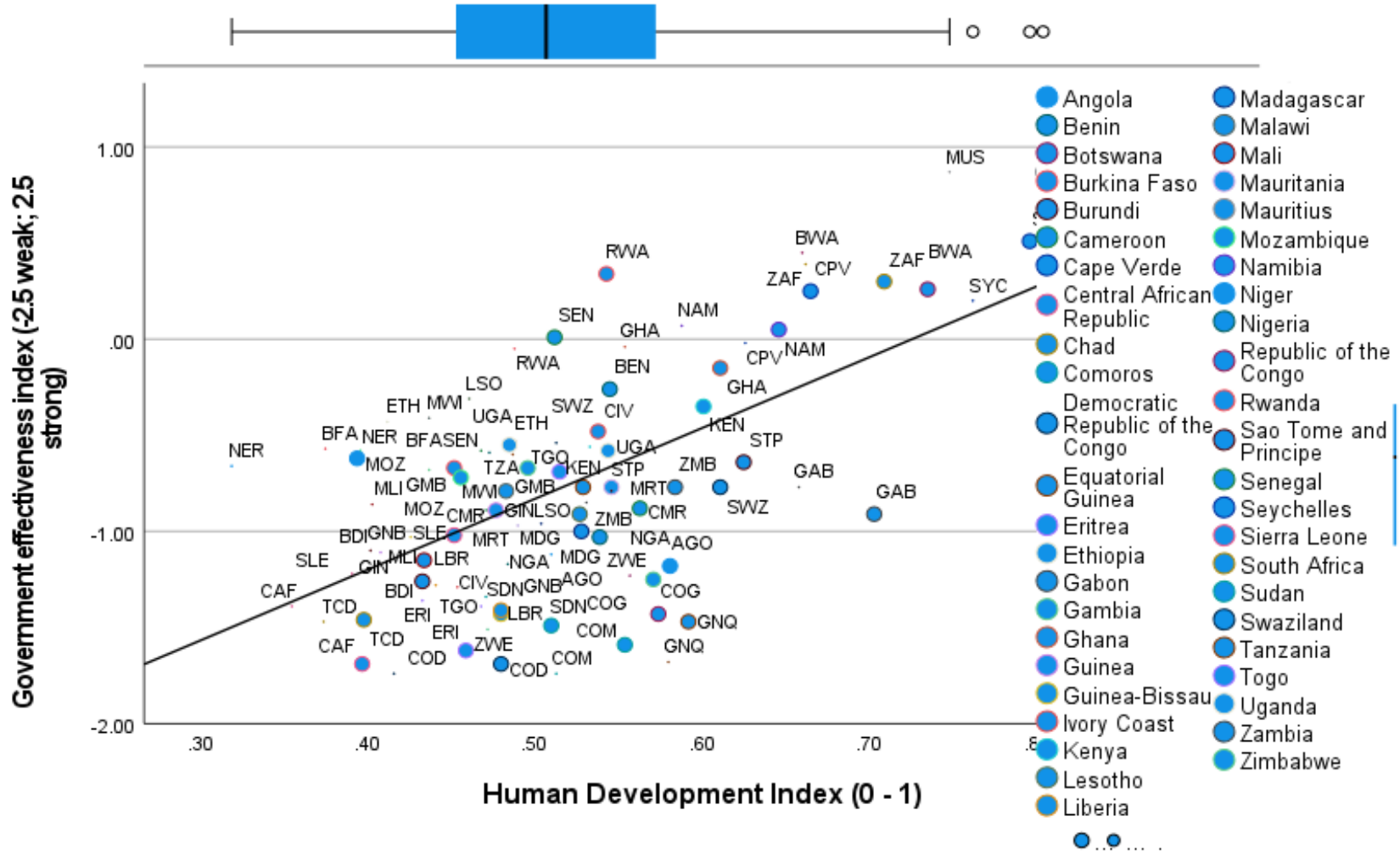


Figure 4.11

Linear Regression Relationship PSE and HDI

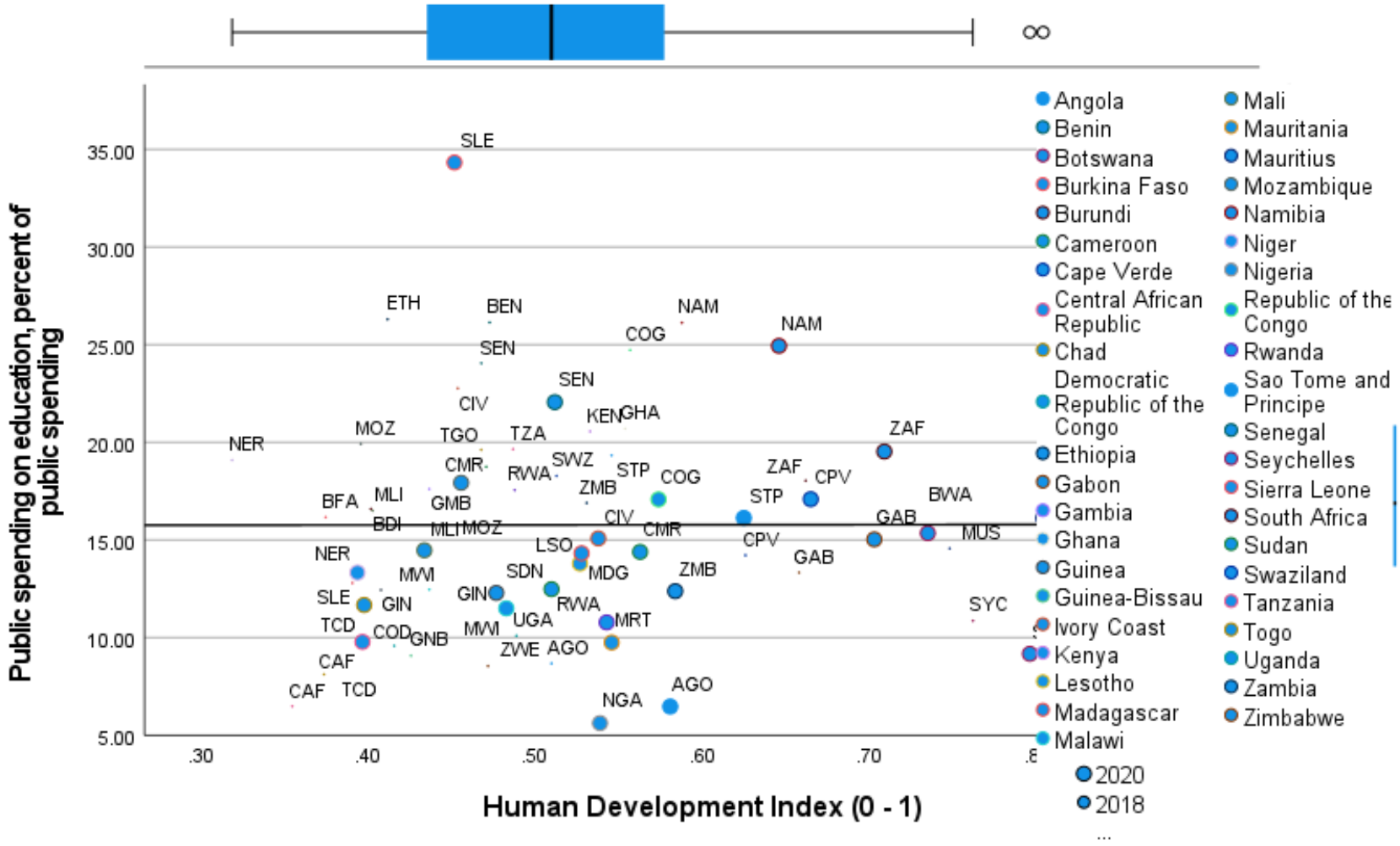
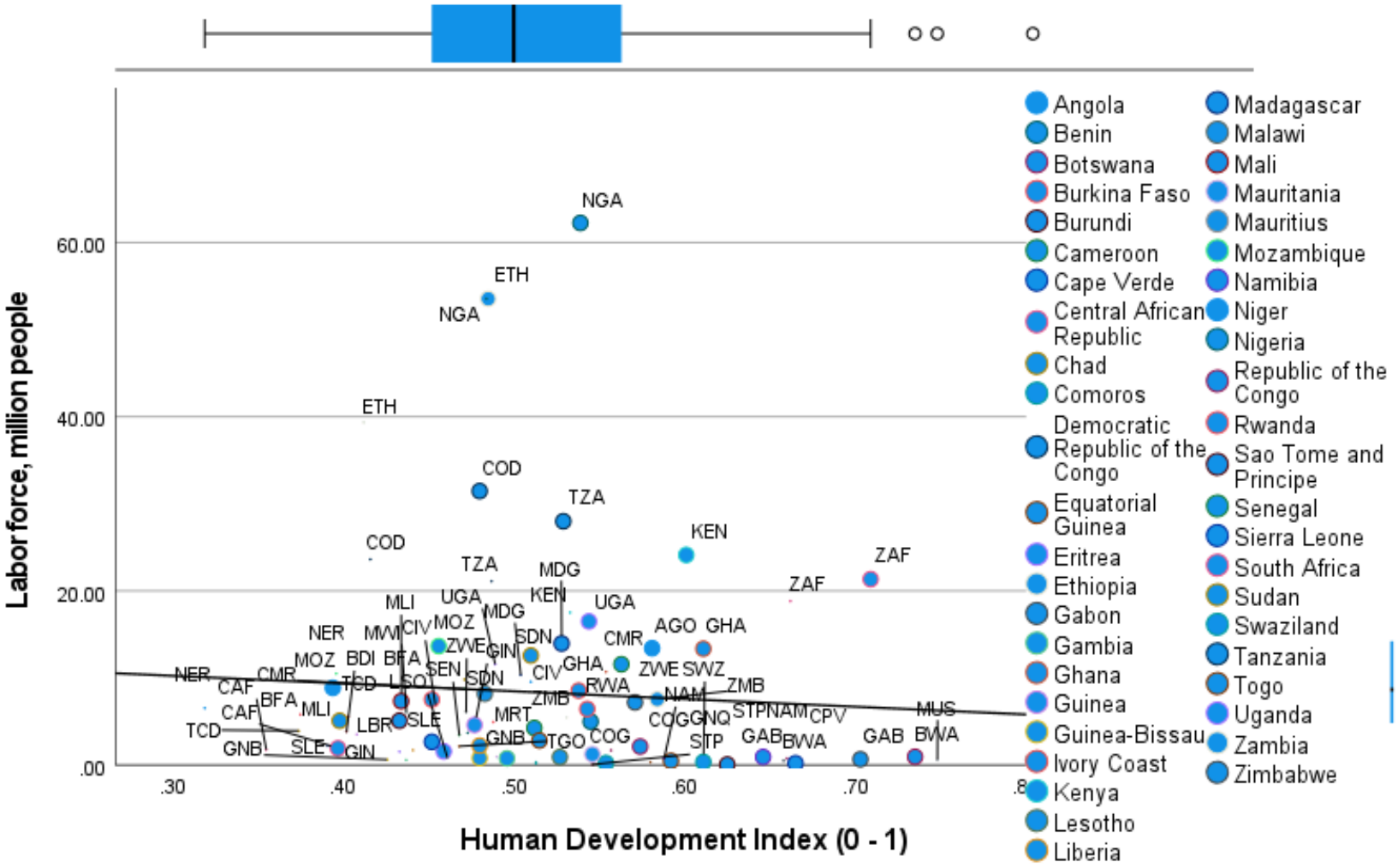


Figure 4.12

Linear Regression Relationship LF and HDI



Chapter 4 Summary

In Chapter 4 the multidimensional quantitative study results are revealed and analyzed. The first part involved a canonical correlation analysis which was conducted to predict the impact of the implementation of STISA 2024 on the dependent variables GDP, GNI and HDI using the independent variables GEI, PSE and LF. The first model of the canonical correlation analysis shows a variance of 70.66% which includes the lower data sets and reveals a greater proportion of the countries involved in the research while the second model shows a variance of 29.09% which displays the higher data and contributes moderately to the study while the final model discloses a 0.25% variance which is very small and insignificant in this study. The second part of the study involved a linear regression and simple linear regression plots which revealed the trend of the dependent variables when analyzed individually with the independent variables. The findings from question two demonstrated the trend the dependent variables are taking by doing a linear regression of each dependent variable separately with all the independent variables.

CHAPTER 5

DISCUSSION

The objective of the study is to assess the influence STISA-2024 has on sustainable economic development through measurement of the NIS of the countries in Sub-Saharan Africa. A quantitative, multidimensional study design was utilized to successfully evaluate the performance of Sub-Saharan Africa's NIS 3 years prior to the implementation of STISA-2024 and 7 years following its implementation. The research studied and established show how predictor variables: GEI, PSE and LF influenced the criterion variables: GDP, GNI and HDI. The quantitative techniques used in the study are canonical correlation analysis and linear regression analysis which were conducted to answer the following questions:

1. How does the implementation of STISA-2024 impact GDP, GNI and HDI in Sub-Saharan Africa as measured in the domains of GEI, PSE and LF?
2. What are the trends to predict the total performance of the sustainable development of the national innovation systems of Sub-Saharan Africa by the end of 2024?

The results showed that the independent (predictor) variables (i.e., GEI, PSE and LF) and the dependent (criterion) variables (i.e., GDP, GNI and HDI) used to measure the NIS of Sub-Saharan Africa with data from 2010 and 2020 revealed the impact the predictor variables have on the outcome variables and revealed the trend or direction of the measured variables in the region. The canonical correlation analysis showed that two of the canonical correlational analysis were significant at .814 (70.66%) and .669 (29.09) and both were significant at .000. However, the last correlation was 0.83 and was insignificant at 0.537. The results show slight changes to what was reported by the World Bank (2018) as mentioned in chapter one that out of the 49 countries in Sub-Saharan Africa, only one Sub-Saharan African country qualifies as "high-income" (Seychelles). Six countries are defined as upper-middle-income (Botswana, Equatorial Guinea, Gabon, Mauritius, Namibia, and South Africa), the rest of the Sub-Saharan African

countries are either lower-middle-income or low-income which are the 70.66% of the first canonical correlations analyzed. Mauritius has leaped to the high-income countries in 2020, and the lower middle-income countries have increased slightly. Two of the canonical correlations were significant and their results were important in showing the impact of the predictor variables on the criterion variables for this research while one of the canonical correlations was not significant. The first canonical correlation analyzed 70.66% of the data which is most of the countries in Sub-Saharan Africa, and the second analyzed 29.09% of the data is representative of the high-income and upper-middle income countries, while the last canonical correlation analyzed only 0.25% of the data.

The linear regression analysis on the other hand was able to determine the strength of the predictor or independent variables in predicting the outcome or dependent variables. It also forecasted the effect the predictor variables have on each outcome variable and forecasted the trend. All three regression models were significant at .000. In the first model, the predictor variables GEI, PSE and LF were used to predict GDP. The results showed GEI to be significant at .009 and LF at .000 while percentage of PSE was insignificant at .252. The second regression model showed that out of the three predictor variables (i.e., GEI, PSE and LF) only GEI had an impact on GNI. The third regression model also showed GEI as the only effective predictor variable to impact HDI.

Discussion of Canonical Correlation Analysis

For Research Question 1, the canonical correlation analysis revealed some vital correlations. For example, it shows a high variance on the first model at 70.66%, and the second model at 29.09% while the third model was at 0.25% which is very low and as a result was

thrown out and not considered to provide a viable analysis even though it was reported as part of the results.

Model 1. Impact of GEI on GDP, GNI and HDI

The fact that the GEI is at 0.006 impacting GDP negatively at -0.936 shows how insignificant GEI is impacting GDP in Sub-Saharan Africa. In fact, GEI has a negative impact on GDP, and it could be attributed to governments not complimenting the efforts of the private sector. Sub-Saharan Africa's high dependence on imports and a lack of strategic plans to industrialize and use the raw materials tapped in the region to create finished goods gravely affects its GDP. As emphasized by Wieczorek & Hekkert (2012) who sought to determine the dynamic roles of NIS concluding that where failure to undertake the innovation processes indicates the failure of national innovation systems. In other words, organizations within the NIS who fail to produce products and services effectively impact the region and nation in a negative way thereby affecting the performance of the NIS. Most of the governments in the region have focused on supplying raw materials to the developed and emerging economies since the colonial era and most governments have no policies in place that can support industrialization initiatives. Cook et al., (2019) pointed out in the literature that there is similarly the prevalence of poor academic infrastructure with minimal availability of human capital to teach, train, and conduct research in the region.

GEI at 0.006 impacts GNI positively at 0.031, this is mainly because the government is the most effective employer in Sub-Saharan Africa. Most of the self-employed farmers in the region heavily depend on their governments to buy their produce after harvesting. The governments buy agricultural produce at a low price from the poor farmers and sell it at a reasonable rate to the industrialized or emerging nations. GNI is positively impacted because the

government is the main source of income for most Sub-Saharan African farmers. As indicated by the United Nations (2018), 33 out of the 47 countries in the list of least developed countries are found in Sub-Saharan Africa which gravely affects the potential earnings of most of the working population.

GEI at 0.006 also has a negative impact on HDI at -0.022. The low GEI does not help the HDI at all in that training and development is limited due to limited institutions to conduct training and qualified trainers. The presence of limited effective institutions of higher education to train and develop the human resources of Sub-Saharan Africa is restricting research and development and retards the NIS of the region. Research and development are needed if any meaningful change should occur in the region as indicated by Michie et al., (2004) that least developed countries and developing countries' ability to increase their people's living standards depends on their ability to absorb, learn, and diffuse technologies.

Model 1. Impact of PSE on GDP, GNI and HDI

PSE been at a low 0.140 impacted GDP negatively at a -0.936 indicating that the minimal amount the public invest in education does not have any impact on GDP. The spending on education in Sub-Saharan Africa is minimal, especially at the tertiary level where research and development should be effective for innovation to take place. Most Sub-Saharan Africans prefer to do their tertiary education abroad when possible and they usually chose to stay in the countries where they did their tertiary academic education to pursue their dreams in life. This is causing a brain drain in the region and has not helped in uplifting the education system in Sub-Saharan Africa to the point of impacting GDP. Capello and Lenzi (2014) elaborated on the relevance of knowledge and innovation as drivers of local economic growth, while Asheim and Gertler (2005) asserted that innovative undertakings and economic structures that measure up to the skill and

efficacy of knowledge connections are essential to growth. However, the results reveal that in the case of Sub-Saharan Africa the PSE is minimal knowledge and innovation are not impacting economic growth as expected.

Conversely, PSE impacts GNI positively because when PSE is at 0.140 GNI is at 0.030. The impact is minimal but noteworthy because the education system employs a lot of people, especially in the primary and secondary level. However, the tertiary sector employs less in comparison with the primary and secondary sectors. The minimal impact that PSE has on GNI could be attributed to the minimum salaries received by teachers in the region and the lack of finance for research and development has also been an issue in the region. Poor institutions and infrastructure have also hampered the growth of the NIS in Sub-Saharan Africa.

PSE at 0.140 also impacted HDI negatively at -0.022 which indicates that the amount of money spent on education does not help the HDI in any reasonable way. The results on PSE and HDI highlight the high dropout rate among students in the region, usually in the primary and secondary sectors. Most Sub-Saharan Africans dropout of school at the primary or secondary level for various reason and it tend to reduce the amount of money spent on developing the necessary skills and training to be innovative and thrive in the job space. The lack of skills and training due to limited or no education affects the job prospects of most Sub-Saharan Africans as emphasized by Ahmad (2004) who highlighted that technological development and transfer significantly affect employment, food security, export incomes, raw materials, and capital for advancement. The academic infrastructure, learning, and training are also gravely affected, impacting nation-building and economic development in the region.

Model 1. Impact of LF on GDP, GNI and HDI

LF in Sub-Saharan Africa has a high negative loading of -0.994 and impacted GDP with

a high negative loading of -0.936 which could be attributed to the high unemployment in the region. The LF is usually very important in NIS (Santos Arteaga et al., 2017), but it was at a negative in Model 1, showing the reason why innovation is still not impacting the Sub-Saharan African economies as it should, because the first model comprises of 70.66% of the data. The unemployment rate in Sub-Saharan Africa is very high and has been the cause of most of the problems the youthful population of Sub-Saharan Africa has been facing such as crime, clandestine immigration and other vices which have claimed the lives of many youths in the region. The results of the first canonical correlations model showing the impact of LF on GDP, GNI and HDI confirmed what The African Development Bank (2015) highlighted that 1/3 of the Africa's 420 million young people ages 15 to 35 were unemployed and another 1/3 were vulnerably employed and that only 1 in six was in wage employment. The catastrophic work condition for youthful individuals throughout Sub-Saharan Africa remains to extinguish their ability and as a result is forcing many youths to embark on clandestine immigration in which lots of lives have been lost.

The LF, just like the other independent variables impacted GNI minimally at 0.031, which reveals how weak the job sector is in Sub-Saharan Africa. The low incomes and unemployment predicament is the main problem of the region. Sub-Saharan Africa's young population should have represented an abundant and dynamic workforce, a blessing for the growth prospects of the region. Instead, the bulk of Africa's youth are unofficially employed, and countless are underemployed or stay in abject poverty regardless of been employed because of low earnings and the absence of a social security network. As earlier indicated by Cook et al., (2019) in the literature severe poverty unpretentiously reduced between the last decade of the 20th century and the new millennium's first decade. Regardless, 41% of Sub-Saharan Africans

lived below the global poverty mark of $1.90 per day as of 2015, and 21% were malnourished as of 2016.

The LF loading at a -0.994 has a very low impact on HDI at -0.022 demonstrating how the Sub-Saharan African LF is comprised of a lot of unskilled labor. The African Development Bank (2015) states that about 10 million to 12 million youth enter the workforce in Africa each year while merely 3 million official vacancies are generated yearly. The unemployment situation among the Sub-Saharan African youth who got no alternative but to seek employment has been forcing some of them to migrate to other countries within the region that are doing better in search of employment because most countries in Sub-Saharan Africa got minimal or no social security. The movement of the youth to the advance economies such as South Africa has caused xenophobia in South Africa and Equatorial Guinea and will likely cause instability in the region going forward. The situation of employment is so serious in the region that countless youth have been crossing the Sahara Desert to get to the Maghreb in order to find their way through the black sea to Europe. A lot of youth has died in the desert and the black sea trying to get to Europe. The situation of most of the Sub-Saharan African is scary because research has shown that the economic gap between Sub-Saharan Africa and the rest of the world will continue to widen over the next five years (Selassie & Hakobyan, 2021). The wider the economic gap between the world and the region, the more youths will travel to more advanced countries for greener pasture.

Model 2. Impact of GEI on GDP, GNI and HDI

In Model 2 we see a different prediction with a 29.09% variance and a 0.667 canonical correlation in which GEI has a high loading of 0.987 which impacted GDP at 0.302. This model depicts the economies that are performing well in Sub-Saharan African. Governments in Model 2

are highly effective and have impacted important sectors to create needed economic development. These countries were able to impact GDP positively and experience growth in their economies, although the positive GDP could be attributed to being rich in natural resources among other things. However, some of these countries have been able to take advantage of the interconnectedness of technology and information among human resources and institutions to vitally effect, support, and promote innovation to sustain the development of their nations (Lyasnikov et al., 2014; Nelson, 1993; OECD, 1997).

In these countries GEI also impacts GNI at a high loading of 0.965 which indicates that the citizens of these countries enjoy a high or decent income in comparison with the countries in the first model. The GNI in Model 2 is indicative of economies that are performing well and are potentially innovative. These countries usually attract immigrants from other Sub-Saharan economies that are not doing well. Although the GNI being higher than GDP is indicative of aid or natural resources playing a major role in the economies of these countries. It could also be attributed to other factors because if a country's GNI is significantly higher than their GDP, it implies they get a great deal of foreign aid, however if their GDP is considerably greater than their GNI, it indicates that non-citizens make up a substantial part of the country's production. Cozijnsen, Vrakking, and IJzerloo (2000) emphasized that innovations must be prosperous in that it can drive regulatory improvement, support infrastructural development, and promote entrepreneurship. Seychelles and Mauritius have been driving regulatory improvement, supporting their infrastructural development and promoting entrepreneurship. As emphasized by Fagerberg and Srholec (2008) who indicated that NIS performs a major role in accomplishing economic security and expanding the economy's effectiveness through the collaborative connection between the government and private sectors.

In this model also GEI impacts HDI at a high loading of 0.969 which indicates that the countries have good institutions of higher education and have a highly trained and effective work force and the public is spending on education to develop their skills. Innovation is likely a priority in these nations and their NIS is on track. Training and development of skills are probably highly prioritized in these countries. These are probably countries that have been doing good before the implementation of STISA (2024). Waite (2018) emphasized that leaders seek to support innovation and are also compelled to act conscientiously to attain economic, social and environmental outcomes. Although STISA-2024 is a good strategy to advance innovation and eliminate poverty in Sub-Saharan Africa, it should be supported by the efforts of the governments to ensure it is a collective agenda for the success of the region. Financial support should be readily available to complement the efforts of the higher learning institutions to support innovation. STISA-2024 strategy was designed to increase and elevate the research establishments such as institutions of higher learning and augment specialized and practical capabilities through robust training and development of the human resources in the region (African Union Commission, 2014), and should be a worthy project for all countries in the region for meaningful economic development.

Model 2. Impact of PSE on GDP, GNI and HDI

The independent variable PSE has a loading of 0.155 and impacted GDP at 0.302 indicating that what the public spend on education (0.155) in these countries is a little more than what is spent in Model 1 (0.140). PSE at 0.155 coupled with a positive GDP and GNI means the citizens of these countries can spend on education to develop themselves and advance their skills in their career of choice.

PSE also impacted GNI at a loading of 0.965 which indicates that the amount spent on

education together with the other independent variables (GEI and LF) have a great impact on GNI. GNI being positive means citizens of these countries can afford new innovations that hit the market and encourage innovation and research and development for more quality products for a public that can afford them. A strong GNI is indicative of a high literacy rate, good public amenities and services. The strong GNI can also indicate that these countries have natural resources.

HDI is also positively impacted at 0.969 highlighting that the human resources of these nations are growing at a very high pace and does impact innovation positively. The high HDI is indicative of these countries having highly skilled workers and industries to innovate. It could also be attributed to high incomes attracting skilled laborers to those countries. The high HDI could be as a result of the influx of skilled and semi-skilled workers in the economies of those countries. Research has shown that an economy's absorptive capacity "depends heavily upon the level of education and training" (Mytelka, 2001, p. 2). Education and training will help develop a country's HDI which is very important because the development of the human capital will root "for strong scientific, engineering, and socio-economic capabilities as a basis for policymaking, especially in sectors undergoing radical change" (Mytelka, 2001, p. 3).

Model 2. Impact of LF on GDP, GNI and HDI

Nevertheless, LF is at a loading of -0.072 in this model revealing the impact of unemployment in Sub-Saharan African countries. Even though unemployment is lower in Model 2, unlike the high negative loading of LF in Model 1 at -0.994. The -0.072 of LF in model two is partly as a result of immigration of other Sub-Saharan African in these more advanced economies for employment and greener pasture among other factors. These immigrations have been causing xenophobia and violence like in the case of South Africa where Sub-Saharan

Africans from other countries are often harassed, attacked and maimed by natives who think their jobs are being taken by those immigrants. The LF should not be taken lightly because human capital is very important in facilitating economic growth. For example, the European Union has spent an estimated 3 billion euros, respectively, for information technologies, biotechnology, and nanotechnology (European Communities, 2006) to achieve stability and regional prosperity by promoting an economy that works for the people.

LF being low at -0.072 also impacts the GNI of these countries. The fact that the LF is at a low negative indicates that human capital of these nations is utilized in the economy effectively. The NIS of these countries is growing unlike in the other Sub-Saharan countries where innovation is minimal, unemployment is high, and salaries are poor. The lucrative incomes are forcing other Sub-Saharan Africans to these countries. The high incomes translate into a high standard of living and a better quality of life.

The LF also impacts HDI positively at a high loading of 0.969 and is indicative of a country heading in the right direction economically. A high HDI basically indicates that these countries present a usually high standard of living, with good healthcare, schooling, and prospects to earn income.

Linear Regression Discussion

Linear regression analysis was utilized to answer Research Question 2. Running a linear regression of the independent variables GEI, PSE and LF, and dependent variable GDP data from 2010 to 2020 reveals that GEI was significant at .009 and has been impacted GDP. LF was also significant at .000 and did have an impact on GDP. However, PSE was insignificant at .252 indicating that it does not have an impact on GDP. This is probably due to the high dropout at the tertiary education level. The high cost of education at the higher level causes most people to use

their money on business or other venues instead of education. This also affects the LF even though it does have an impact on GDP, most of the LF in Sub-Saharan Africa is unskilled labor and it tend to minimize the impact it would have had on GDP if there were more Semi-skilled and skilled workers in the LF. The NIS of Sub-Saharan Africa would have done better if more was spent on education, because people will engage in research and development to promote and facilitate innovation. Young (2007) reiterated that some governments even institute local development agencies and science and technology parks to facilitate a technology development regime to reinforce and uphold its innovation leader. In the case of Sub-Saharan Africa, the governments should prioritize innovation by embracing strategies such as STISA-2024 religiously to their economies are reinforced by science, technology, and innovation as multi-function tools for acquiring the objectives and expanding the sources of growth and sustainability of the economic performance of member states to end poverty in Africa as emphasized by the African Union Commission (2014).

The linear regression analysis of GEI, PSE, and LF on GNI revealed that GEI is significant at .000 because in most of the Sub-Saharan African countries the government pretty much control all sectors of the economy and is usually the biggest employer, unlike in the innovation savvy nations in which private enterprises take the lead in both business and innovation. Sub-Saharan Africa does not have big companies' linkup with institutions of higher learning and value research and development, which is the root cause of most innovations. The fact that government is the biggest employer in most of the countries in the region, GEI is significant and impacted GNI positively at .682 for every unit of GEI increase. For example, Equatorial Guinea and Gabon are mineral rich and could have done way better if their governments had a positive GEI. GEI is a very important contributor to NIS because the

government plays a major role in initiating policies that facilitate innovation. Most of the countries that have seen growth in Sub-Saharan Africa did so because of the presence of natural resources in those countries. PSE is insignificant also when it comes to impacting GNI, this could partly be attributed to the lack of quality academic research institutions which is forcing most of the brains in the region to seek the necessary academic skills elsewhere and in most cases chose not to return and contribute their quota for development due to the low wages in the region. The institutions of higher learning don't usually have the funds to conduct the necessary research to advance innovation at the global level. The low spending on education contributes to the reason why there are no effective NIS to drive income and grow the economies and improve the standards of living of the people. For STISA-2024 to have an impact in Sub-Saharan Africa, a lot of investment must be made to give a boost to science, technology, engineering and mathematics' and arts. The LF was also insignificant at impacting GNI at .646 due to the low wages paid in most of the nations in Sub-Saharan Africa. The wages are poor in the region and most of the workers been unskilled makes it worse. Most of the workers just want to make money to make a living and will accept any pay to sustain themselves and their families. The poor wages promote bribery and corruption in both government and private institutions.

The second linear regression analysis of GEI, PSE, and LF on HDI show that GEI is significant at .000 and have an impact on HDI just like how it impacted all the other variables because the present-day governance is synonymous to the colonial style of governance. The governments in Sub-Saharan Africa, just like their predecessors, embrace the same tactic of the colonial masters of having control over every sector of the economy. GEI has an impact on HDI, because the governments control the resources and determine in most cases who gets developed because most of their citizens cannot afford the price tag that comes with acquiring the skills

they need to thrive in a vibrant and innovative job market. Public spending on education as a percentage of public spending is insignificant at .243 highlighting that it does not impact HDI. This could be attributed to the low number of people making it to the institutions of higher learning and the unaffordability of education at a higher level for most of the poor people of the region. The LF is also insignificant at impacting the HDI because there are fewer skilled laborers who are available to coach, train and advance the careers of other people in the same domain. The private sector in the region does not train beyond what is required to do a job function and this undermines the ability of people engaging in research and development for innovative purposes. The richer countries in Sub-Saharan Africa have a higher HDI. The region has been seeing improvement in its human development even though it is not as fast and sustainable due to brain drain and immigration of most people to advanced economies for greener pasture. For meaningful innovation to take place in order to develop Sub-Saharan Africa's NIS the HDI needs to be constantly improved. Nada (2012) emphasized that instead of embracing the existing ad-hoc approach to technology and information transfer, governments should establish more operational structures and techniques to secure society's knowledge

Finally, the linear regression of the impact of GEI, PSE, and LF on HDI revealed that the LF has been decreasing in the region and this is partly due to many educated young Sub-Saharan Africans migrating to advanced global economies to look for work and increase their earning potentials. Clandestine immigration in which a lot of Sub-Saharan African youth have lost their lives is also a factor. The linear regression graph also reveals that countries in Sub-Saharan Africa with a smaller LF like Gabon, Botswana, Mauritius and South Africa have better HDI. I would assume that these countries HDI is partially due to wealth in natural resources because other countries with small LF have low HDI. The importance of funding skills training, research

and development can't be underestimated if the NIS of Sub-Saharan African is to make any meaningful impact in the global space. Developing the LF will help improve HDI and advance the growth of the region. A lot of Sub-Saharan Africans go for higher education in the developed world, where they can develop themselves and get their money's worth of education. The weak academic institution in the region is to blame for poor performance or low spending on education. The NIS is gravely affected by the low PSE and the lack of confidence in most academic institutions in the region. The OECD (2022) indicated that the percentage of public expenditure on education is very vital for comparing education expenditure between countries in relation to their economies, but in Sub-Saharan Africa the percentage of PSE is insignificant. South Africa have been benefitting a lot from the influx of students from other Sub-Saharan African countries for higher education purposes. All the other countries with minimal PSE have other problems in their education system let alone implementing strategy (STISA-24) to promote innovation in the region.

Implications for Research and Practice

The results of this study have several implications for researchers and policy makers in Sub-Saharan Africa and all the actors in the NIS, especially those who initiate strategies such as STISA-2024 for the advancement of the region. As expressed by Lall (2002), NIS includes a visualization of the direction a nation should take technologically, the techniques, and the determination to allot funds as desirable for Innovation to take place. Sub-Saharan African governments should ensure funding is readily available to support its implemented strategies to avoid waste of valuable time in crating redundant strategies. It is necessary to use monitoring and evaluation to measure whether strategic goals were achieved, identify areas that are not performing well, and use the knowledge gained on the assessments to improve performance in

the future (Buffel et al., 2017). This study is based on the premise that measurement and evaluation can show the impact of NIS on Sub-Saharan African countries' economic growth and sustainability. The results reveal that measurement could frame how the region can move forward to secure meaningful economic development especially after knowing the economic standing of the nations in the region. Integrating measurement and evaluation as a tool in the system will significantly support Sub-Saharan Africa's quest for sustainable economic growth. It will give policymakers the leverage to resolve issues, as Otley (2003) stated that what gets measured gets done. The ability to measure and evaluate the impact of the NIS will facilitate identifying sectors of the economy that need attention and identify how to solve problems confronting the region to advance the economy of the countries in the region and alleviate poverty. Measurement and evaluation in supporting Sub-Saharan Africa's quest for sustainable development should be the focus and investing in setting a vision and orchestrating a strategy to facilitate that vision (Olve et al., 1999) should be ultimate for the development of the region. The reason for using measuring and evaluation techniques (or methods) within a society is predominantly to inform, inspire, and govern all parties involved, but exclusively to assess the past, present, and future outcomes of an organization (Ax, Johansson, & Kullvén, 2002).

Corporations should interact with numerous establishments such as higher learning institutions, research establishments, financial institutions, governments, merchants, and clienteles in such a process for meaning social development. Borras et al., (2011) explained how the system of innovation framework became vital for policy design and analysis in the domain of science, technology, and innovation. There is an accord among science and policy professionals that the utmost suitable instrument for scrutinizing innovation is the NIS approach (Ghazinoory & Bitaab, 2014). Suitable organizational and policy structures have added substantially in aiding

and promoting the activities of the actors in the NIS and hasten the processes of knowledge creation (Schmid & Wang, 2017b; Reiljan & Paltser, 2016b). The governments should play a major role in leading the way for meaningful innovation to be realized.

Fagerberg and Srholec (2008) highlighted that NIS plays a key role in achieving economic security and developing the economy's competitiveness through the interactive relationship between the government and business sectors and should not be underestimated. A highly developed knowledge management system plays an essential role in supporting NIS (Chu et., 2014). NIS presents foresights that create flexibility to eliminate numerous deficiencies and blind spots of the neoclassical mainstream, and sufficiently reveals the innovation methods and their fundamental dynamics (Golichenko, 2016), and it is vital to measure its performance trends to advance its cause. Simultaneously, the governmental organizations have a specific part in planning and implementing strategies to make national innovation systems advanced, vigorous, and maintainable (Lundvall, 1997). Atkinson, Banker, Kaplan and Young (1995) viewed performance measurement as inseparable from the control system, a group of techniques utilized to keep the business in trajectory and accomplish identical objectives.

Recommendations for Sustainable Growth

The study reveals a lot of fixes that go beyond implementing a single strategy to solve the NIS of Sub-Saharan Africa. STISA-2024 will have a positive impact if it is vigorously pursued with determination and steadfastness among other things. Despite, the education system needs to be revisited to ensure academic programs that encourage critical thinking and innovation are implemented. The academic settings of most Sub-Saharan countries only focus more on theory, rather than inculcating practical in the academic settings. STISA-2024 should have funds readily available to support research and development and important innovation projects or ideas of

innovation presented by the students in higher education to complement the efforts of students in science, technology engineering and mathematics. The economic importance of knowledge cannot be underestimated, especially when it comes to innovation. The use of systems approach should be encouraged by policy makers and knowledge generation should be facilitated by investing heavily in research and development.

The situation of Sub-Saharan African Countries is unique because they are catch-up economies. The income level in the region is much lower, and less innovative knowledge is accumulated by the countries in Sub Saharan Africa. However, Sub-Saharan African countries have exceptionally elevated vitality due to their young population. Countries in Sub-Saharan Africa will have to plan a pathway to facilitate the potential of employment in their national policies for economic growth. This could be done by encouraging industrial development through foreign direct investment. Foreign direct investments in the catch-up economies can play a much more important role in helping industrialization in these nations. Industrialization should help increase innovation and employment in the region. As revealed in the results of the research, LF is one of the least impactful independent variables and this is mainly due to the high unemployment and lack of skills in the region. Foreign direct investment will help train the work force and improve the skills of the citizens of Sub-Saharan Africa and in the process improve innovation and create employment.

The unemployment situation in Sub-Saharan Africa is becoming a global dilemma. It has led many youths into clandestine immigration and thousands of lives have been lost at sea or in the Sahara Desert. Most European countries such as Germany, Italy and Spain have been receiving a lot of these youths as illegal immigrants. The dilemma is that struggling hordes of African youths and employment seekers will continue to migrate in large groups to advanced

nations in search of a better life. It would be hard for the world to accomplish global sustainable development with a large segment of youths in Sub-Saharan Africa alienated and unemployed. The advanced nations should help design a pathway to help fight unemployment in the region instead of frequently giving aid to these countries which are usually mismanaged due to high level corruption. Helping these countries fight unemployment will reduce illegal migration and risky ventures to Europe and elsewhere in search of greener pastures.

NIS is amid the most important paths for organizations and countries to stay viable and adhere to a sustainable growth path. The position of knowledge in producing economic improvement should be emphasized and gradually strengthened. For the governments of the region to be more effective, the capacity to create innovative learning should be encouraged and a knowledge-based system of innovation should be implemented, and the presence of dynamic knowledge by all performers of the NIS should be diversified. Organizations are vital players in the NIS, and it is imperative for them to sustain lasting capacity to learn and transform in order to endure and grow. The growth of the knowledge capability is mainly vital for the catch-up countries to help them obtain new technology from more advanced nations in order to learn, modernize and utilize innovative technologies effectively. When new knowledge is learned and diffused, the catch-up countries can step up their development by embarking on industrially new intricate endeavors to improve their organizational capabilities. The lack of organizational and administrative skills is amongst the extremely significant hurdles of growth in the catch-up countries, especially those in Sub-Saharan Africa. Countries in the region should similarly choose to concentrate on the ability to learn and take advantage of the technological innovations at their disposal to improve economically and technologically.

The study reveals that the private sector in Sub-Saharan Africa is weak while

governments are highly effective and play a major role in the economic setup. For meaningful development to take place in Sub-Saharan Africa, the policy makers should create policies that are business friendly in order to attract private investors in the region. Private sector businesses together with the governments should create a hybrid economy in which both would play significant roles to advance economically and solve the current issues facing the region. Government cannot do it all, because other actors in the economy like the private sector and not for profit organizations have contributions to make. The private sector can only be effective if there are policies to facilitate a friendly business atmosphere. The private sector business should support the goal of STISA-2024 by employing and training the graduates in productive innovation and improving the NIS as a result.

The lack of a peaceful business environment in most Sub-Saharan African countries has been limiting foreign direct investment in the region in addition to inequality, poverty, insurgencies and terrorist activities. The governments in the region should be more proactive in ensuring there is political stability by creating social programs for the youths where they can learn survival skills and innovative trades and techniques that can benefit them financially. The academic system should be decentralized should that the youths can learn other academic disciplines that are complimentary to economic and social development.

Limitations of the Study

The limitations of the research include the unavailability of data for some of the countries in Sub-Saharan Africa in order to conduct an accurate and complete secondary data analysis of all the countries. Countries with incomplete data sets relative to the variables of interest were not part of the analysis. It is demanding to have a reliable monitoring and evaluation framework in Sub-Saharan Africa due to the low participation and capabilities of most countries (African

Union Commission, 2014). It is also difficult for most countries to tender reliable data to measure their innovation systems (African Union Commission, 2014). They revealed some gaps that need to be explored for further research. For example, the research revealed a strong government and weak private sector revealed in the LF. Further research needs to be done to determine why governments are most effective while the private sector is weak. Another gap shown in the study is the fact that GDP and GNI are always impacted in similar ways, but the research revealed otherwise indicating that aid or other factors are inflating the GNI of the Sub-Saharan African countries. What factors are inflating the GNI in certain Sub-Saharan countries? Is it the illegal drug trade by cartels in North America that are finding their way in the region or is it the aid coming from the developed countries. Recently we have seen an increase in billions of dollars' worth of cocaine seized in the region and the dynamics of the results reveal incomes that are covert causing a huge difference between GDP and GNI.

Conclusion

The region of Sub-Saharan Africa has very valuable natural resources, yet it is the poorest region in the world in terms of income per capita. As revealed in the study, so far STISA-2024 has not significantly impacted the region since its implementation. Even though STISA-2024 is a universal policy, it is not embraced in all the countries due to poor academic settings. The region should form a union or federal alliance to face the current global challenges. The xenophobia in the region is as a result of the poor leadership in the least developed countries whose citizens have been migrating to other more developed countries in the region. This can be a huge problem going forward because it can lead to political upheaval in the region. The unity of Sub-Saharan African countries can promote trade between the countries and facilitate

travelling within the region. Countries will also be able to share ideas and institutions, governments and businesses will be able to collaborate for the betterment of the region.

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