

University-Industry-Government Interaction: Drivers  
for Innovation in Nigeria

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## **Abstract**

This study examines the University-Industry-Government (UIG) collaboration as a potential driver for innovation in Nigeria. While Nelson and Rosenberg (1993), Freeman and Soete (1997) and Lundvall (1998) acknowledge the roles of innovation in economic development, Wallin et al. (2014) and Ankrah and Omar (2015) note that University-Industry-Government interactions are central to stimulating regional and national economic growth. However, most of these studies focus on developed countries, unlike developing economies like Nigeria, whose institutions are weak occasioned with limited resources (Lehrer, Nell and Gärber, 2009; Datta and Souleh, 2018). This study, therefore, draws on the various theories of innovations such as National Systems of Innovation (NIS), National Innovative Capacity (NIC) and Triple Helix Model (THM) to examine the trilateral interaction in Nigeria based on three parameters, including channels of interaction, developmental stages of the Triple Helix and inhibiting factors. The study is based on a qualitative approach using semi-structured interviews from 28 participants drawn from 6 universities - one each from the 6 geo-political zones in Nigeria, 12 knowledge-intensive companies and 10 government organisations. Findings from this study indicate heterogeneity in the level of interactions between the UIG components. For the channels of interaction, inter-organisational human capital mobility, facility sharing, and contract and consultancy are strong, whereas joint curricula design is weak. While internal transformation and role talking, the influence of each helix on the other, and the creation of a new overlay of communication are strong, and the recursive effect is weak. The results also identified social and institutional factors inhibiting UIG interactions. The study concludes that despite the tremendous effort of the government and the considerable transformation within each institutional sphere, many factors are inhibiting the effectiveness of the UIG in Nigeria. Consequently, the theories of innovation developed in advanced countries have limited application in Nigeria, resulting in a gap between the science system and the technological sub-system.

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## List of Abbreviations

ABU	Ahmadu Bello University
ASUU	Academic Staff Union of Universities
ATBU	Abubakar Tafawa Balewa University
BOI	Bank of Industry
DFRRI	Directorate of Food, Road and Rural Infrastructure
E U	European Union
ECA	Excess Crude Account
ECOWAS	Economic Community of West African States
EFCC	Economic and Financial Crimes Commission
FGN	Federal Government of Nigeria
FMCDE	Federal Ministry of Communication and Digital Economy
FMST	Federal Ministry of Science and Technology
GDP	Gross Domestic Product
GEF	Graduate Entrepreneurship Fund
GERD	Global Expenditure on Research and Development
HEI	Higher Education Institutions
ICPC	Independent Corrupt Practices and other Offences Related Commission
IDC	Industrial Development Centres
IGDA	International Game Development Agency
IIT	Indian Institute of Technology
IMF	International Monetary Fund
IPTTO	Intellectual Property and Technology Transfer
LECON	Office Leasing Company of Nigeria Limited
MAN	Manufacturers Association of Nigeria Ministries,
MDA	Departments and Agencies Massachusetts Institute
MIT	of Technology
NACD	Nigerian Agricultural and Cooperative Bank
NACETEM	National Centre for Technology Management
NASNI	National Agency for Science and Technology Infrastructure
NASRDA	National Space Research and Development Agency
NBCI	Nigerian Bank for Commerce and Industry
NBS	National Bureau of Statistics
NBTI	National Board for Technology Incubation
NCSIR	National Council for Science and Industrial Research
NCST	National Council for Science and Technology
NDE	National Directorate of Employment
NEEDS	National Economic Empowerment and Development Strategy
NEITI	Nigerian Extractive Industries and Transparency International
NEP	Nigerian Enterprise Promotion
NEP	Nigerian Enterprise Promotion
NERFUND	National Economic Reconstruction Fund
NGO	Non-Governmental Organisation
NIC	National Innovation Capacity

NIDB	Nigerian Industrial Development Bank
NIS	National Innovation System
NISER	Nigerian Institute for Social and Economic Research
NITDA	National Information Technology Development Agency
NOTAP	National Office for Technology Acquisition and Promotion
NPC	National Planning Commission
NPST	National Policy on Science and Technology
NRIF	National Research Innovation Fund
OECD	Organisations for Economic Cooperation and Development
OIIE	Office for Information Communication Technology Entrepreneurship
OPEC	Organisation for Petroleum Exporting
SAP	Countries Structural Adjustment Program
SBIR	Small Business Innovation Research
SIWES	Student Industrial Work Experience Scheme
SME	Small and Medium Enterprise
SMEDAN	Small and Medium Enterprise Development Commission
STEM	Science Technology Engineering and Mathematics
STI	Science Technology and Innovation
SWF	Sovereign Wealth Fund
TETFUND	Tertiary Education Trust Fund
TSA	Treasury Single Account
UI	University of Ibadan
UN	United Nations
UNIDO	United Nations Industrial Development Organisation
UNN	University of Nsukka
WAIFOR	West African Institute for Oil Palm Research
WEF	World Economic Forum
YES	Youth Entrepreneurship Support

### **Dedication**

In the memory of my beloved dad, I dedicate this thesis to my parents, Wali Kyari Shettima and Ya Halima. I hope that this achievement will fulfil the dream you envisioned for me when you invested so much in my education over the years. I forever remain grateful for the unconditional love, guidance, support, and prayers you have given to me.

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## **CHAPTER ONE**

### **1 INTRODUCTION:**

The previous chapter focused on Nigeria's country profile and the various policies and institutional frameworks for industrialisation including the critical roles Science, Technology, and Innovation (STI) played in the Nigerian innovation system. The chapter also identified and discussed the critical national factors inhibiting the Nigerian innovation systems. This chapter reviews the extant literature on University-Industry-Government collaboration (UIG) including the various theories of innovation embedded in the UIG interaction. The chapter metamorphosed into a conceptual framework based on which data was collected, analysed, and discussed.

#### **1.1 BACKGROUND OF THE STUDY**

Universities-Industry-Government (UIG) plays a critical role in knowledge creation and its deployment to the benefit of society at large. UIG collaboration refers to the interaction between higher education and industry seeking to promote knowledge and technology exchange (Ankrah and Omar, 2015). Scholars have devoted a substantial amount of research examining how the interaction can bring about innovation and competitiveness in a country or region (Cooke, 2001). As this interaction grows across the globe intensively, the volume of such cooperation to re-ignite innovation and produce broader social and economic development has been acknowledged by many scholars (Cooke, 2001; Leydesdoff, 1995). The increase in the intensity of UIG collaboration has been attributed to pressure on both universities and industry (Ankrah and Omar, 2015). The pressure on all stakeholders of the UIG includes globalisation, rapid technological change, fierce international competition, and the creation of new knowledge (Ankrah and Omar, 2015).

A substantial amount of research recognises that UIG collaboration has a significant place allowing firms to develop and rejuvenate their knowledge base and take advantage of scientific knowledge and novel ideas (Archibugi, Filippetti and Frenz, 2013). Forming these relationships enables companies of valuable external knowledge, which in combination with firm internal knowledge may significantly improve the likelihood of producing innovation (Leiponen and Helfat, 2010). Some scholars have conceptualised UIG interaction as having three main phases: drivers of interaction, channels of interaction, and the perceived benefits from collaboration (De Fuentes and Dutrénit, 2012). The three stakeholders engaged in this collaborative relationship differ in their motivations and behaviours during the collaboration process (De Fuentes and Dutrénit, 2012). This collaboration is embedded within various theoretical frameworks such as the National Systems of Innovation, (NIS) National Innovative Capacity, (NIC) Triple Helix Model, (THM) Mode 1, and Mode 2.

The National Systems of Innovation (NIS) concept had its origins by the end of the 1980s and middle of the 1990s (Freeman 1987, 1988; Lundvall 1988, 1992a; Nelson 1988, 1992, 1993; Pelikan 1988). The collaboration between Chris Freeman, Richard Nelson, and Bent-Åke Lundvall in the International Federation of Institutes for Advanced Study (IFIAS) project was crucial for developing the concept. Yet, the concept could not have been developed without a new notion of firms and innovation, thus positioning itself immediately within the evolutionary tradition. The precise definition of the term ‘national innovation systems’ remains unclear (Edquist, 2005; Mowery and Sampat, 2005).

Nonetheless, scholars commonly describe the ‘national systems of innovation’ as the institutions or the actors and relations between them, which affect the creation, development, and diffusion of innovations. This systemic approach to innovation has developed over the past two decades, and at present, it consists of various branches (Boden *et al.*, 2004). The present’ systems of innovation’ can be described within several parameters apart from a national level, including regional, sectoral, and technological, depending on the chosen level of analysis. In other literature, it is argued that the NSI is constituted of three different aspects: the institutional (or the components of the systems), the structural (related to the structure of the systems) and the cultural/ideological (Boden *et al.*, 2004). The fundamental supposition behind NSI is that it prescribes a division of labour for actors involved in the innovation process. It is the role of firms to convert ideas and inventions to innovation. Government plays a supporting role by formulating appropriate industry and technology policies and providing funds for research. The higher education sector plays a critical role in educating and training people (Saad, Guermat and Brodie, 2015; Datta, Saad and Sarpong, 2019).

National Innovation Capacity (NIC) is a framework based on a combination of three different theoretical models. These are the ‘Endogenous Growth’ theory (Romer, 1990; Nelson and Romer, 1996), the concept of NSI (Freeman, 1995; Lundvall, 1992; Nelson, 1993) and Cluster-Based Theory (Cooke and Huggins, 2018; Porter, 1998). NIC stipulates that a country’s possibility to create commercially relevant innovations is supported by various factors, including human capital and financial resources available for R&D activity, level of technology sophistication, intellectual property protection, and related and supporting industries (Furman, Porter and Stern, 2002). NIC underscores the prominence of skilled labour that can carry out R&D activities. Its emphases on investment in education and training are crucial factors of a nation’s innovative capacity.

Furthermore, the Triple Helix is a theory propounded by Etzkowitz and Leidesdorff (1995) to study the UIG collaboration, emphasising an intersection and overlapping responsibilities among the UIG stakeholders. The model highlights the leading roles of universities in enhancing innovation and

economic growth through knowledge exchange among the institutional spheres (Ankrah and Omar, 2015). Additionally, UIG collaborative knowledge production has also been analysed from the theoretical lenses of Mode 1 and Mode 2. Mode 1 knowledge production presupposes that knowledge production is motivated by scientific knowledge alone (basic research), which is not primarily concerned with the applicability of its findings (Nowotny, 2003). Mode 1 is founded on a conceptualisation of science as separated into discrete disciplines. Mode 2 knowledge presupposes application context; within a trans-disciplinarity, heterogeneity and organisational diversity; social accountability and reflexivity (Nowotny, 2003).

Nevertheless, previous studies on UIG collaboration have predominantly focused on the practices and experiences of developed and industrialised economies, mainly the United Kingdom (UK), the United States (US) and the Organisation of Economic Cooperation and Development. (OECD) countries (Lehrer, Nell and Gärber, 2009; Ankrah and Omar, 2015). There is also evolving literature that focuses on emerging economies such as South-East Asia (Win, 2004; Woolgar, 2007; and Africa, especially those from Sub-Saharan Africa (Lee and Win, 2004; Woolgar, 2007; Adeoti, 2009). However, the approaches and policies in many emerging countries, especially those from Africa, including Nigeria, appeared to be imitative of the developed countries (Sepulveda, 2008; Saad and Zawdie, 2005) without fully grasping the peculiarities and complexities in the context of the low and middle-income countries (Adeoti, 2009). For instance, there is a noticeable discrepancy in the institutional practices, interactive capabilities, resource constraints (Datta and Souleh, 2018) among the UIGs in most developing countries than those in developed countries (Etzkowitz and Dzisah, 2007; Adeoti, 2009).

Additionally, there are variations in knowledge and how it is accumulated and applied to solve societal challenges among countries. These variances can be ascribed to the strength and depth of their institutional structures. Therefore, within the Nigerian context, a new conceptual model is required to extend the understanding of the interaction, taking into consideration the organisational practices and capabilities of the UIG. This thesis will develop a comprehensive conceptual framework to study the interaction among the UIG. The conceptual framework will be applied to assess the collaboration based on four interaction channels, four developmental stages of the Triple Helix theoretical model and identify the factors impeding the interaction.

## **1.2 Importance of the Research Topic**

The relevance of academia-industry interactions to technological progress and economic development, especially in terms of stimulating technological advancement in the private sector, promoting industrial competitiveness, and encouraging the generation of new products,



processes, and services, should be of interest to emerging and developing economies (Siyabola *et al.*, 2012). Like many developing countries, Nigeria still struggles to create strong interactions between NIS elements and cope with the rising globalisation and market competition (Siyabola *et al.*, 2012). With about 200 million people and about 60-70 % living below the poverty line, coupled with impoverished infrastructural amenities and a weak industrial base, the pursuit for full-fledged UIG interactions to drive all the sectors of the economy is of strategic importance in Nigeria. Moreover, despite the Science, Technology, and Innovation (STI) Policy and the knowledge infrastructure comprising 170 universities, 128 polytechnics and 177 colleges of education (NUC 2019) in Nigeria, the institutional spheres are yet to leverage these infrastructures and demonstrate the capacity to create jobs and contribute to the economy (Joshua, Azuh and Olanrewaju, 2015). This has resulted in low-quality research and universities producing graduates that cannot fit into labour demand in the industry, thus creating a gap between what is taught in the universities and the skills needed to support the UIG interaction and stimulate an innovation-driven economy. Therefore, this research bridges this gap by developing a conceptual framework to examine the effectiveness of the UIG collaboration in Nigeria. Therefore, this research is undertaken to contribute to the body of literature and knowledge on this subject in developing countries, taking Nigeria as a case country. Furthermore, in addition to the academic significance mentioned above, this research will be of tremendous benefit to Nigeria as the country struggling to diversify its economy away from depending on oil as its primary source of foreign exchange revenue.

### **1.3 Research Aim**

The study aimed to understand better the effectiveness of the UIG interaction in Nigeria, particularly in the knowledge-intensive firms and STEM-related areas in the universities. This has been made possible by developing a conceptual framework identifying the critical channels of UIG and scrutinising to what extent the existing theories of innovation can be applied to explain the phenomenon of UIG linkages in developing countries, taking the case study of Nigeria. This thesis effectively contends that the existing theories of innovation explaining the UIG interactions, i.e., NIS, THM, NIC being developed in industrialised countries, have some limitations in describing the institutional linkages in Nigeria. Deriving from this study, the thesis also extended the understating of the factors inhibiting the collaboration within the Nigerian context.

The aim of the thesis is achieved through the following objectives:

### **1.4 Research Objectives**

- 1) To examine the critical national factors inhibiting the effectiveness of UIG interaction in Nigeria.
- 2) To critically examine the UIG literature in order to identify and discuss the key theories of innovation, channels of interaction, enablers, and inhibitors of the collaborations.
- 3) To develop a conceptual framework from a critical and analytical review of the literature
- 4) To develop and evaluate a revised conceptual framework following an in-depth analysis of the fieldwork data and make a significant contribution to existing knowledge on UIG interactions.
- 5) To develop recommendations for the institutional spheres on measures to stimulate the UIG collaboration in Nigeria.

### **1.5 Research Question**

Given the above aim, the research question is:

What is the nature of the University-Industry-Government (UIG) interaction in Nigeria, and what constitutes the inhibiting factors of such collaboration?

### **1.6 Research Context**

The study was undertaken as part of a deductive, multiple case study strategy in 10 government agencies, 12 companies and 6 universities. The government agencies are responsible for collaborative research, knowledge creation, and regulation of the Nigerian economy's science and ICT sectors. The companies are domestic knowledge-intensive firms focused on software and hardware development. One of the motivations for undertaking this research is the desire to answer the broad question of how University-Industry-Government interaction can promote social and economic development in Nigeria. This question mainly originated from the researcher's desire to create more jobs and achieve economic independence for Nigerians, especially the researcher's region that has been devastated by the Boko Haram insurgency.

### **1.7 Structure of the Thesis**

The research is organised in chapters with subsections falling under them.

#### **Chapter one: Introduction**

Chapter one of this thesis covers the introduction, statement of the problem, importance of the research study, research objective research aim, research questions, and the context of the research study. This chapter helps in providing the preliminary background and clarify the context of the research.

## **Chapter two: Overview of the Nigerian Economy**

Chapter two covers the overview of the economy with various current and previous industrial policies and identifies the national factors inhibiting the UIG collaboration in Nigeria. These national factors helped in designing the conceptual framework

## **Chapter three**

This chapter critically analyses University-Industry-Government (UIG) literature and discusses the key theories innovations embedded in the UIG interactions. The chapter helped in identifying the key channels of interactions, enablers, and inhibitors of the collaboration culminating in designing a conceptual framework.

## **Chapter four**

Chapter five analyses the research methodology and design for the study, including methods of data collection and the use of thematic analysis for analysing the data.

## **Chapter Five and Six**

Chapters Five and Six present the findings from the semi-structured interviews for the studies. Chapter Five presents the findings on the four channels of UIG interaction, while chapter Six presents the findings on the four developmental stages of the Triple Helix development and the practical inhibitors of the UIG collaboration in Nigeria.

## **Chapter Seven**

Chapter Seven presents the Cross-case analysis and discussions of the main findings highlighting the congruencies and incongruencies between the theories and practice. The chapter metamorphosed into an evaluated conceptual framework.

## **Chapter Nine**

Finally, Chapter Eight presents the summary of findings, contributions to knowledge and recommendation for each institutional sphere. The chapter provided a limitation of the studies and recommendations for future areas for studies.

## 2 CHAPTER -TWO

The previous chapter highlights the overview of the research including the aim, objective, research question and the overall structure of the thesis. This chapter presents the structure of the Nigerian economy, and the various attempts to leapfrog the country into industrialised economy. The chapter showed how the Nigerian government also attempted to promote University-Industry-Government collaboration using the various Science Technology and Innovation (STI) policies. The chapter followed on to identify the national factors impeding the UIG collaboration which form part of the components of the development of a conceptual framework.

### 2.1 THE NIGERIAN CONTEXT

Nigeria is the most populous country in Africa, with a population of about 200 million comprising of about 350 diverse ethnic groups over 500 languages (Falola and Heaton, 2008). Nigeria occupies a landmass of 934,000 square in Sub-Saharan Africa (NPE 2013, Falola and Heaton, 2008). The country accounts for 47% of the West African population and has a rapid population growth rate of 2.76% as of 2017. Among the ten most populous nations worldwide, Nigeria is one of the fastest-growing countries. Thus, the population of Nigeria, presently the world's 7th largest, is predicted to exceed that of the United States and become the third-largest nation in the world shortly before 2050 (UN, 2017). Nigeria comprises 36 states, and it has a diverse cultural and ethnic society. Figure 2.1 below indicates the composition of the 36 states of the Federation and the Federal Capital Territory (FCT) Abuj

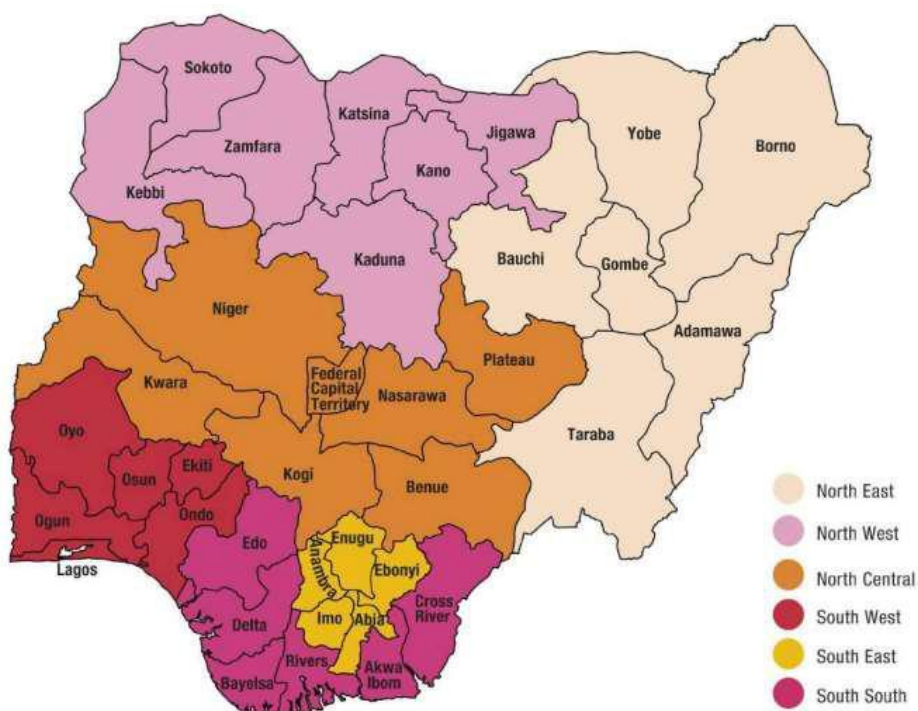


Figure 2: 1 Map of Nigeria; Source: (WHO, 2002)

Nigeria has a border with Cameroon to the East, the Niger Republic to the North, the Republic of Benin to the West, and the Atlantic Ocean to the South. The countries' terrain ranges from coastal swamps and tropical forests in the South to Savannah and semi-desert in the north (Shahaban 2013). Nigeria has ethnic, cultural, and religious diversity. The three largest ethnics groups, which include Hausa-Fulani, Yoruba, and Igbo. These three essential groups embody about 70 per cent of the population (Falola and Heaton, 2008). Nigeria is blessed with a considerable amount of natural gas and other untapped natural resources. The country is ranked the 10th largest crude oil producer globally and has the second-largest oil reserve in Africa after Libya, with an estimated 37 billion barrels of proved oil reserves by the end of 2015 (Shahaban 2013; EIA 2015).

Before discovering crude oil in commercial quantities in 1956, agriculture was the primary source of foreign exchange earnings in Nigeria. The country was well-known for its agrarian economy. Cash crops like palm produce, cocoa, rubber, timber, and groundnuts, were exported, thus making Nigeria a vital exporter of these products. After discovering oil and the subsequent oil boom in the international market in the 1970s, the oil sector dominated the economy. Agriculture and other industries that hitherto contributed to the economy were neglected. Nigeria has experienced constant political instability, bad governance, inadequate infrastructure, and macroeconomic mismanagement. The country is considered to have the potential to be one of the leading players in the world economy due to its considerable human and natural resources; however, this potential has remained unfulfilled over the years (Sanusi, 2012). After neglecting agriculture in favour of oil, the growth trajectory in the country has been propelled by the oil sector for decades. Earlier fiscal policies left the nation unprepared for the downfall of crude oil prices and production. The economy is still dependent on the importation of vital resources like foods and other manufactured goods. Oil accounts for more than 90% of Nigeria's exports, and the manufacturing sector account for a very insignificant percentage of the economy (Pagaragha, 2017).

## **2.2 Nigeria's Industrial Structures and Policies**

After Nigeria's independence in 1960, successive administrations had a desire to establish a robust manufacturing sector. But economic growth through an industrial production system has continued to be the major challenge in Nigeria. Various trade policies have been introduced to promote industrial development, but the trade policies have witnessed swings from protection a few years after independence to a more liberal position (Briggs, 2007). Nigeria adopted and applied different tariff regimes to raise fiscal revenue and limit imports to safeguard and protect the indigenous industries from competition. Several forms of non-tariff barriers such as quotas, prohibitions and licensing schemes have also been used to restrict the importation of foreign manufactured goods.

The country has also made several attempts to implement trade policies and encourage domestically manufactured products for export and increase the linkages in the domestic economy. The nation has made efforts to improve and stabilise foreign exchange revenue and to reduce the country's dependence on the oil sector. According to Bankole and Bankole (2004), Trade policies discouraged dumping: - aided import substitution and restricted undesirable activities in the balance of payments to protect foreign earnings and generate government revenue. However, it appears as if no policy had provided an adequate solution to the challenges faced by the nation's industries. This challenge has raised some suspicion that as the various governments have introduced new development plans, the country has moved further away from industrialisation (Iwuagwu, 2011).

### **2.2.1 Post-colonial Era**

Nigeria introduced the first National Development Plan 1962 to 1968, and the primary function was the Import-Substitution Industrialisation Strategy. At the macro level, the objective of the plan was to ensure an economic growth rate of 4.0% per annum and achieve economic take-off by the year 1980 (Ejumudo, 2013). The policy strongly emphasised the health care system, education, employment generation, and the fair and equitable distribution of resources to promote macroeconomic stability. The development plan intended to achieve these goals by encouraging entrepreneurship development and private sector participation. This plan similarly highlighted the need for agriculture and workforce development (Ibietan and Ekhosuehi, 2013; Okejiri, 2000). The primary goal of this strategy was to encourage the start-up and development of industries and improve home-grown involvement by changing the ownership structure and management of enterprises. However, many challenges pervaded the strategies, and the desired positive result was not achieved due to the high degree of technological dependence on foreign companies, which mainly were monopolist or oligopolistic producers (multinational enterprises or affiliates), either under the foreign or expatriate ownership and with considerable expatriate technical and managerial domination

### **2.2.2 The Oil Boom Era**

During the oil boom era, the Second National Development Plan (1970-74); was introduced, which tried to address the challenges experienced in the Import Substitution Strategy adopted in the First Development Plan. The Second Plan coincided with the time Nigeria joined the status of a petroleum-producing country. As the Nigerian economy gained a substantial influx of foreign exchange earnings, the government incorporated robust and expensive industrial projects in specific segments of the economy, including steel, iron salt and fertiliser pulp and

paper (Ibietan and Ekhosuehi, 2013). In 1967, Nigeria had a civil war, and this Development Plan coincided with the post-civil war efforts made by the government. It was introduced to rebuild and rehabilitate the structures that were destroyed during the civil war. It also aimed to resettle displaced persons, reintegrate the demobilised soldiers, and create economic growth and employment opportunities. However, it failed to achieve the desired objective, which led to the introduction of the Third National Development Plan was developed between (1975 and 1980). The Third Developmental Plan was a long-term plan intended to increase per capita income, reduce unemployment, and promote the equal distribution of resources among all the regions. It also aimed to increase the supply of a skilled workforce and encourage the diversification of the economy and the indigenisation of economic activities (Briggs, 2007). The Development Plan was considered to have made some specific achievements. For instance, GDP grew at an average rate of 5% per annum; the manufacturing sector saw the fastest growth with an average of 18.1% per annum; building and construction grew at 13.9%; Government services rose to 17.7%, and other services grew at 15.7%. However, this time around, the agricultural sector experienced negative growth by 21% per annum (Ibietan and Ekhosuehi, 2013).

These challenges faced in the Third Development Plan paved the way for introducing the Fourth National Development Plan (1981-85), which coincided with the global economic meltdown. Nigeria began to experience a problematic fiscal situation due to the sharp decline in the output of petroleum products, which later resulted in lowering Nigeria's OPEC quota in the early 1980s. Other issues that exacerbated the situation were the growing and ill-directed government expenditure during the 1970s, the neglect of the agricultural sector, and inward-looking industrial policies. The fall in oil export revenues precipitated a sharp decline in the nation's public finances and balance of payments. This situation led to recession and economical corrosion, as demonstrated by the fiscal crisis, foreign exchange shortage, the balance of payments and debt crisis, a high rate of unemployment, and negative economic growth (NACETEM 2008). Many factories were closing, and staff were being laid off all over the country. The manufacturing companies began to decay due to numerous challenges, including low-capacity utilisation, unstable electricity infrastructure, the high cost of doing business, and the absence of start-up venture capital. There was a need to adjust to the structural imbalances and external shocks. The government then decided to adopt the Structural Adjustment Policy in 1986.

### **2.2.3 Structural Adjustment Programme (SAP)**

Structural Adjustment Programme (SAP) was adopted due to the need to diversify and restructure the economy and move away from depending on the oil, carry out the stability of payments viability over the medium term, promote non-inflationary economic growth. The SAP policy and other associated strategies, in general, have been pursued with various implementation strategies. The government was concerned about the unintended consequences brought about by this plan. Therefore, it decided to bring relief by setting up the National Directorate of Employment (NDE) in 1986. The Urban Mass Transit Programme in 1988, and various Community banks in 1989/90. Other institutions that were created to improve the suffering of the people included the Directorate of Food, Road and Rural Infrastructure (DFRRI) in 1986; a reflationary budget package in 1988; the 1991/1992 relief package for public sector officers; the reform of the civil service; and the Better Life for Rural Dwellers' program in 1989 (NACETEM 2008).

Additionally, the Nigerian government formulated the National Science and Technology (S&T) Policy. It launched in 1986 to promote research and development to encourage innovation and translate research into products to attract a market and boost competitiveness. (This policy will be discussed in detail in sections 2.4.1). The National Economic Reconstruction Fund (NERFUND) was set up in 1989 to complement the other existing industrial policies. NERFUND was set up due to the financial constraints experienced by the SMEs entrepreneurs. It was aimed to provide them with essential business resources and loans over a repayment period of five to ten years. Another measure was the establishment of the Bank of Industry (BOI) set up in 2000. The bank was introduced to accelerate industrial advances by providing long-term loans, equity finances and technical assistance. The bank was made up of the following institutions: Since the transition to democracy in 1999, many other policy initiatives have also been introduced to promote industrialisation in Nigeria. Some strategies include the National Economic Empowerment and Development Strategy (NEEDS) 1999-2007, Vision 20:2020, The Seven Point Agenda, 2007-2011, The Transformation Agenda 2011-2015. The NEEDS framework considered Science Technology and Innovation (STI) one of the drivers behind the economic development and diversification strategy. Similarly, Vision 20: 2020 ponders the essentials of STI in critical sectors of the economy. Those sectors include biotechnology, nanotechnology, renewable energy, venture capital, space research, small- and medium-scale. Industry targeted research, knowledge-intensive new and advanced materials, STI information management, information and communication technology, intellectual property rights etc. (Chete et al., 2014).



#### **2.2.4 National Economic Empowerment and Development Strategy (NEEDS)**

As outlined in the NEEDS document, the policy was intended to attract the competitiveness of domestic industries. The policy seeks to encourage local value-added business and diversify the export base of the economy. NEEDS attempts to rigorously pursue the industrial integration of the Nigerian market to the rest of the world and exploit the advantages of strategic alliance (Briggs, 2007). The document first emphasised the regional integration of trade to raise the industrial competitiveness and efficiency of the indigenous firms. The trade policy under NEEDS aims to reduce unpredictable environments and uncertainty in trading activities. The policy also seeks to streamline and harmonise trade practices in the West African Economic Community of West Africa (ECOWAS) nations and enable complete integration. In pursuing these objectives, the Federal Government encouraged the states and local governments to adopt the NEEDS document to suit its peculiar purposes. Accordingly, the equivalent of NEEDS in the states is called SEEDS, while in the local governments, they go by the acronym LEEDS. However, Adeoti (2005) notes that the widely acknowledged economic blueprint identified that the National Economic Empowerment and Development Strategy (NEEDS) was poorly comprehended because the sectoral innovation systems in information technology and biotechnology were weak and lacked adequate resources.

#### **2.2.5 Vision 20:2020 as an Economic Planning Initiative**

As one of the economic planning strategies, Vision 20:2020 aims to grow its size from its current position to the 20th best-performing economy globally by the year 2020 (NPC 2010). Therefore, to actualise this vision, some sets of objectives were established. Some goals include long-term growth that will propel the country onto sustained economic growth and raise the standard of living of its people. To grow the GDP, making it broad, competitive, and sustainable to the level of other developed countries like the UK, US, France, Germany, Spain, etc. (Eneh, 2011). Some primary goals of the vision listed indicate the priority of the Nigerian government to diversify the economy and make science and technology one of the leading drivers, macroeconomic reform, debt reduction, budget, taxation and public financial management reforms, and counter-cyclical policies such as the Excess Crude Account (ECA) and the Sovereign Wealth Fund (SWF). Economic liberalisation and private sector development, deregulation, and liberalisation of the telecommunications sector, the downstream of the petroleum sector and the power sector; privatisation of state-owned corporations; reforming the banking sector, and trade, tariff, and customs reform regimes. Other includes economic growth: focus on growth drivers such as crude oil, agriculture, natural resources, industry (including Small and Medium-Scale Enterprises), trade and services. However, many scholars have expressed concern over the feasibility, readiness, and infrastructure to achieve these goals (Thomas and Brycz, 2014; Imbua and Ecoma, 2014; Gyang, 2011). Olaseni and Alade (2012) noted that Nigeria's economy is growing slower than previously

envisioned. The authors also showed that the extent and quality of infrastructure required to push a rapid economic development were lacking. To achieve these ambitious objectives, there must be adequate funding in a vital segment of the nation. Olaseni and Alade (2012) concluded that there should be some level of transparency and good governance, population control, and physical planning of settlements, among other things, to realise the vision.

### **2.2.6 National Industrial Revolution Plan 2014.**

In 2014, the Federal Government of Nigeria (FGN) launched another ambitious National Industrial Revolution Plan (2014) to expand the economy and move away from the traditional oil and gas to a manufacturing sector after realising the decline of the manufacturing industry. The Industrial Revolution Plan (2014) was drafted after reviewing and acknowledging the challenges and issues that the previous development plans from the 1950s to 2007 failed to address adequately. According to NIRP (2014), there were considerable gaps in the planning and implementation of the previous development plans. The deficiencies were mainly attributed to the inclusion of the industrial plans within bigger, more general development plans, which may have led to attention from the central objective of pursuing industrialisation becoming less focused. The NIRP 2014 was based on the following themes: Industrialisation, reconstruction and trade development through rapid expansion and diversification of industry. Growing national income from manufacturing, promoting exports, and raising the level of intermediate and capital goods production Promoting indigenous participation through SMEs and increasing the number of large-scale manufacturing outfits. Provision of infrastructure and establishment of training funds, industrial development centres, industrial estates, product development centres, manufacturing companies, etc. Laying a solid foundation for self-reliant industrial development as a key to self-sustaining, dynamic growth by de-emphasising ‘assembly type’ industries and successfully implementing industrial plans with very high linkage effects.

Nevertheless, despite the successive governments’ efforts to launch the various development plans and other strategies, little sustainable growth and industrialisation have been achieved (Ugonna and Onwualu, 2016). Notwithstanding the efforts by the federal government to revamp Nigeria’s economy and place it on the path of development, the country remains mainly underdeveloped and non-industrialised. Nigeria has always been desirous of industrialisation, but it is still battling with the fruitless efforts made toward its actualisation. This forced Nigeria to depend on more developed countries in the West for capital goods, industrial inputs, technology, and liquid capital. This weak capital base has acted as a significant obstacle to the industrialisation process in Nigeria. Available statistics still show that Nigeria has been ranked among the five nations to find the world’s poorest people (Ugonna and Onwualu, 2016). Global competitiveness ranking (Table 2. 1) was 116 out of

144 countries (WEF, 2018). Nigeria’s human development index value in 2018 was 152 out of 157 countries.

*Table 2. 1: Global Competitiveness Index 2019; Source: WEF 2019*

Nigeria - Global Competitiveness Index		
Date	Competitiveness Ranking	Competitiveness Index
2019	116°	48.33
2018	115°	47.53
2017	125°	47.14
2016	124°	49.43
2015	127°	49.11
2014	120°	51.05
2013	115°	52.45
2012	127°	49.22
2011	127°	48.22
2010	99°	52.13
2009	94°	54.47
2008	95°	52.78
2007	95°	51.25

Furthermore, over 60% of Nigerians earn less than one dollar a day (Ugonna and Onwualu, 2016). According to the data from NBS (2016), unemployment and underemployment increased for persons aged from 15-34, which represents the youth population who can make a significant contribution to the economy. Additionally, it was about 25.2% in the fourth quarter of 2016, 25.0% in the third quarter, and 24.0% in the first quarter of 2015. Whereas the underemployment proportion for the same age group enlarged to 36.5% in the first quarter of 2016, the underemployment rate for the same age group rose to 22.1% in Q4 2016 up from 20.8% in Q3, 20.5% in Q2, 19.9% in Q1, and 19.9% in Q4, 2015. Moreover, the Global Competitiveness Report published by the World Economic Forum 2017, as indicated in Figure 2.2 below, shows the aggregated results of 10 years of Nigeria competitiveness index, which assesses 137 items comprising 110 variables.



Figure 2: 2 Nigeria's Competitiveness Index; Source: (WEF 2018)

The data depicts the scorecard and variation in the performance of these variables between 2009 to 2018. The figure shows the declining institutional conditions directly responsible for the low quality of life, low human development, low education, and ultimately low economic progress. In 2009 Nigeria scored the highest position of 3.81 and dropped to as low as 3.3 in 2018. According to the NBS (2016), another issue that raised a serious concern was the rise in the number of people not gainfully employed or underemployed. The data shows that youth unemployment between the ages of 15 to 24 stood at 25.2%, while underemployment for the youth of the same age remained at 36.5%. For people between the ages of 24 to 34, the unemployment rate was 15.4%, while underemployment was at 21.1%. Unemployment for people between the ages of 35 to 44 was at 8.8 per cent while underemployment for people of the same age remained 14.5%. In the same vein, unemployment for the ages of 44 to 54 stood at 8.9, and underemployment was 12.45. The data also showed that the unemployment for people within the age range of 55 and 64 was 9.4, and underemployment at 15.1%. Furthermore, almost all development plans, dreams, and aspirations in various documents have failed to achieve their objectives. Nigerians are still living on less than a dollar per day; unemployment is still rising, and corruption and public fund mismanagement remain pervasive in the economy. Nigeria still battles with insecurity, inefficient representation, religious crises, successionist crisis and Boko Haram terrorism. Moreover, the money flowing from the oil sector does not trickle down to the people or infrastructural development, but to public office holders and politicians amassing wealth and becoming rich while most people wallow in poverty. According to the recent World Poverty Clock 2018, World Data Lab (2020) reports that Nigeria has some people living on less than \$1.90.

## 2.3 The Private Sector in Nigeria

The previous section has demonstrated the historical perspective of the industrialisation strides of the government and their relative failures. This section will illustrate the composition of the Nigerian private sector and how they operate at the macro and micro levels. The private sector in Nigeria covers a wide range of enterprises as categorised by several conditions such as size, industry/sector, ownership structure, employment, and technology. The private sector in Nigeria encompasses a sizeable informal section and a relatively small formal component, and most firms prefer to remain informal. The manufacturing industry is represented by the Manufacturers Association of Nigeria (MAN) and several sectoral associations. The Nigerian private sector is made up of 13 diverse activities. Figure 2.3 shows the various divisions within the industrial sector.

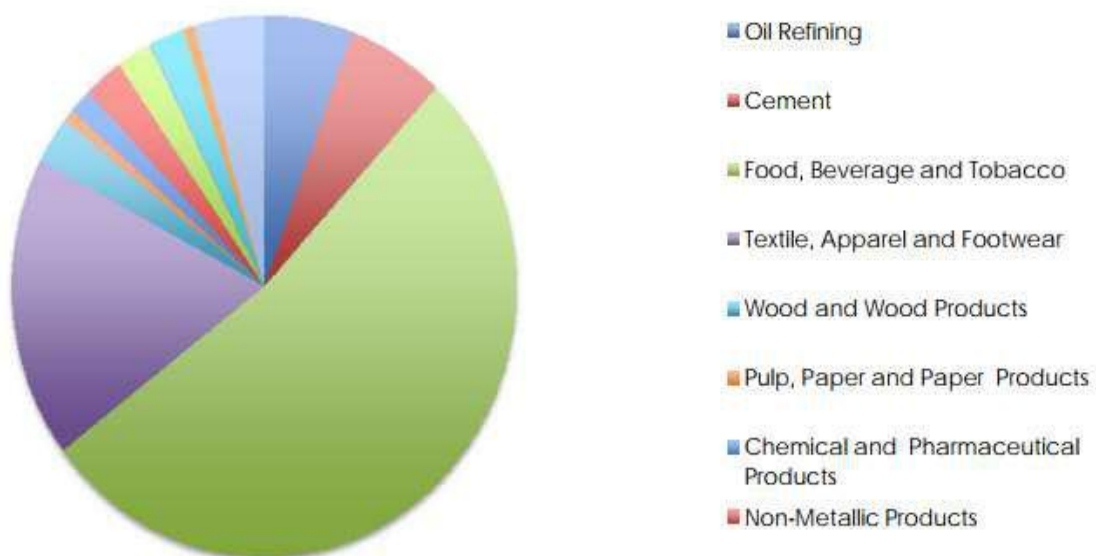


Figure 2: 3 Compositions of the Private Sector in Nigeria; Source: (NBC 2014)

The thirteen activities in the Manufacturing sector consist of Oil Refining; Cement; Food, Beverages and Tobacco; Textile, Apparel, and Footwear; Wood and Wood Products; Pulp Paper and Paper Products; Chemical and Pharmaceutical products; Non-metallic Products, Plastic and Rubber products; Electrical and Electronic, Basic Metal and Iron and Steel; Motor Vehicles and Assembly; and Other Manufacturing.

### 2.3.1 Small, Micro and Medium-scale Enterprises in Nigeria

Small Micro and Medium-scale enterprises (SMEs) play a vital role in economic growth and development worldwide. SMEs are a critical foundation in encouraging private sector development and enterprise formation in developed and developing countries (Apulu and Ige, 2011). SMEs create employment opportunities and influence the growth of innovation and product development.

They also help accelerate industrialisation and increase per capita income (Kuyoro' Shade *et al.*, 2013). According to SMEDAN (2005) and Abdullahi et al. (2015), Microenterprises in Nigeria are described as those firms that have an employment capacity of less than 10 and an income of less than 10 million naira. Small-scale enterprises are firms with ten to forty-nine employees with annual revenue of less than 100 million Naira. While medium-scale enterprises are those firms that have fifty to one hundred and ninety-nine (199) employees with a yearly turnover of 100 million but less than 1 billion Naira. Table 2.2 below depicts the various definitions contained in the SMEDAN document 2005. The table shows the composition and inclusion criteria of SMEs in Nigeria

*Table 2. 2: Composition of SMEs in Nigeria; Source: (SMEDAN 2005)*

S/N	SIZE CATEGORY	EMPLOYMENT	ASSETS (Naira, million) (excluding land and buildings)
1	Micro enterprises	Less than 10	Less than 10
2	Small enterprises	10 - 49	10 - less than 100
3	Medium enterprises	50 - 199	100 - less than 1,000

In Nigeria, SMEs cover economic activities within all sectors of the economy. SMEs are diverse, with some being dynamic, growth-oriented, and innovative while others are not (Abdullahi *et al.*, 2015). Micro, Small and Medium Enterprises (MSMEs) are recognised in the developed nations as the incubators of innovation and foundation of job creation. As Nigeria acclimatises to this situation, the government has introduced specific policies and intervention funds for the development of the MSMEs. With the government's renewed emphasis on diversifying the economy from oil, there has been a clamour for a broad policy that can foster the growth and development of MSMEs. This policy framework becomes more relevant, given that MSMEs are more vulnerable to the adverse and fragile Nigerian economic situation.

### **2.3.2 National Policy on Micro, Small and Medium Enterprises**

In 2007, Nigeria introduced its first National Policy on Micro, Small and Medium Enterprises (MSMEs) through the institution responsible for regulating the MSMEs; Small and Medium Enterprises Development Agency of Nigeria (SMEDAN) and approved by the Federal Executive Council (FEC) 9th May 2007. Nevertheless, the general implementation of the policy was weak and faced many challenges. Some of the problems included the weak stakeholder buy-in (public and private sector institutions), the absence of robust commitment to MSME development by all levels of government and weak institutional interaction. Other problems included insufficient funding of the MSMEs and the inadequate capacity of MSMEs. These challenges led to a policy review in 2012 with the launch of the new National Policy on MSMEs in May 2015. The revised

policy considered a close interaction between the various government institutions and the private sector, including SMEs (MSMEs policy 2012). The system adopted a cluster approach for the growth and development of MSMEs in Nigeria. Universally, the cluster approach has been confirmed to be an efficient way of accomplishing MSMEs and integrating them into a broader national objective. It also serves as a guide to creating a healthy and synergetic ecosystem in which these firms can grow.

#### **2.4 National Innovation System in Nigeria**

The previous sections discussed the overview of the Nigerian economy; this section will discuss the National Innovation policies and identify the difficulties that prevented the policies from achieving the desired results. These difficulties have brought about inhibiting factors for the development of UIG interaction in Nigeria. The productivity of countries worldwide is the primary foundation of cross-country income disparities, and technological change is a driver of productivity and growth. Therefore, technological innovation is a critical component of transformation, industrialisation and catch-up in emerging countries (Fu, Pietrobelli and Soete, 2011). Science and technology are vital to any nation's economic and social development, and what makes the difference between industrialised and unindustrialised countries is the level of technological progress. According to Dorothy (2011), this transformation between the advanced and the less developing countries is ascribed to differences in their various levels of technological development. As discussed in the introduction section of the chapter earlier, industrialisation initiatives in Nigeria date back to the 1950s and 1960s, establishing different development plans by successive administrations. Many policies were implemented to encourage industrialisation by promoting indigenous technology and developing imported technologies. Many of these policies were contained in the various development plans and policy documents, although these Development Plans did not explicitly emphasise the importance of science and technology (Okejiri, 2000; Dutse, 2013).

However, many policies were introduced and implemented to encourage the development and application of science and technology activities. Based on the United Nations Education, Science and Cultural Organisation (UNESCO) initiatives, The National Council for Science, and Industrial Research (NCSIR) was established in 1966, emphasising industrial research to direct the government on S&T activities. In 1969, the institution was replaced by National Council for Science and Technology (NCST). Nigeria began to take the route of technology development with the establishment of technological infrastructure in the 1970s. Moreover, not much emphasis was placed on science and technology in the subsequent development plans. In 1972 the Nigeria Enterprises Promotion (NEP) Act was approved to allow Nigerians

to participate in Tech-based business. Subsequently, the Nigerian business environment improved and attracted a massive inflow of foreign investment. The government also recognised the danger of the unregulated influx of imported technologies and established Decree 70 in 1979. The Decree gave birth to the National Office of Industrial Property (NOIP) establishment, currently known as the National Office for Technology Acquisition and Promotion (NOTAP). In 1979, the Federal Government of Nigeria created the Ministry of Science and Technology. It charged them with the responsibility of giving guidance and direction to the advancement of S&T for socio-economic welfare. The Ministry was instructed to manage and undertake scientific and technological research and development. The gradual development of science and technology gave rise to the Nigerian Science and Technology Policy formation in 1986 by the Federal Ministry of Science and Technology (Sanni et al., 2001). Subsequently, the National Agency for Science and Engineering Infrastructure (NASENI) was also created in 1992. Since then, many policies have been introduced to promote interaction between the federal and national and international firms. This interaction is aimed at encouraging human capital development and technology transfer, empowering small and medium-sized enterprises, engineering materials development, among other things.

#### **2.4.1 Science and Technology Policy 1986**

Before Nigeria's independence in 1960, scientific and technological research were conducted without paying much attention to their commercial benefit and exposing the research output to the international community. The research output was not integrated into broader national objectives to develop the economy (NPST 1996). Most of the scientists were individuals, no emphasis was given to corporate or organisational research, and these individuals concentrated more on the publication of their research than commercialisation. Then the 1986 policy was introduced to integrate the system into a broader national objective; it reads thus: Consequently, numerous institutions and government agencies were established to execute these activities and implement the Science and Technology Policy philosophy. The Ministry also drew a plan, the "Blueprint on Science and Technology", which is a guideline intended to synchronise the pursuit of knowledge and the application of research output to guarantee an improved value of life. The blueprint emphasised a strategy for scientific exploration, exploiting natural resources in Nigeria, and improving the workforce. It also highlighted the development of the scientific and technological base, providing incentives and enough funding for science and technology activities from the public and private sectors. However, the 1986 S&T policy had ignored the commercialisation of research output and gave more prominence to the publication of the results. It also lacked a policy structure to address the weak linkages in the National Innovation



System (NIS). There was also coordination, funding, partnership, and the lack of exploitation of evolving knowledge such as biotechnology, ICT, and nanotechnology in solving societal issues. The STI policy of 1986 was revised in 1997 with an implementation time frame of 25 years, which is to be reviewed every five years. The 1997 Policy went through yet another review in 2003 to incorporate the lapses observed in the implementation process relating to the institutional framework that will promote the interaction among the various elements in the NIS.

#### **2.4.2 Science and Technology Policy 2003**

The Ministry of Science and Technology revised the document to reflect the utilisation of S&T in raising the standard of living of Nigerians in line with the rest of the developed world (FMST 2003). It is in appreciation of the shifting universal scene of S&T that a new policy framework was articulated to inspire creativity and make a link between their talent to the education system and ultimately to the economy and society. It encourages scientists and researchers to link with one another and explore the best opportunities in the country and abroad to improve their competence. It also increases the share of the productive sector in the national effort for scientific and technological development, especially by supporting more significant R&D activities in the production industry. It promotes a robust indigenous capability in the areas of protection of Intellectual Property and rights of access to information, biotechnology and biosafety, environmental control, and the establishment of technical standards in international communication networks (Abdullahi, 2004). Therefore, the revised policy highlighted the need to upgrade the country's technological base and raise domestic ability to produce goods and services in agriculture and rural development, energy, health and environment, food security, biotechnology, ICT, and space exploration (FMST, 2003). However, in 2011, the policy was also revised to integrate innovation, and the name was modified to reflect Science Technology and Innovation Policy.

#### **2.4.3 Science, Technology, and Innovation (STI) Policy 2011**

Science, technology, and Innovation Policy 2011 are the latest National Innovation Policy in Nigeria, which aims to accelerate development, encourage competitiveness, and create wealth for all Nigerians. According to the FMST (2011), this policy is the beginning of implementing the vision 20:2020 Economic Transformation Blueprint (NV20:2020). The policy aims to achieve its strategic objectives based on three fundamental pillars: to improve the sources of economic growth, raise the Nigerian people's productivity and well-being, and finally foster sustainable economic development. The policy was designed in line with the objectives set out by the vision 20:2020 to address the long-standing disconnection between economic planning and science and technology. The policy aims to create a diverse, robust, productive, and competitive economy based on science

and technology to ensure high quality of life for its people. The new policy identified the loopholes in the previous document, which were seen as a significant setback to achieving active innovation systems. Those challenges identified included the lack of coordination within the innovation system and the stand-alone, uncoordinated, and scattered research all over the country. Therefore, the new policy will consider the importance of interaction among the various stakeholders and tie their research agenda to broader national priorities. This will reduce the time to market research activities and encourage smooth and unified interaction among the institutional spheres of the innovation system (FMST 2011).

The STI policy has a vision statement.

"By 2020, Nigeria will have a large, strong, and diversified sustainable and competitive economy that will effectively harness the talents and energies of its people and responsibly exploits its natural endowments to guarantee a high standard of living and quality of life for its citizens" (FMST 2011p4).

The mission also reads thus.

"Evolving a nation that harnesses, develops and utilises ST&I to build a large, strong and diversified, sustainable and competitive economy that guarantees a high standard of living and quality of life for its citizens" (FMST 2011p.4).

Some of the broader objectives of this policy include: -

- To facilitate the acquisition of knowledge, adapt, utilise, and replicate the technologies for the growth of the SMEs, agricultural development, food security, power generation and poverty reduction.
- Support the establishment and strengthening of organisations, institutions and structures for effective coordination and management of ST&I activities within a virile National Innovation Systems.
- Support and promote the creation of innovative enterprise utilising Nigeria's indigenous knowledge and technology to produce marketable goods and services" (FMST 2011 p.5).

The 2011 STI policy has set out ambitious plans and strategies for implementing them. The system aims to achieve these objectives through the relevant institutions within the NIS. Universities, research institutes, and the private sector are the National Innovation System (NIS) principal actors responsible for generating prosperity in a country. The competencies of each stakeholder and the strength of their synergy determine the degree of economic success and global competitiveness. The universities and research organisations create new knowledge

within science and technology domains, while the industry is converting this knowledge into the market to attract value.

## **2.5 Higher Education System in Nigeria**

The previous section highlighted the innovation systems in Nigeria and the various science and technology policies, and initiatives adopted by the government to enhance science and technology in the production of goods and services in the country. One of the critical stakeholders of the innovation system in higher education, especially the universities and the government research institutions. This section will discuss the higher education system in Nigeria and the education policies, including the historical evolution of the education system in Nigeria.

Higher Education in Nigeria dates to the 19th century, introduced by the British colonial government after a national clamour for knowledge institutions. The colonial government established Yaba Higher College in 1932 to deliver well-qualified assistants in medical, engineering, and other vocational training and teachers for high schools, then known as higher middle schools (Okojie 2008). Subsequently, the college began to run sub-degrees in engineering, medicine, agriculture, and teacher training to fill specific vacancies in the colonial administration. Initially, the scope of the college was restricted to offering only a few courses, but due to pressure mounting on the colonial administration, the Elliot Commission was established in 1945 to submit a report on the need to expand the college and develop more universities. In 1948, the University College of Ibadan was established under the guidance of the University of London. To assess the need for additional educational requirements after the proposed independence, another Commission, the Ashby Commission, was established in 1959. In 1960, The University of Nigeria Nsukka was set up as the first indigenous university in Nigeria.

The university system in Nigeria has gone through a historical evolution since independence in the 1960s. The conclusions of the Ashby Commission 1959 concerning the availability of the universities in the geo-political zones of the federation led to the establishment of new Universities in Lagos and Ife in 1962. The same year, University College, Ibadan attained an autonomous status as a degree-awarding institution. The government established regional universities like ABU, Ile Ife, Nsukka in 1974 and created more universities in Uniben, Calabar, Jos etc. (Okojie 2008). The term higher education includes several forms of educational establishments beyond the secondary school level. These are comprised of the conventional universities, which offer courses in both the sciences and humanities and individual universities for sciences, agriculture, or engineering. Higher education also includes polytechnics, which provide advanced vocational training,

professional schools such as management or public administration schools, and the colleges of education, which train professional teachers (Okuwa, 2004).

Initially, the Nigerian university system was administered based on colonial influence (Nwagwu, 2008). During the 1970s and 1980s, the university system went through another transformation in its structures and institutional setup. The first significant change relates to the universities' institutional and structural configurations inherited from the colonial government. The nationalisation of the universities redefined the administrative structures and roles based on the indigenous realities in the country. The Nigerian constitution stipulates that education is a concurrent legislative item legislated upon by the Federal and States governments. The law also provides that the local government perform primary education, adult, and vocational training in Nigeria. In this regard, the Federal Government's responsibilities are carried out through the Federal Ministry of Education, 36 states Ministries of Education and the Federal Capital Territory (FCT), and the 774 Local Education Authorities in Nigeria. The highest national body that oversees the implementation of policies is the National Council on Education which comprises the Minister of Education as the chairman and states Commissioners of Education and FCT education secretary.

However, the universities were mainly concerned with fundamental research like surveys, data collections, and executing the script of the colonial masters (Nwagwu, 2008). According to Gaillard (1992), most African universities during the 1980s went through a radical transformation, which led to a rise in student enrolment, creating more departments and increasing demand for higher education access. Subsequently, the number of Nigerian universities multiplied from 45 in 2000 to 132 in 2004 and 155 in 2017. Universities are owned either by the federal government, the state government or private individuals or organisations. There are 43 federal universities, 48 state universities and 79 private universities in Nigeria (NUC 2017). This rapid growth of the Nigerian universities was realised through the privatisation policy of 1991, which was a policy approach to complement the federal universities with state and privately-owned universities. The Nigerian universities are regulated and supervised by the Nigerian Universities Commission. The National Universities Commission (NUC) was formed in 1962 and was transformed in 1974; the NUC was initially intended to function as a modest university granting a commission, guiding the government on policy matters, introducing rules for quality assurance. NUC is charged with assessing the quality of academic courses or programs administered by universities in Nigeria by accreditation. According to Alani (2008), accreditation aims to certify that minimum standards are attained in the universities. Acceptable levels of competence by applicants in their various areas of interest are also accomplished. In addition, it should ensure that international standards are met, and the programmes available in Nigerian universities are of high morals and sound quality and that

their graduates are suitably qualified for employment and further studies (Alani and Ilusanya, 2008).

### **2.5.1 Research and Development (R&D) in Nigeria**

The advanced economies are based on knowledge and information and are driven by investment in research development and innovation in science and technology-related fields. Science and Technology (S&T) are inextricably intertwined and are integral elements in developing the industrial sector of every nation (Siyanbola *et al.*, 2011). The application of knowledge and its linkage into the industries is imperative in achieving competitiveness and economic growth. A country with a close link between its knowledge institutions and the industrial sector remains stagnant or deteriorates. Therefore, most developed nations devote a significant proportion of their resources to research and development in the science and technology sector to build competitive advantage or catch up with others who have done so. Innovation feeds on the knowledge that results from growing R&D experiences, and it also contributes to this stock of knowledge (Egbetokun, Siyanbola and Adeniyi, 2007; Ukwuoma, Amade and Moghalu, 2013). Historically, scientific research and development in Nigeria functioned like a department under a Federal Ministry (NPC 2017). Throughout the 1960s, 14 of such research-based departments were in the Ministry of Agriculture and Water Resources. Other departments in the Ministry of Trade and Investment have engaged in the R&D. The departments worked in isolation and without any coordination or effective communication between them. According to NPC (2017), there was the West African Institute for Oil Palm Research (WAIFOR), which later became the Nigerian Institute for Oil Palm Research (NIFOR).

Moreover, the West African Institute for Medical Research (WAIFMR) was converted to the Nigerian Institute for Medical Research (NIFMR). These institutions worked for the whole continent of Africa, and they were formed mainly to assist the English-speaking parts of West Africa, with each nation donating resources for its operations. When the government realised that each research department worked in isolation, the Nigerian Council for Science and Technology [NCST] was established in the 1970s to coordinate them. The government then set up the Agricultural Research Council and the Industrial Research Council in 1971, while the Medical Research Council and the Natural Science Research Council of Nigeria were created in 1972 and 1973, respectively, to assist the NCST in specific areas. In the past, Nigerian research and development activities have gained an international reputation for their excellence in research and scientific publications in particular disciplines. For instance, the University of Ibadan was famous in medicine, education, religious studies, and history. Ahmadu Bello University was celebrated in Engineering, Veterinary Medicine, Agriculture, History, Arts and Radical Social Sciences. The University of Lagos was famous in Business Administration, Law and Social

studies (Bako, 2005). Due to the wide-ranging areas of education and quality research carried out by scholars coupled with the availability of research facilities in the past, Nigerian graduates were eminent and considered among the best in the world and the institutions of higher learning were rated some of the best in the world (Bako, 2005). According to Bako (2005), throughout the first phase of the development of Nigerian universities, the rate of returns from investment in higher education was the highest in Nigeria compared to other African countries where the statistics were retrieved for that period. As depicted in Table 2.3 below, Nigerian universities produced the maximum rate of return of 46% against 15% between 1960 and 1980, as recorded in the Table below.

*Table 2. 3 Rates of Return in Percentage from 1960 to 1980; Source: Bako (2005)*

Country	Rate of return on higher education
Botswana	38.0%
Ethiopia	27.4%
Ghana	37.0%
Kenya	31.0%
Lesotho	36.0%
Liberia	17.0%
Nigeria	46.0%
Rhodesia	34.0%
Sierra Leone	33.2%
Somalia	15.0%

Following the impressive performance of Nigerian universities in research and development and attracting a higher rate of return by higher education, Nigeria could sustain a special growth rate and prosperity. The success recorded in the state of higher education was attributed to the then prevailing positive environments. The first factor was the colonial legacy left by the British colonial administrators, who handed over some excellent infrastructures and operational institutions to the Nigerian people (Bako, 2005). The British colonial masters also bequeathed well-trained personnel and researchers who had a zeal and passion for research and who led the universities after the end of colonial rule. For instance, during the colonial period, Agricultural Research Centres at Moor Plantation, Ibadan, Umudike, Umuahia, and Samaru in Zaria were created where applied scientific research made its debut country. In the 1940s, the British colonial masters also established the West African Institute of Social and Economic Research that operated in collaboration with the University College of Ibadan until it ceased to exist and was converted to the Nigerian Institute of Social and Economic Research (NISER) in 1959 (Bako, 2005). Acknowledging the numerous challenges facing the commercialisation of research output in Nigeria, the government set up a Ministerial Consultative Committee on the commercialisation of R&D results (MCCR) in 1997. The committee's primary

responsibilities were to examine and recommend means to facilitate the efficient and effective conversion of R&D results for industries to create wealth in Nigeria (Ukwuoma, Amade and Moghalu, 2013). Subsequently, the National Office for Technology Acquisition and Promotion (NOTAP) was directed to serve as a centre of excellence to coordinate the commercialisation process and license the imported technologies. NOTAP assist in linking the research and development activities with the market and enable a smooth commercialisation process in Nigeria. The agency has established over 23 Intellectual Property and Technology Transfer Offices (IPTTO's) in tertiary institutions across Nigeria and support innovators in preparing and filing applications for property rights. Despite the international achievements and the reputation gained by R&D in the higher education system in Nigeria, there has been a constant decline in the quality of research output in Nigeria

## **2.6 Challenges of the Innovation System and Inhibitors of UIG in Nigeria**

Many studies have been carried out that raised some critical questions on why many developing nations, especially in Sub-Saharan Africa, are not experiencing substantial growth and progress. Generally, there is an agreement in the literature regarding the weakness of the innovation system and UIG interaction in many developing countries (Etzkowitz and Dzisah, 2008; Datta and Souleh, 2018). Within the Nigerian context, the following factors are the primary bottlenecks or inhibitors for the UIG collaboration. These challenges relate to the institutional configuration, poor education system, or lack of the culture of innovation (Isola, Ogundari and Siyanbola). For this sector, the policy statement aims, and approaches are well expressed to meet the national goal in scientific and technological education for national development. However, the institutional policy instruments, such as universities, colleges and other learning institutions involved in applying the formulated S&T policy are not well equipped with the advanced training facilities necessary to produce skilled human resources. Additionally, motivations for teachers and educationists are inadequate when compared to developed countries. Consequently, this has led to the relocation of Nigerian scientists and engineering educators to other nations (Sanni *et al.*, 2001). Another issue was that all government-owned research institutions are closed units, independent of the productive sector, and hence their S&T efforts have little or no relevance to the economy. Many researchers concern themselves mainly with writing papers, with less attention paid to the productive sector to solve practical problems (Sanni *et al.*, 2001). Most importantly, the following items are the vital inhibitors of the UIG interaction and the innovation system.

### **2.6.1 Lack of National Intellectual Property Policy and Poor Enforcement**

Intellectual property rights (IPR) play a crucial role in promoting innovation, fostering technological progress, and stimulating economic growth (Neves *et al.*, 2021). Intellectual property policy is an instrument made to guide the creation, protection, and effective IP management. It provides a framework within which the IP is developed, managed, and effectively harnessed for the overall benefit of the institutions, inventors, authors, and the public (Oboh and Okwilagwe, 2017). IP policy addresses seven fundamental issues: coverage of the policy, ownership, disclosure, marketing, commercialisation and licensing of patents, distribution of income, rights and obligations of an inventor and the institution, and any other pertinent issues (WIPO, 2012). One of the key problems of UIG collaboration in Nigeria today is the lack of national policy on IP protection. Nigeria currently applies obsolete laws to protect intellectual assets, leading to limited commercialisation of research in the country.

Concerted efforts have been made over the years to initiate IP policy in Nigeria. The National Assembly has started a national Industrial Property Commission Bill, which seeks to repeal the current Trademarks Act 1965, harmonise, and modernise all the IP laws to comply with the global best practice. However, this Bill has been hanging in the National Assembly for years without any tangible results. There is a prevalence of ineffectiveness in protecting and enforcing IP rights, inadequate penalties for infringements, and a total lack of coordination among the various government agencies responsible for protecting IP rights. Some of the legal instrument governing the IP rights in Nigeria includes Copy Right Act (as amended) Cap.C28 Laws of the Federation, Patent and Designs Act Cap.12 Laws of the Federation of Nigeria 2004. Trademark Act, Cap.T13 Laws of the Federation of Nigeria. Nigeria has ratified some specific international regimes and treaties, such as the Convention for the Protection of Industrial Property (Ratified in 1963), the Berne Convention 1986, The Rome Convention (performers, Producers and Phonograms and Broadcasting Organisations ratified in 1993, etc. Despite the availability of legal instruments aimed at protecting IP in Nigeria, common infringements take the form of piracy, counterfeiting, unauthorised /unlicensed use, and unfair competition is prevalent. This infringement has the potential to deny collaborating partners, individuals, or institutions the right to reap the benefit of their intellectual benefits. The violations negatively affect the collaborative relationship between UIG, hamper investment both by domestic and international companies, hinder job creation, and ultimately obstruct genuine innovation and growth. According to Olubanwo and Oguntuase (2019), copyright violation is a significant challenge to IP rights in Nigeria. It manifests in book piracy, ICT and internet and software piracy and film and entertainment piracy. Today, universities in developed countries have entered many IP agreements with industries that need their research findings and inventions because they have IPP. The lack of a national IP policy has resulted in



demoralising many universities from having their IP policies. WIPO (2004) posits that lack of IP policy handicaps effective transfer of technology and dissemination of research findings from universities in Africa as IPP is a prerequisite for applying commercial activities related to innovation. In Nigeria, few universities have developed their IPP. For instance, the University of Ibadan IPP was approved by the University's Senate on October 16th, 2012, and Afor instance Ahmadu Bello University (ABU) also relies on Article 3 of the University Research Policy to apply IP laws. Therefore, the lack of clear national policies or outdated laws in Nigeria is one of the fundamental factors that inhibit the UIG collaboration in Nigeria.

### **2.6.2 Poor Work Ethics in Private and Public Organisations**

Poor work ethics and other unethical practices pose a challenge to the University-Industry-Government in Nigeria. Work ethics and behaviour of employees in any organisation is very crucial for general development. The production of goods and services, both for domestic consumption and global trade or exchange, creation of national wealth, the fulfilment of political stability and cannot be achieved without ethical practices in both public and private organisations (Adeyeye *et al.*, 2015). How well organisations adhere to ethical standards determines the well-being of all the stakeholders, the organisation's productivity, the subsequent profitability, and the macroeconomic growth and development of the nation (Adeyeye *et al.*, 2015). In Nigeria, most employees join the train of workers with bad ethical attitude in workplaces, which has resulted in the low productivity of workers. No matter how good the plans are or how efficient the organisation is, nothing happens until the people who make up the organisation are stimulated to perform (Omisore and Adeleke, 2015). The Nigerian Code of Conduct Bureau and Tribunal Act and Civil Service Rules require civil servants to be disciplined and courageous. It must have Courtesy and Co-Operation in the discharge of their duties. However, you find that both private and public organisations are confronted with gross indiscipline and repellent attitude for any form of cooperation. It is also faced with unethical behaviour and corrupt practices, and pervasive and even institutionalised norms of behaviour in Nigeria to the extent that one may conveniently speak of a crisis of ethics in the Nigerian public service (Omisore and Adeleke, 2015). Furthermore, the Nigerian universities are not also spared of these unethical practices that appear to be threatening their mission and vision of providing quality education for individual and national development. Radda (2009) argues that staff (both academic and non-academic) commits unethical practices for, among other reasons, sexual gratification from girls, money, and other items of value from parents, guardians, students, companies, among others.

### **2.6.3 Lack of Funding:**

Insufficient funds are one of the main difficulties limiting the contribution of innovation to industrial development in Nigeria (Isola and Siyanbola 2010). The government sponsors many of the R&D activities in Nigeria, compared to other developing countries who spend only about 40% (Ogunwusi and Ibrahim, 2014). The Nigerian government allocated N1.5 billion to science and technology in 1998 and 5 billion in 2004, which depicts 33 % yearly over a seven-year period. Moreover, by 2007, federal allocation to S&T had increased to N16.0 billion representing a 220% increase from 2004 and a 730% rise from 1998 (Ogunwusi and Ibrahim, 2014). Despite the steady annual growth of the budgetary allocation by the government, it represents only about 0.11% of the GDP. Without proper financing, a nation cannot achieve efficient research in science, technology, and innovation.

### **2.6.4 Lack of Infrastructure:**

Another significant challenge to the UIG collaboration and research commercialisation in Nigeria is the infrastructure to carry out meaningful research work. Most organisations, especially the universities and the various research institutions, are not adequately equipped with modern facilities (Ogunwusi and Ibrahim, 2014). This challenge is intensified by the deficiency of stable electricity supply, an inadequate water supply, and an inefficient transportation system. The other problems that hamper the success of this collaboration and indeed in Nigeria are that most often, all endogenous R&D activities are not connected to the national goals and priorities. All the national development plans and other strategies like the NEEDS, 7-point Agenda and vision 20;2020 have explicitly mentioned the need for wealth creation through science and technology. However, the ongoing research in the higher education systems is not adequately connected or coordinated and channelled through the pre-set national goals. This has been consistently hampering the relevant results and translating them into national development both at micro-macro levels. According to Siyanbola et al. (2011), one of the most significant challenges of UIG collaboration and R&D in the Nigerian higher education system is that most researchers do not engage in market-driven research. R&D outputs do not suddenly appear in the marketplace; a process must be followed to ensure that the outputs meet market expectations, thus improving their chances of success. Such a method will help moderate and eliminate barriers and strengthen any technology's profit and sustainability potentials.

## **2.7 Chapter Summary**

The industrialisation has always been a desirable idea for the Nigerian government. Therefore, the government adopted various policies and strategies from the pre-colonial period to the post-colonial period. Despite all the plans through the macroeconomic environment, science and technology and the higher education sector remain unstable and unpredictable. The volatility of the oil resources has threatened macroeconomic stability and has posed some questions on the need to diversify and move away from extreme oil dependence. The Nigerian government has taken multiple development plans and strategies to industrialise and move away from its reliance on oil as its source of foreign exchange revenue. In this regard, the government has introduced different policies to try and address the situation. Nevertheless, the significance of the chapter is to identify the critical problems and challenges that inhibit the UIG collaboration. These factors including lack of national IP policy and weak enforcement of IPR, and poor work ethics. These factors help design the conceptual framework for the study.

### **3 CHAPTER THREE:**

The previous chapter focused on Nigeria's country profile and the various policies and institutional frameworks for industrialisation including the critical roles Science, Technology, and Innovation (STI) played in the Nigerian innovation system. The chapter also identified and discussed the critical national factors inhibiting the Nigerian innovation systems. This chapter reviews the extant literature on University-Industry-Government collaboration (UIG) including the various theories of innovation embedded in the UIG interaction. The chapter metamorphosed into a conceptual framework based upon which data was collected, analysed, and discussed.

#### **3.1 UNIVERSITY-INDUSTRY-GOVERNMENT INTERACTION**

University-Industry-Government (UIG) relationships have received substantial attention over the last decades due to their critical role in innovation and promoting economic growth and international competitiveness (Lundvall 1992 Nelson,1993). Scholars have devoted a substantial amount of time examining how and when linkages between governments, economic actors, universities, and other institutions may lead to the identification of opportunities that create practical value not just to the agents involved but the society in general (Saad, Datta and Razak, 2017). The literature emphasises the importance of the interactions and institutional arrangements, considering universities as actors that can contribute to economic development in knowledge-based economies (Geuna and Muscio, 2009). Within the NSI, universities can establish links with productive structures that accelerate the transfer of knowledge and technology (Wynn and Rezaeian, 2015). The interaction between UIG is considered a foundation for knowledge formation and continued competitive advantage in firms (Saad, Datta and Razak, 2017). Many countries have implemented policies to strengthen interactions between universities and firms to achieve better economic performance supported by academic research. Such policies, in many cases, involved changes in legislation, creating support mechanisms that encourage UIG interaction to believe that firm innovation requires academic research (da Cunha Lemos and Cario, 2017). Similarly, firms have been increasing the pressure for academic researchers to engage in projects with commercial partners (da Cunha Lemos and Cario, 2017). According to Edquist (1997), the method that produces innovations is multifaceted, and it depends on elements associated with the knowledge that translates into new products and processes. These elements are entrenched in an environment characterised by feedback mechanisms and interactions involving learning, production, policy, and demand. In this view, a systemic idea of innovation is developed that emphasises the role of interactions between the agents involved in innovation processes and institutional arrangements that create

conditions for the competitiveness of a country, distinguishing it from others (Freeman & Soete, 2008).

UIG stakeholders differ in how they collaborate and commercialise academic research, and the extent that such instruments are shown to be successful. Even within countries, there are significant heterogeneity levels in universities' approaches when interacting with firms (Geuna and Muscio, 2009). Thus, this collaboration is established in a learning process, both by the university and the firm, whose relationships involve sharing knowledge, mutual trust, and personnel transfer between the two actors (Albuquerque *et al.*, 2015).

Plewa *et al.* (2013) describe the dynamic process of the UIG linkages through different phases; first, they note that such development does not automatically adhere to a linear direction but differs according to strength and engagement. According to the authors, the first phase is the “pre-linkage” stage, which identifies stakeholders or players as possible research allies depending on the network of the researcher concern. Secondly, there is also the “establishment” phase, where serious deliberations are initiated, aiming to comprehend each party's strengths, needs, and interests, leading to a contract/agreement. The third stage is the “engagement” phase encompassing a cooperative situation to work on specific projects. The final “latent” phase strengthens and consolidates the relationship and opens the door for future cooperation.

In this collaborative effort, the role of the university is very critical. For centuries universities have been the source of knowledge through teaching and research as their traditional role but limited interaction with the larger society (Mowery and Sampat, 2004). However, recently the trend in most developed countries is that national development plans are tied to universities' work (Mowery and Sampat, 2004). It is also true that knowledge generation in most developed countries has gone through an evolutionary process, thus: from mode 1 (a Newtonian notion of knowledge production) to mode 2 models of innovation (transdisciplinary). Knowledge generation has moved further on and is now at a point where several actors play pivotal roles in its creation for the good of the larger society (Mowery and Sampat, 2004). Higher learning institutions have become important actors in national and regional economic development through the production and diffusion of knowledge relevant to the industry. This occurs when many countries and their governments grappling with limited resources (Datta and Souleh, 2018). This situation has presented a significant challenge for universities to justify their direct impact on society and begin looking at other sources to fund and effectively live up to the new responsibilities. These changing roles also present a vital task for the universities suggesting that universities cannot maintain the ‘ivory towers’, generating research results without the direct benefit of the public (Mowery and Sampat, 2004). Moreover, this new model of

universities in developed countries varies with the trend in developing countries. Saad et al. (2010) described this trend as the 'new mission' of higher education where the role of universities in national economic development and society can now join in (bottom-up learning process) on how research result should affect their lives or how innovation should be tackled.

From the company's perspective, one of the knowledge-intensive firms' attributes is that it is continuously being improved to respond to the new technologies, making old technologies more obsolete (Norman, 2002). The life circles of products are deteriorating, necessitating new products, and attracting new markets more rapidly. These processes are highly complex and need more integration of various kinds of knowledge input from different agents of knowledge production or partners. For such firms, their ability to share and use diverse knowledge irrespective of where this knowledge comes from creates value. Access to external knowledge across firms' boundaries is a key to their sources of innovation and success (Powell, Koput and Smith-Doerr, 1996; Dyer and Singh, 1998). Firms tap into external sources based on inter-organisational alliances. They need to develop their internal absorptive capacity to learn from the pool of knowledge from the external sources of knowledge. Cohen and Levinthal (1990) described absorptive capacity as the firm's ability to assimilate and utilise external knowledge for commercial purposes and a new way for organisational learning and innovation. This search for external knowledge originated from Fusfeld (1995) work called "the decline of technical self-sufficiency": who emphasise the inability of firms to sustain they co-operate growth strategies based on in-house technical knowledge resource.

Fusfeld (1995) notes that in the last 30 years following World War II, companies were able to design and execute their growth strategies based on their internal resources at a reasonable cost and time. In that sense, corporations were self-sufficient. But after the 1970s and 1980s, the situation was not the same because of the growing demand for industrial research. By the end of the 1970s, there was an increasing mismatch between the rising demand for industrial research and increases in R&D to meet those demands because of the swelling cost and complexity involved due to the application of new knowledge. Until recently, firms began to see a gradual change of approaches to develop access to external sources of technology and knowledge to have more information and identify partners for collaborations with universities, government consortia, cooperative research programs, and joint ventures.

The role of government in fostering innovation has been acknowledged since the seminal work of (Dosi 1988; Lundvall, 1992). The government provides incentives for creating a collaborative environment and serves as an agent that presses the higher education institutions to go beyond the traditional teaching and research functions and make more direct contributions

to regional or national economic development. Generally, the role of the government is to create an environment of certainty for the collaborations of economic, political, and social actors by establishing guidelines, building institutions, identifying difficulties and bottlenecks, and developing rules and implementing the relevant policies (Rodriguez 2013). According to Trippel, Sinozic, and Lawton Smith (2015), various frameworks have been identified that explain the multiple university activities and engagements contributing to national and regional economic developments. The UIG interaction has been studied from different theoretical lenses, including National Systems of Innovation, Mode 1 and Mode 2, National Innovative Capacity and Triple Helix.

### **3.2 National Systems of Innovation**

The National Innovation System (NIS) concept dates to the seminal work of a German economist, Friedrich List 1841. In his work, he described it as "National Systems of Political Economy", where he examined the economic stagnation of Germany compared to other industrialised countries like Britain. He mapped out certain policy recommendations on protecting the infant industries and developing indigenous technological development through relevant policies. The concept was later developed by Lundvall (1992), Nelson (1993) Edquist (1997). Since then, the idea has gathered a universal body of literature and increasing the influence of the NIS approach. Supra-national organisations – particularly the Organisation for Economic Cooperation and Development (OECD) – have absorbed or the notion of NIS as a fundamental part of their analytical perspective. According to Freeman (1987), the National System of Innovation is the network of institutions in the public and private sectors, whose activities and interactions start, import, modify and diffuse new technologies. Nelson (1993) also defines it as 'a set of institutions whose interactions determine the innovative performance of national firms. Lundvall (1992) defines it as the elements and relationships that interact in the production, diffusion, and use of new and economically valuable knowledge and are either found within or rooted inside the borders of a nation-state. The OECD (1997) describe innovation as "the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organisational method in business practices, workplace organisation or external relations. This definition has four essential types of innovation. A) Product innovation: goods or services that are new or meaningfully enhanced. Examples include large enhancement in technical products, technical specifications, components and materials, incorporated software, user-friendliness, or other functional characteristics. B) Process innovation: new or significantly improved production or delivery methods. The example here includes significant changes in techniques, equipment, and software. C) Marketing innovation: innovative marketing methods involving significant

changes in product design or packaging, product placement, product promotion or pricing. d) Organisational innovation: introducing new organisational methods in the firm's business practices, workplace organisation or external relations (Smith, 2005).

To Schumpeter (1912), innovation consists of any of the following: i) introduction of a new good; ii) introduction of a new method of production; iii) opening a new market; iv) conquest of a new source of supply of raw materials or half-manufactured goods and v) implementation of a new form of organisation. Moreover, in the evolutionary approach, novelty streams from new knowledge, thus making innovation an interactive social learning process. Only when new knowledge is created can innovation flourish. Knowledge contains two dimensions: a “public” one, taking the shape of information easily codified in patents, blueprints, textbooks, etc., and a “tacit” one, embodied in routines, skills, competencies, and specific practices (Nelson and Winter 1982, Polanyi 1967). The public aspect is costly to create but costs less to transfer or make available to others once it has been created. By contrast, the tacit one is not so easily transferred, resulting from different learning processes: learning by doing, by using, searching, imitation, interaction, and by cooperation (Howells 2002). Owing to this tacit feature, new knowledge and innovations are partly context-specific and localised, thus calling for the introduction of geographical aspects. When the geographical gap is negligible, and the language and culture are common, the tacit aspects are easier to transfer (Polanyi 1967). Hence, an interaction between space and innovation occurs with developing concepts such as national, regional, and local production systems.

Edquist (1997) further extended the definitions and encompassed all-important economic, social, political, organisational, institutional, and other factors that influence the development, diffusion, and use of innovations. Lundvall (1992) highlights the importance of a close relationship between key institutions such as research organisations, institutions of knowledge production, and industries involved in producing and disseminating new and valuable knowledge. Stressing the significant roles of the state, Lundvall (1992) identified five areas where significant differences in NIS could manifest. First, the internal organisation of the firms, inter-firm relationships, roles of the public sector, institutional set-up of the financial sector and the intensity of the R&D. According to the NSI framework, a firm’s ability to innovate largely depends on many interrelated factors (Datta, Saad and Sarpong, 2019). These factors include quality of education system, quality of technical and scientific organisations, industrial relations, government policies and cultural dispositions. Just like other frameworks, the NSI framework also considers the criticality of a division of labour, and it presupposes that companies convert knowledge into goods and services, universities produce human capital while the government provides incentive and friendly environment through policy



interventions (Fischer, Schaeffer and Vonortas, 2019). NSI framework has been criticised for adhering to the linear model of knowledge creation (Datta, Saad and Sarpong, 2019). However, ideas for innovation can come from many sources and any stage of research, development, marketing, and diffusion. Innovation can take many forms, including adaptations of products and incremental improvements to processes (Godin, 2006). Additionally, While the importance of the role of academia in the NSI is well acknowledged, the scope for the commercialisation of research output is limited in the NSI framework (Freeman, 1995).

### **3.3 Regional Innovation System**

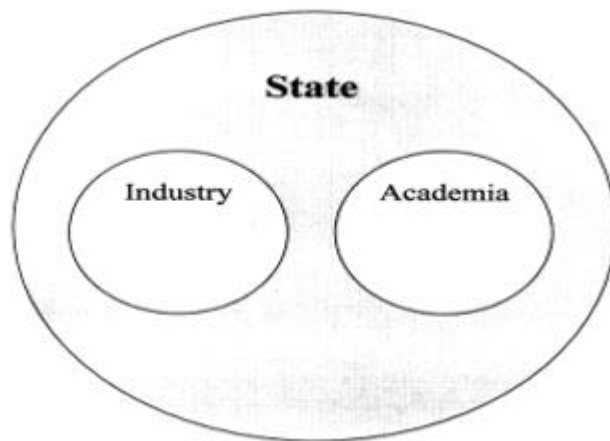
The concept of Regional Innovation System RIS could be traced to National Innovation Systems' foundation in the 1980s (Stuck, Broekel and Revilla Diez, 2016). Since the 1980s, various localised production systems have appeared, emphasising the importance of economic geography and regional development. New concepts, such as technological districts, innovative milieu, learning regions, introduced another theoretical and empirical dimension to the industrial development of local economic growth (Doloreux, 2002). Regional Innovation Systems is a regional dimension of the innovation process that emphasises the geographical proximity of inter-connected firms, learning institutions, and government agencies. Lau and Lo (2015) define RIS as the set of networks between public and private agents that interact and give feedback in a specific territory to adapt, generate and extend knowledge and innovation. The framework emphasised the critical role of political actors by providing incentives, upgrading infrastructures, and other relevant policy frameworks. Cooke (2004) describes RIS as the interactive knowledge creation and utilisation by exploitation subsystems linked to global, national, and other regional systems in which firms and other organisations are systematically engaged in interactive learning through institutional milieu. Asheim (2005) found specific fundamental reasons why companies' competitiveness and innovation in the regions are enhanced. Emphasis is on the localised learning process stimulated by geographical, social, and cultural proximity. Regional networks became prominent due to globalisation and information technology incorporating regions into the global flows of information and knowledge, replacing special considerations (Castell,1989). However, in the global economy where people, knowledge, and capital are mobile, boundaries are blurred and porous, and spatial consideration is debatable. On the contrary, Asheim and Gertler (2005) observed that spatial concentration remains vital for innovative activities, despite the argument that modern information and communication technologies would render spatial distances insignificant.

### 3.4 Triple Helix Model

Triple Helix theory came as a reaction to the propositions of the NSI, especially those prominent features on a division of labour embedded in NSI (Datta, Saad and Sarpong, 2019). Triple Helix appeared in the mid-1990s by the seminal work of Etzkowitz (1993) and Etzkowitz and Leydesdorff (1995). Since the model appeared in the literature, a large body of Triple Helix theoretical and empirical research developed over the last two decades that gives a general framework for exploring complex regional and national innovation dynamics. Etzkowitz and De Mello (2004) traced the origin of the Triple Helix model of innovation back to 1967 when a director in Netherlands Central Organisation for Applied Research named Julius introduced the concept "Triangle". The Triangle idea was later adopted by Argentinian physicist Jorge Sabato and applied to examine the relationship between academia and industry in Latin America. At that time, the "Triangle" between science and the industry in Latin America did not exist. Etzkowitz and De Mello (2004) described the absence of the triangle as the factor behind the slow economic growth in Latin American countries. Triple Helix Concept has some essential elements. First, it presumes a more prominent role to the university in innovation; second, it assumes that there is a movement toward more collaborative relationships among the three institutions in which innovation policy is an outcome of interaction rather than a prescription from the government, and lastly, each institution taking the role of the other. Most of these occur at the regional level, where specific contexts of industrial clusters, academic development, and the presence or lack of governing authority influence the development of the Triple Helix (Etzkowitz, 2008).

#### 3.4.1 Different Routes to Triple Helix

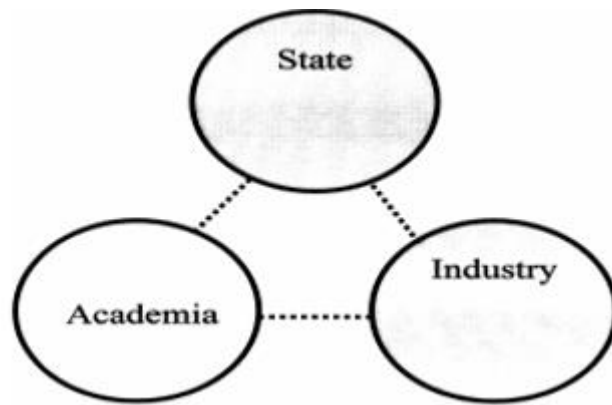
The innovation path from Triple Helix Model perspective is based on the various institutional arrangement which begins with two opposing standpoints. As depicted in Figure 3.1 Below, each model has its certain assumptions. First is the **Statist model**, where government plays the leading role, driving academia and industry, and at the same time controlling and directing them to encourage and motivate them to create innovation, give resources for new initiatives.



*Figure 3 1 Statist model Source: (Etzkowitz and Leydesdorf 2008)*

An example of countries that practice the Statist model is (e.g., in Russia, China, some Latin American and Eastern European countries); In this institutional configuration, universities are distant from the industries and restricted to teaching institutions only (Razak and White, 2015). The government decides and prioritise university activities. Universities must wait until decisions are made to perform specific projects because firms lack power in the model. Etzkowitz (2003) notes that universities and industries have limited capability to exploit the potentials of knowledge creation without the government's decision in this model. The statistic model's central assumption is that countries should develop their technological ability separately without coming together or interacting in any way except for market purposes.

**(b) Laissez-faire** configuration is another model of a Triple Helix that emphasises the separation of the institutional spheres. Universities, industries, and government-run independently. In this model, the university only provides trained persons, supplying knowledge to the industry in the form of publication and human resources employed by the industry with their tacit knowledge. Trades are also running on their own. The only linkage they have is the market relationships of buying and selling. Figure 3.2 shows the separate institutions keeping their spaces and only having mutual respect. Collaboration is not allowed because firms were forbidden to collaborate for fear of forming cartels to set the prices of products in the market (Etzkowitz, 2008).



*Figure 3 2 Laissez-faire Source: (Etzkowitz and Leydesdoff 2008)*

According to Etzkowitz (2008), this rule changed in the US when they faced fierce competition from Japan. That led to rethinking the relationship between corporations, government institutions, and academia in the 1970s. The anti-trust policies in the US were changed to allow for cooperation and engagement in pre-competitive research and allow for joint product development. Industries could restructure based on the framework of strategic alliances with different companies. After that, companies should be allowed to compete and cooperate in product development and joint research. In this model, the role of the government is limited; it intervenes where there is a market failure. There is also a limited interaction between the government, universities, and the industries (Etzkowitz, 2008). The Laissez-faire model also presupposes boundary maintenance, separate institutional spheres, distinct roles with firms as the centre of economic activity.

**c) Hybrid Triple Helix:** This model helps create innovative synergies and set in motion what Etzkowitz (2008) described as “innovation in innovation”. The actors in this model collaborate in knowledge creation and sharing knowledge in a secure and friendly environment for mutual benefit. The model encourages the institutional actors to go beyond their primary responsibilities to collaborate with other actors for economic, social, and institutional gains. It creates a level playing ground for interaction among the institutional actors of a Triple Helix. Figure 3.3 showing the Hybrid Triple Helix model placing a prominent role for the university in innovation systems. In this innovation configuration, universities shift from teaching and research to entrepreneurial and commercialisation of universities research and combining teaching, research, and entrepreneurship.

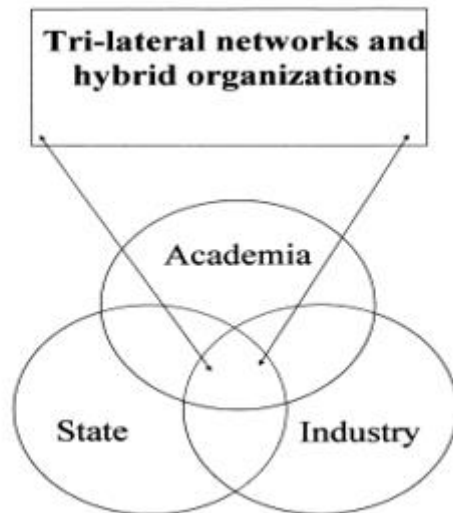


Figure 3.3 Hybrid Triple Helix Source: (Etzkowitz and Leydesdorf 2008)

### 3.4.2 Four Developmental Stages of Triple Helix Model

The first major stage is the ‘‘*internal transformation and role-taking*’’, which suggest some major internal changes within each institution to reflect the knowledge production within a Hybrid Triple Helix perspective. Taking the role of each other indicates that each institutional sphere and performing its traditional roles takes on the role of the other as a secondary role. Suppose an institution already performs a function as its primary duty. In that case, another institution's utility as a secondary duty is the innovation contribution of that institution toward the innovation process. The second is *the influence of each helix upon another*, for instance, enacting a policy or law by the government of a new way of knowledge creation, sharing and diffusion, which influences the behaviour of the university and industry. The third is the *creation of a new overlay*, which means the formation of the new network, linkages among organisations within the three institutional helices to institutionalise collaboration and inspire inter-organisational creativity. The fourth is the ‘‘*recursive effect*’’ of this inter-organisational collaboration between the university-Industry-Government in innovation and knowledge creation Leydesdoff, (1995;1998;2008). It means that knowledge creation becomes routine, continues collaboratively with mutual benefits. The Triple Helix Model puts the university as the leading institution informing the knowledge-based economy. According to Etzkowitz *et al.* (2018), the formation of Triple Helix largely depends on the overlap of the relationship between the three institutional spheres. The theory also strongly emphasised the circulation of people within the three spheres enhancing learning, thereby contributing to the national and regional economy (Etzkowitz, 2003a).

### 3.5 National Innovation Capacity Framework

The National Innovative Capacity (NIC) framework seeks to incorporate three perspectives of innovation dynamics: ideas-driven growth theory (Romer, 1990), microeconomics-based models of national competitive advantage and industrial clusters (Porter, 1998), and National System of Innovation national System (Freeman, 1995; Lundvall, 1992b; Nelson and Rosenberg, 1993). Though these perspectives encompass common elements, each emphasises different drivers of the innovation process at the national level (Furman, Porter and Stern, 2002). The fundamental idea of National innovation capability is the ability of a nation to manage resources and skills to transform existing knowledge into new knowledge, technology, and creative outputs for the benefit of firms, industries, and the entire economy (Khedhaouria and Thurik, 2017).

The productive learning system of any country needs institutional structures with formal legal institutions that develop human capital through appropriate education and research systems. According to Furman, Porter and Stern (2002), NIC is considered a nation's potential to create commercially relevant innovations, depending on many factors. These factors include the intensity of R&D, human capital, and financial resources available for R&D, the strength of intellectual property protection, technological sophistication. This assertion is supported by the Endogenous Growth theory where it assumes that the stock and quality of human capital in possession of a country gives birth to the level of technological sophistication and economic growth it can potentially achieve (Furman, Porter and Stern, 2002). NIC is similar to the NIS in many ways. They both stress the national R&D capacities and related and supportive institutional infrastructures available of nations, including the critical roles of intellectual property protection. The other fundamental assumption of NIC driven from Cluster Theory is competition, which was considered central to the innovation dynamics. The idea of clustering is the geographical concentration of interconnected companies and institutions in a particular field, ensure the availability of high-quality, specialised inputs and create a context that encourages investment coupled with intense local rivalry, pressure and insight gleaned from sophisticated local demand, and the local presence of related and supporting industries (Porter and Stern, 2001). Scholars have often cited Silicon Valley as the most successful and prominent cluster. Even though cluster formation is not clearly understood, the research regarding Silicon Valley highlights five fundamentals vital for cluster success. These factors include access to technology and technical knowledge, access to highly qualified people; creating visionary entrepreneurship; access to venture capital; and availability of networks and linkages (Mallett, 2004; Shavinina, 2004). However, NIS considers these factors necessary but not sufficient conditions for building national innovation (Datta, Saad and Sarpong, 2019). According to Datta, Saad and Sarpong (2019), the success of Silicon Valley has been attributed to its network

of institutions (including excellent universities such as Stanford University), strong protection and enforcement of intellectual property rights, availability of risk-tolerant venture capital and angel funding, a culture of entrepreneurship and skilled workers' strong social networks. NIC and NIS share certain similarities and differences. For instance, they both strongly emphasise the critical role of skilled labour that carries out R&D activities in building national innovation capacity. They also both stress the value of an investment in education and training as a precursor for a nation's innovative capacity (Furman, Porter and Stern, 2002; Saad, Guermat and Brodie, 2015). Nevertheless, Datta, Saad and Sarpong (2019) note that in NSI, universities are considered an institution that is not just charged with supplying a skilled workforce but also create unique ideas and discoveries that companies commercialise. In contrast, the NIC, while recognising the vital role of the university in supplying human capital, understates its direct role in the innovation process.

### **3.6 Mode 1 and Mode 2 Frameworks**

The collaboration of scientist across University-Industry-Government have long been known to have difficulties due to the divergent research goals different knowledge production systems (Lam, 2011). The first issue relates to the nature of the activities and joint production of knowledge with commercial application potentials and joint critical human capital development. The second is about the kind of carriers and incentives to ensure that academic scientists are prepared to take part in short term industrial projects while retaining their positions at the university and staying incorporated into the academic community (Lam, 2011). Academic knowledge production tends to be inclined towards what Gibbons et al. (1994) describe as Mode 1 knowledge. Mode 1 presupposes that knowledge production happens within the borders of academic disciplines and, in the context, is defined by the cognitive and social norms of a scientific community (Auranen 2005). Other attributes of Mode 1 include knowledge production in the scientific setting, based on specific disciplines with accountability to peers. Structural systems in Mode 1 are stable, homogenous, and hierarchical (Veit *et al.*, 2017). Gibbons et al. (1994) have described this model as an outdated form of knowledge production and proposed Model 2 knowledge production to replace the old paradigm. The new model of Knowledge production (Mode 2) claimed that knowledge production has transformed into a more comprehensive and socially distributed form to incorporate actors outside the academia. Those actors include think-tank NGOs, industrial labs, and private institutions. This mode is a significant shift from the established academic structures. According to Lam (2011), the dominance of the Mode 1 knowledge production system poses a challenge for commercial collaboration. Partnership secured through mode 1 is problematic because the mode of intellectual discovery differs. The knowledge imparted through a formal education system

tends to conform to Mode 1 rather than Mode 2. In the new model, (Mode 2) heterogeneous sets of people would research in an application environment. They envisage that in the new mode of production, the universities will comprise only a small part of the knowledge-producing institution (Godin and Gingras, 2000). Mode 2 knowledge production is diverse and heterogeneous regarding the skills and experience people bring to it. Figure 3. 4 below outlines the difference between the models for better understanding. Compared with Mode 1, Mode 2 includes a broader, more temporary, and heterogeneous set of professionals collaborating on a problem defined in a specific context.

Attributes	Mode 1	Mode 2
Application context	Academic, without concern for the practical application	Solutions focused on the result of the organizations
Limits	Disciplinary, with clearly defined borders	Transdisciplinary, outside the boundaries of the discipline
Structure	Homogeneous	Heterogeneous
Organization	Hierarchical and tends to preserve the form	Heterarchical and transactional
Quality control	Evaluation of peers on the contributions made by the individual	In addition to the intellectual interest are added questions such as: Finding the solution, with it, will I be competitive in the market? Will this solution be profitable? Will it be socially acceptable?

Sources: Adapted from Gibbons *et al.* (1994) and Gibbons (1998)

Source: (Hessels and Van Lente, 2008)

Figure 3 4 Mode 1 and Mode 2 Source: (Hessels and Van Lente,2008)

The critics of the Mode 2 debate argue that Gibbons et al. (1994) have exaggerated their claims, adding that nothing is new in Mode 2 knowledge production system. They claim that model of knowledge production is not shifting into a new phase (Nieminen 2005). The critics suggested that instead of the scholars requesting a complete transition from mode 1 to mode 2, they should have portrayed a shift in the balance of the knowledge production system. The critics claim that both models of Knowledge production should exist side by side in the university system (Auranen 2005).

### 3.7 Enablers of UIG Interaction (University Perspective)

University knowledge production is significant for industrial innovation. Universities have traditionally been more concerned with abstract and theoretical knowledge than application (Mitra and Formica, 1997). Studies show that both university and industry actors are motivated to cooperate and utilise their complementary organisational strength to achieve corporate goals. Universities offer knowledge and technology, and graduates and faculty serve as employees and consultants to the firms (Arvanitis, Kubli and Woerter, 2008).

**Access to financial benefit** –According to Bozeman and Gaughan (2007), the increasing pressure on the public funds has put universities under enamours pressure to seek external sources of funding for their basic and applied research. University, therefore, must collaborate



to ease their financial burden and complement their income. Universities commercialise their IPR or licencing and patenting activities to reduce their dependence on the government and diversify their sources of income. University-Industry-Government collaboration offers a stream of secure funding that can reinforce academic strength. According to Edmondson et al. (2012), financial benefits can help revolutionise teaching and learning by encouraging an exchange of ideas and developing people with the skills and competencies needed to innovate and transform markets and industries. However, Santoro and Chakrabarti (2002) note that, in the past, industry often donated substantial financial support and equipment to the university's research, but industry funding for university research is now more targeted and usually tied to a specific study that brings about mutual benefit.

***Necessity:*** According to Ankrah (2015), due to the fierce international competition, and technological change, governments most often introduce policies that strongly encourages University-Industry- interactions to improve the environment for innovation. Universities as the core of innovation and knowledge creation, it becomes a matter of necessity for the university to respond to the government's policies and transform

***Exposing students and enhancing prestige:*** According to Santaoro and Chakrabati (2001), universities co-operate with industries to present their staff and student with practical experience in the industry. The advantage of university gaining helpful knowledge in the industrial environment is that it exposes them to product development and prototypes testing. University also engages in collaboration to enhance the prestige of the university. Mora-Valantine (2000) notes that the benefit of UIG interactions can take place either directly or indirectly, and this apparent success influences universities to engage in a collaborative relationship with the industries and other institutions.

### **3.7.1 Industry perspective**

Companies can obtain knowledge and technology from many external sources. These sources include other rival firms, research organisations, government laboratories, industry research associations, and universities. Industries' collaboration with the university considers the research quality, university size, and faculty/discipline age of the university. However, quality of the academic research and proximity is often used as a yardstick and is given more priority than other factors (Mansfield (1996). Industrial cluster analysis by Porter (1998) and localised knowledge spill-over literature has also emphasised the fundamental role of the proximity of actors. According to Mansfield (1995), universities with a higher quality of research are more likely to contribute to industrial innovation. Therefore, firms prefer to interact with universities that top research in the quality of research capable of enhancing innovative activities. According to Johnston and Huggins (2015) nurtures face to face communication and

encourages collective learning. It also allows the collaborating partners to network and share knowledge more efficiently, foster trust and reduce the cost of network activities. It also allows the transmission of tacit knowledge, which is personal and context-dependent. This knowledge cannot be easily bought via the market and is challenging to communicate other than through personal interaction in the context of shared experiences. However, Laursen et al. (2011) note that the choices of firms about cooperating with high-quality local universities depend on the firm's absorptive capacity. Companies with low absorptive capacity choose to collaborate with a high-quality local university or a high-quality non-local university. For businesses with high absorptive capacity, geographical proximity to a top university does not affect collaboration choice.

***Necessity:*** This strategy centres around the globalisation of knowledge; just like the university, the industry is also facing global competition because of the rapid technological advancement and competitive environment. Because of the rapid changes in product life cycles, increasing product development complexity, it is not feasible for companies to create knowledge alone (Caloghirou, Vonortas and Ioannides, 2004). This development has challenged the firms to source knowledge and upgrade their products and process and remain competitive. According to Ankrah and Omar (2015), academic research can complement technical expertise in finding a solution to their problems. Some SMEs lack the in-house ability to conduct an innovative study. Therefore, it has become necessary for them to collaborate with the universities to keep their firms competitive. According to Scharfetter et al. (2002), even companies with R&D capabilities collaborate with the university because it reduces risk and manages their resources.

***The commercialisation of university research:*** - one of the primary motivating factors for the industry to engage in collaboration with the university is to convert the university research into a product or process to attract economic value. Ankrah et al. (2013) note that industry players commercialise research output from the university and exploit exclusive rights to the technology. In the US, the Bay-Dole Act was instrumental in bringing researchers and entrepreneurs together to commercialise university research. Several universities created technology transfer offices (TTOs) to manage and protect their intellectual property after the Bay-Dole Act came into force in the U.S. The role of the TTO (sometimes referred to as the Technology Licensing Office) is to help commercial knowledge transfers (or technological diffusion) through licensing to an industry of inventions or other forms of intellectual property resulting from university research. In so doing, the firms will boost their competitive advantage, improve their financial performance, and reduce the cost of engaging in in-house research and development and share risk.

***Enhancing competitiveness:*** Some approaches consider collaboration with external sources to improve a firm's competitiveness (Caloghirou, Vonortas and Ioannides, 2004). The competitive

force analysis propounded by Porter (1980, 1985) emphasises inter-firm interactions to enhance a firm's comparative advantage. Inter-firm and intra-firm collaboration with higher education institutions and other external sources achieve better external economies of scale, market strength, or exploit new opportunities. They participate formally and informally in cooperative events such as joint marketing, joint production, shared resources, or joint development (Rosenfeld, 1996).

***Access to students:*** - Industries collaborate with the universities to gain access to innovative students for hiring or internships. The industry also hires faculty members and senior researchers within the university to consult for them. According to Liew, Shahdan and Lim, (2013), the firms stand to gain a human capital development from the university concerning professional education, access to cutting-edge technology and research facilities. This process helps enterprises in enhancing their competitive advantage. It also provides the industries with talented students who will work for the industry in exchange for industrial training. This system attracts job training for students and new employees and achieves a technology transfer and development (Ankrah and Omar, 2015).

### **3.7.2 Government perspective**

As noted in the previous section, the role of government is incentivising and encouraging University-Industry interaction. Government support comes through policies on research and development via monetary instruments like grants, tax credit and supporting legislative atmosphere (Bozeman and Gaughan, 2007; da Cunha Lemos and Cario, 2017). Roshani, Lehoux and Frayret, (2013) identified several motivating factors that encourage each stakeholder to interact. They mention that the government is primarily motivated to collaborate with universities and industries through its various agencies to raise the competitiveness of the firms, improve industrial productivity, create wealth, and tackle unemployment. Government introduces policies that promote regional and national innovation systems, proposing policies that will establish industrial clusters. The government also introduces corrective measures to market failures (Van Horne et al., 2008), enacts policies that remove barriers and increase synergy between University-Industry. Government add support structures to higher education institutions, private enterprise and research institutions. Martin (2011) points out the specific ways government comes in to include creating the incentive for joint research between university and industry, supporting the development of new high-tech firms or spinoffs, creating a climate and structures for innovation and providing a framework condition that is sustainable for the interaction between university and industry.

### 3.8 Inhibitors of the UIG collaboration

Despite a growing number of academia-industry collaborations, certain issues and barriers affect collaboration mechanisms (Walsh, 2008). Many studies have been carried out to investigate the factors that facilitate or inhibit the interactions (Ankrah and Omar, 2015; Ramli and Senin, 2015; Sarpong *et al.*, 2015). Some of the inhibitors of this interaction identified in the literature include:

***Institutional differences:*** According to Bruneel, d'Este and Salter (2010), the friction is caused by the institutional and functional variations such as responsibilities, histories, publicity, beliefs and aims between the three stakeholders of UIG interaction. The university creates knowledge through research and development to help the socio-economic well-being of the people and the immediate community. Government support is oriented toward solving general social, technical, and economic problems, while firms' process of knowledge creation is driven by profit maximisation to enhance their competitiveness (Jain, George and Maltarich, 2009). Geuna *et al.* (2003) note that the establishment of dependable and public knowledge has been key to developing these institutions, leading to support from the government for research to expand the pool of economically valuable knowledge. These institutional norms are essential to the way that researchers operate. Scientists are prepared to cut their salaries to work for the universities, suggesting that many scientists are driven by intrinsic ambitions (Bruneel, d'Este and Salter 2010). Additionally, the priority of establishing a reputation through publication is critical to academic success and career sustainability. Academics frequently compete with their peers based on publication records, institutional affiliations, and prizes. These competitions take the form of winner-takes-all, in which publishing first or winning the largest research grants precludes others from these same achievements or resources. Given this environment, much of the science system is driven by internal dynamics separate from market transactions (Polanyi, 1962; Dasgupta and David, 1994). However, the industry is driven mainly by market dynamics.

***Orientation Difference:*** Another cultural difference identified by the UIG collaboration is a conflict of interest. According to Nieminen and Kaukonen (2001), universities ignore the market rules that guide the conduct of the industry and their commercialisation process. Bruneel, d'Este and Salter (2010) submit that faculty members compete based on raising their status with their peers based on the number of publications records. The more they publish, the more they gain access to grants based on the winner takes it all. These internal university systems do not capture market dynamics very well, suggesting that the science system operates outside the market transactions (Bruneel, d'Este and Salter, 2010). Cantoni, Bello and Frigerio (2001) present two significant obstacles to collaboration: localisation and culture. Localisation

represents the physical barriers to transfer, most noticeably distance that can disrupt the flow of information between two parties. On the other hand, culture means the physical disruptions that appear based on the difference in understanding, norms, and practices in the respective organisation.

***Weak academic research capacity and lack of commercialisation potential.*** Ranga and Ezzkowitz (2010) note that universities in most countries mainly teach institutions with limited infrastructure and commercialisation skills. Unfriendly and unclear government policies, poor quality of leadership and weak institutional capacities, unfriendly or unsuitable policies set by governments. Ramli and Senin (2015) suggest that time is also another big difference related to the orientation of the university and industry. While research in the university takes an extended period, industrial research is relatively short. Therefore, there is a mismatch between the culture, resulting in a conflict and disagreement between the parties.

***Insufficient funding and lack of infrastructure*** Resources (financial and physical) play an essential role in successfully implementing UIG collaboration. The quality and the utility of a partnership is strongly dependent on the resources a partner can offer. The need for certain kinds of resources limits the number of potential partners considerably shortage of investment funds is a significant problem for the universities (Nokkala et al., 2008). These inhibitors are sometimes referred to as resource-related barriers, which relates to the limitation of finance, human resources and infrastructure in implementing R&D collaboration between universities and industries. In creating R&D activities, scientists need a significant amount of financial support since it is costly (Hanel & St-Pierre, 2006). According to Abeda et al. (2011), universities rely on monetary assistance from both the government and industry to execute R&D activities. Most funds universities receive is not sufficient to fund research within universities (Hall, 2001). Consequently, this leads to trouble for university researchers to execute practical or development research (Hamisah Tapsir et al., 2010; Shapiro, 2013). Banal-Estanol et al. (2011) indicate that when universities have efficient researchers, their probability of enhancing the number and quality of research findings is significant. Skills also have a substantial relationship with successful collaborations (Nokkala et al., 2008). Universities themselves are functioning on a government budgetary allocation; their ability to invest in new ideas is limited. It is also challenging to raise funds from financial institutions because of the long-term gestation period of the university research output. Therefore, adequate priority does not go for research and development forming another critical barrier (Mitra and Formica, 1997).

***Digression from organisational core objectives:*** actors in these interactions are more likely to drift away from their corporate goals. For instance, for University to become business linked poses challenges to the university mission of teaching and research and detract them from "open science" (Ankrah et al., 2013). The science system's Openness means academic freedom,

a pursuit of truth and diffusion of knowledge for as wide as possible. For the university to focus on commercialisation may undermine the public commons of science and weaken the institution for open science by imposing private norms into their practice (Bruneel, d'Este and Salter, 2010).

***Lack of Effective Communication:*** Communication is one of the inhibitors to the University-Industry-Government interaction. Santoro and Chakrabarti (199) described communication as the transfer of meaning from one person to another. Communication is when information, ideas or concepts being communicated or conveyed between persons. Communication between individuals is not just face-to-face contact but or word contact. Still, it also involves much variety of ways, including emails, telephone conversations, voice mail, printed and written documents. It also includes non-verbal methods, which may consist of symbols conveyed through body language and gestures. The frequency of communication is vital to creating a shared understanding between UIG stakeholders (Hong et al. 2010; Lee 2011).

***Bureaucratic Bottlenecks:*** Other general inhibitors of the UIG cooperation include bureaucracy, where government and university administrators tend to be rigid and strictly follow laid down procedures (Siegel et al., 2004). For the government, bureaucracy is a considerable challenge because everything needs to get into the appropriate bureaucratic process, which might take time. Therefore, bureaucratic organisations and unclear responsibilities are significant barriers to a successful partnership (Mitra and Formica, 1997). A similar belief is articulated by Anderson et al. (2007). They identify bureaucracy and inflexibility of universities' processes and policies, lack of well-designed reward mechanisms and inefficient management of knowledge transfer transactions as barriers to knowledge transfer between academia and industry.

### **3.9 Channels of University-Industry-Government Interaction**

The rate of research and technology development is rapidly increasing because widely distributed knowledge reduces organisational costs, enhances the corporate stock of knowledge, and improves productivity. According to Markman, Siegel and Wright, (2008), organisations no longer rely on their internal R&D capabilities. No organisation has sufficient human resources or talents inside its boundaries to innovate and be competitive. No institution, whether public or private, has the scientific capacity to control its end-to-end production process. Instead, every organisation, private and public, are compelled to supplement their research capabilities by collaborating with either the firms or government institutions or the institutions of knowledge production. This collaboration includes co-developing, discoveries, inventions, or joint publications. This process has given birth to the conception of the open

innovation networks comprising a global network of scientists, engineers, and other professionals in the open innovation platforms (Markman, Siegel and Wright, 2008).

There are several channels or “mechanisms” through which the UIG relationships are established (Meyer-Kramer & Schmoch, 1998), “channels” (Cohen, Nelson, & Walsh, 2002; D’este & Patel, 2007; Dutrénit & Arza, 2010), or “links” (Ahrweiler, Pyka, & Gilbert, 2011; Perkmann & Walsh, 2007). Concerning mechanisms, Meyer-Kramer and Schmoch (1998) connect collaborative research, informal contacts, staff training, theses, research contracts, conferences, consultancy, seminars for industry, exchange of scientists, publications, and committees. For channels, Cohen et al. (2002) cite publications and reports, informal interaction, public meetings and conferences, contract research, consultancy, joint and cooperative ventures, patents, personnel exchanges, licenses, and the hiring of graduates. D’este and Patel (2007) position the interaction channels into five broad categories: meetings and conferences, consultancy, and contract research, creating spin-offs and physical facilities, training, and joint research. Ahrweiler et al. (2011) mention formal links: contract research, joint supervision of master and doctoral students, licensing patents from universities to firms, co-publications, co-patenting, purchasing of prototypes developed in universities, contract consultancy, the formation of spin-offs, training and professional development of employees at universities, the use of university libraries, laboratories, and other facilities by firms; deployment of joint staff, joint research programs, and collaborative R&D. And informal links: meetings, e-mail communication, and joint participation in seminars and conferences and complementing the previous information. Perkmann and Walsh (2007) suggest the following typology for UIG ties: research partnerships, research services, academic entrepreneurship, human resource transfers, informal interaction, commercialisation of property rights, and scientific publications.

### **3.9.1 Human Capital Mobility/ Circulation of Staff /Student Internship:**

highly qualified researchers and engineers can be considered vital resources for creating innovative products and firm performance. Mobility of employees, personnel exchanges, or staff circulation is the movement of people around the three institutional spheres (Dzisah and Etzkowitz, 2008). People's movement in the institutional sphere has been critical in enhancing creativity, exchanging ideas, and improving human capital stock. Otto and Kroth (2011) identified one way of the linkage as staff exchange. They note that one-way personnel can be shared through sabbaticals, which are necessary channels where higher education and industry exchange ideas and upgrade skills to enhance organisational creativity and innovation. They note that sabbatical stimulates positive externalities such as rejuvenation, reflection, fresh perspectives, an opportunity to develop new professional relationships, stay current in their discipline, and ultimately enhance teaching and research. It offers enhanced productivity,

resourcefulness, productivity, enhanced learning environments, higher morale, increased institutional loyalty, enhanced faculty recruitment and retention and enhanced overall academic climate and reputation. According to Dzisah and Etzkowitz (2008), removing the blockages to the circulation of staff among the three institutional spheres is the development challenge of the 21st century.

### **3.9.2 Joint Curriculum Design:**

University-Industry Government (UIG) collaboration provides effective training for students and knowledge production in universities for the industry to contribute to the economy. The UIG collaboration can take various forms, including direct and indirect mechanisms (Erkarslan and Aykul, 2018). The intensification of the partnership has given birth to many channels that bring the institutional actors together. One of these channels is collaborative curriculum development/design (Erkarslan and Aykul, 2018). Over the years, many scholars have expressed concern over the critical gap between the knowledge produced by university researchers and what is used in practice (Siegel, Waldman & Link, 2003). Indeed, a tremendous amount of knowledge created in academia does not come to be applied and consequently create value (Sedlacek, 2013; Tessema and Abejehu, 2017). Hence, a collaboration between the critical institutional actors of UIG became necessary. Tumbas, Sakal and Pavlicevic, (2018) contend that University-Industry cooperation on curriculum design represents a basis for reaching innovations, developing new products, improving research and development (R&D), producing new knowledge, faster transmission of discoveries of research from lab settings onto the market, as a source of competitive advantage. Stabback (2016) concludes strong collaboration between university and industry in the curriculum development process has become critical in producing well-equipped graduates that could fit in the world of work. Therefore, modern curriculum development processes encompass stakeholder discussions before it is reviewed or designed.

### **3.9.3 Sharing of Research Facilities:**

University–Industry-Government interaction identify how scientific knowledge produced within universities enhances technological development in firms and facilitates innovations. D’este and Patel (2007) categorised this interaction into five broad categories: meetings and conferences, consultancy, and contract research, creating spin-offs and physical facilities, training, and joint research. According to the resource-based view of firms, companies' resources are critical to their success in technology development and competitive advantage. The resources include three categories: physical resources, organisational resources: and human resources (Barney, Wright and Ketchen Jr, 2001). Physical resources comprise equipment, production facilities, access to natural resources and geographical location. Human



resources include skills and knowledge capital in the firm, while organisational resources include coordination, corporate structure, an image of the companies. Businesses need all these resources to advance their technological development and competitiveness. However, most firms have limited funds in their possession to achieve their organisational objectives. External sources for resources have become necessary to compete, and the best external associate is the university (Santoro and Chakrabarti, 1999; Barney, Wright and Ketchen Jr, 2001). Moreover, the extending the resource-based view, the Dynamic Capabilities view also highlights the development of capabilities in the organisation (Makadok, 2001). It is not just the resources that matter, but the ability of managers to coordinate the organisation's activities in the best manner to achieve its objective. The fundamental principle of the dynamic capabilities view of the firm is that firms obtain new and innovative knowledge, skills, expertise, and competencies through organisational learning. According to Siegel et al. (2003), firms enhance their image when collaborating with a reputable university. That image enhancement will project the companies positively to the customers and attract sales and improve commercialisation. However, some researchers have noted that the university could sometimes appear to be more theoretical than practical

#### **3.9.4 Commercialisation of Academic Knowledge:**

The growth and expansion of the notion of the knowledge-based economy and the growing demand for innovation have given birth to a fresh challenge for the universities to move outside their traditional role as an educational institution into more outreach activities in collaboration with businesses and government research institutions (Etzkowitz and Leydesdorff, 2001; Etzkowitz and Leydesdorff, 1997; Etzkowitz and De Mello, 2003). There is a growing pressure to maximise the social return on public investment for the universities and public research institutions. Efforts made toward self-sustenance will push them to commercialise their academic knowledge. The appearance of knowledge commercialisation into the university system as a "third mission" has brought about the academic revolution that has had an enormous impact on economic development. According to Charles (1992) and Baycan (2013), academic knowledge commercialisation was first embedded as an economic development plan in the U.S in the 1980s. It later spread through Europe. There are three major approaches to the concept of transforming knowledge in universities to create value. It is referred to as the 'valorisation of knowledge' in Europe and knowledge commercialisation in the U.S. After the passage of the Bayh-Dole Act in 1980, the universities reinforced their efforts in technology transfer, firm formation, and licencing. After 20 years, the number of universities that produced technology licencing and transfer offices increased from 20 in 1980 to 200 in 1990, and by 2000, each research university had one technology transfer office Baycan (, 2013). According to Perkmann et al. (2013), the commercialisation of knowledge is a prime example of generating the

academic impact of research because it constitutes immediate and measurable market acceptance for university research output. Markman, Siegel and Wright (2008) have identified three research and technology commercialisation models by the universities.

#### **3.9.4.1 Internal Approach:**

The authors have acknowledged some of the pacifying conflicting demands the universities are facing because of technology commercialisation. The key personnel responsible for addressing this conflict are the academic scientist, sometimes discussed as the Technology Licencing or Technology Transfer Officers. They act as the boundary spanners acting as bridges between the university and other stakeholders, e.g., suppliers, entrepreneurs, customers, academic scientists. This method has raised some worries about the possibility of conflicting roles of the university in managing research and teaching and commercialising it is of research output. However, some scholars have suggested that universities apply the ambidexterity theory to modify the organisation's structure to deal with conflicting objectives (Duncan, 1976).

#### **3.9.4.2 Quasi Internal Approach:**

This process has been identified as one of the strategic ways of stimulating technology commercialisation from the university. The critical facilitators of this process are business incubators. It is the property or building facility that supports the start-up and primary phase of new commercial endeavours by providing them with a safe harbour and resources within a pleasant atmosphere in which they can flourish. Many universities have created a business incubator to foster new companies based on university-owned or licenced technologies. According to Phan and Siegel (2006), incubators seem to work out well when the university is entrepreneurial and has an internal innovation system. The internal innovation systems within the university include the incubators, science parks, academic entrepreneurs, or surrogate entrepreneurs (individuals with commercial experience who take on the roles of the entrepreneur within the academic scientist), post-doctorate candidates and graduate students. The authors suggest that internal innovation networks work best when venture capitalists and other personnel who have solid industrial relationships get involved in designing the incubator, a parallel education system is in place, and incubator managers are also working with some real estate developers.

#### **3.9.5 External Approach:**

This relates to research and technology commercialisation, which involve research parks, regional clusters, academic spin-off licencing, a contract research consultancy, joint ventures, spin-offs alliances, collaborations, cooperative venture capital, and open science and

innovation. Under the external approach, various approaches link UIG for a mutually beneficial interaction. These approaches include:

### **3.9.6 University Research Park:**

Science parks and incubators are property-based bodies that aim to accelerate business through a collection of various stakeholders and the sharing of resources. There is a difference between an incubator and a research park. While incubators give business advice to infant firms, and research parks do not provide such information to start-up businesses, a research park is a complete project that houses a wide range of entities, such as government labs and medium and small firms (Markman, Siegel and Wright, 2008).

### **3.9.7 Regional Clusters:**

This is the geographic concentration of interconnected firms, institutions of knowledge production and government laboratories or private labs. Numerous authors have pointed out that the principal businesses in several industries are situated in the same nation, region, or even city. Regional clustering is found in almost every forward-thinking economy and is appearing gradually in emerging economies. Clear examples of such regional clusters are in places like the Silicon Valley, Route 128, the M4 area, Tokyo, and lesser-known high technology centres, such as Austin, Ottawa, North Sydney, Minneapolis, and Hsinchu (Enright, 2003). Regional clusters facilitate the UIG interactions by creating a critical mass to the TTOs' discipline-specific skills and some development agencies, both private and public, local, and intermediary organisations and venture capitalists.

### **3.9.8 Academic Spin-Offs:**

According to Ndonzuau, Pirnay and Surlemont, (2002), the birthplace of the academic spin-off is the USA, where academic entrepreneurship and the spin-off phenomenon attained enormous accomplishments. The concept was promoted by the development of 'Silicon Valley' and 'Route 128' around respected universities such as Stanford and MIT. Wright (2007) described it as the new ventures that are created from licencing or assignment of a university's IP for initiation. The clear example cited by the author is when a university or cooperation owns equity in the spin-off in exchange for patent rights.

Licensing: this takes place when companies or universities decide to licence their inventions. There are many reasons why investors are licenced. These include exploiting external ideas and talents, reducing the risks related to R&D, and attracting domination over technology corridors (Wright, 2007). Therefore, many universities find it difficult to license their inventions, primarily because universities are answerable to many stakeholders and their aims are usually more complex than those of firms (Markman, Siegel and Wright, 2008).

### **3.9.9 Contract And Consultancy:**

A contract is referred to as an externally funded academic/technical or scientific research-based in the university. It utilises university-owned resources such as laboratories, scientific equipment, workshops, and other technical and administrative support staff or researchers. Consultancy is when an organisation hires a specific, skilled individual to provide expert and professional services to an individual or organisation. The academic consultants apply their skills and experience to help the client and resolve practical problems. This work often has relatively short timescales (a few weeks or months) and should have clear and well-defined deliverables. The client organisation would typically expect to own the results of the work. Any publication arrangement is made by agreement with the client (Armbrüster, 2004; Bloomfield and Danieli, 1995; Clark, 2004; Giroux, 2006; Sturdy, 1997). Contract research and consultancy may generate significant revenues, although their measurement may be problematical (Wright et al., 2008).

### **3.10 Mapping the Differences Embedded in The Theories of Innovation:**

Scanning the UIG from the theoretical lenses of Triple Helix, Model (THM) National Systems of Innovation (NIS) and National Innovative Capacity (NIC), each theory presents a different proposition. Although all the theories have some resemblance, they each have a unique input regarding the UIG network. For instance, all the frameworks have acknowledged the significant roles of the university at the heart of knowledge production, dissemination, and exploitation process within the society, but with different conceptualisations (Datta, Saad and Sarpong, 2019). The NIS framework stresses the role of academia in co-producing of knowledge with the industry and supplying human capital/trained personnel to the society. This joint production of trained personnel and advanced research may be more effective than specialisation in one or the other activity. For instance, the movement of trained personnel into the industry and other occupations can be a powerful mechanism for the diffusion of scientific research and demands from students and their prospective employers, which can help the UIG linkage. According to Etzkowitz (2003), NIS comprises primarily the industrial sector and other supporting structures in which new product development occurs in a given society. NIS contemplates that industry could be regarded in terms of sectors that sustained long term trajectories with a secure knowledge base that could mainly be captured within a firm. Much of this knowledge is tacit and tied directly to the production process rather than research. Additionally, the NIS sees innovation or development of new products from combining knowledge and experience and taking place through learning by doing rather than formal research, which is also the firm's responsibility (Etzkowitz, 2003a). A strong emphasis has been

given to basic and applied research from the NIS perspective, but more priority is given to basic research.

Like the NIS, THM stresses an expanded role to the universities, highlighting its direct role in commercialising university research output. The model promotes the transition of universities from institutions of teaching and research to entrepreneurial universities where commercialisation of academic research is through patenting, licensing and academic spin-offs is advocated. Moreover, in contrast to the NIS, the THM operates along with collaborative institutional engagements. Each institutional sphere plays its primary responsibility and incorporates others as a secondary obligation (Etzkowitz, 2008). The THM gives the three institutional spheres flexible responsibilities to play multiple roles without the original role being degraded (Saad, 2004). The government also promotes the entrepreneurial ethos embedded within the universities through appropriate policies and creates an avenue for staff circulation among the three institutional spheres. The industry serves as an engine for the commercialisation of the research conducted by universities. NIC, on the other hand, stipulates that academia provides human capital and plays an indirect role through training and education provided to scientists and engineers who will serve as a critical input to the innovation process in the future (Saad, Guermat and Brodie, 2015; Datta, Saad and Sarpong, 2019). NIC stress that government creates an appropriate environment and incentive in the economy for innovation to thrive and invest in higher education to raise human capital. Just like the NIS and THM, NIC also charged the industry to become the engine for the generation and commercialisation of new ideas.

### **3.11 Application of the Theories of Innovation in Developing Countries:**

Developed nations dominate the role of technology leaders while developing countries act as technological followers. The key to development success lies in closing the technological gap by importing existing technology and creating the internal capabilities to utilise and improve those technologies. Innovation theories, predominantly those that take a system perspective, acknowledge the critical roles of universities in the production and commercialisation of knowledge (Lundvall, 1992; Freeman, 1995; Etzkowitz and Leydesdorff, 2000). These theories have predominantly focused on the practices and experiences of industrialised economies, mainly the United Kingdom (U.K.), the United States, (U.S) and the Organisation of Economic Cooperation and Development (OECD) countries (Lehrer, Nell and Gärber, 2009; Ankrah and Omar, 2015) and ignored the specificities of developing countries (Datta and Souleh, 2018). In developed countries, universities play a critical role in the production and commercialisation of knowledge. Furthermore, most universities located in rich countries such as United States, UK, and Western Europe have been shaped by economic prosperity and matured political

histories such as the two World Wars and the Cold War, which ensued increased resource allocation and support to produce knowledge that could be put into military use (Datta and Souleh, 2018). The resource allocation has resulted in a ripe University-Industry system, contributing enormously to these nations' economic growth and prosperity.

However, these success factors such as resources (funding, facilities/infrastructure, maturity of the firms, absorptive capacity, institutional capacity, skilled personnel, research capacity, and sound education system) in developing countries are limited. According to Saad and Zawdie (2008), there is a noticeable institutional fragmentation in developing countries that undermines the technology transfer process or converting technologies into development. This is because most developing countries cannot absorb and assimilate the technologies. Dzisah and Etzkowitz (2008) note that universities have primarily focused on teaching in most developing countries because of their role in colonial or neo-colonial technology transfer regimes, where attention was directed at importing technology rather than encouraging endogenous innovation research capacities were developed. They further cited the examples of Africa where many of the countries inherited a colonial educational system that was oriented to the developmental needs at the time. The goal of the educational system was to churn out clerks to monitor and record basic accounting terms or purchase of traditional agricultural export commodities.

Furthermore, In the African context, university research capacity appears to be very limited. Research capacity, defined by Volmink (2005), comprises the institutional and regulatory frameworks, infrastructure, investment, and sufficiently skilled people to conduct and publish research, which varies significantly across the continent. Therefore, the big question remains whether developing countries generally are ripe at all in social, economic, institutional, and technological terms for such a policy to be adapted and applied. Invariably, making these innovation system theories work in developing countries like Nigeria is a daunting policy challenge. Therefore, the current studies will fill this gap by developing a conceptual framework from the critical and analytical literature review and other unique Nigerian factors and subject the framework to empirical scrutiny. This conceptual framework will be based on synthesising the major theories (NIS, THM and NIC,) and domestic (Nigerian factors). In developing country context and Nigeria in specific, adapting these theories will require a comprehensive study to understand the nature of the interaction between the three institutional spheres and identify the factors inhibiting this interaction.

### **3.12 Conceptualising University-Industry-Government Interaction:**

A primary aim of this research study is to develop a conceptual framework from a critical and analytical review of the UIG literature. The conceptual framework is a visual interpretation and synthesis of existing empirical and conceptual viewpoints and models that emanated from the literature. The framework is built based on the propositions of the theories of innovation and national factors of the UIG linkage in Nigeria. The first elements are the four channels of the UIG interaction identified in the literature considered relevant in the Nigerian context. These channels include inter-organisational human capital mobility/staff exchange, research facility sharing, collaborative curriculum design and contract and consultancy. The second element of the conceptual framework is the four developmental stages of the Triple Helix Model. According to the Triple Helix Theory, the first primary core development of the network is internal transformation and role-taking, which suggest some significant internal changes within each institution to reflect a collaborative knowledge production. Taking the role of each other means that each institutional sphere, in addition to performing its traditional tasks, takes on the role of the other as a secondary role. Suppose an institution already performs a function as its primary duty. In that case, the utility of another institution taking it as a secondary duty is the innovation contribution of that institution toward the innovation process (Etzkowitz, 2008). Universities and other institutions of knowledge production have become new actors with new roles in societies. Not only do they create knowledge, conduct research and train students, but they fundamentally trying to put knowledge to use. Universities in this regard move toward the more entrepreneurial university, combining its traditional teaching and research with academic entrepreneurship through TTO and firm formation (Leydesdorff and Deakin, 2011).

The second is the influence of each helix upon another, for instance, enacting a policy or law by the government of a new way of knowledge creation, sharing, and diffusion, which influences the university and industry (Etzkowitz, 2003). The third is creating a new overlay communication, which means the formation of the new network, linkages within the three institutional helices to institutionalise collaboration and inspire inter-organisational creativity. The fourth is the recursive effect of this inter-organisational collaboration between the University-Industry-Government in innovation and knowledge creation (Etzkowitz, 2003). It means that knowledge creation becomes routine and continues collaboratively with mutual benefits. The third stage of the conceptual framework is to examine the general inhibitors of UIG interactions. Some of the inhibitors are identified and adopted from the UIG literature, while others are unique Nigerian factors serving as inhibitors to the UIG collaboration in the Nigerian context. The inhibitors adopted from the literature include bureaucracy, different orientations of the stakeholders, lack of resources/funding, low quality of research output, and

lack of communication. The Nigerian factors include lack of IP policy or weak enforcement of IPR, and poor work ethics. The three stages of the conceptual framework have helped in thoroughly exploring the UIG development in the Nigerian context. The first four channels of the interaction were used to assess the network. The four developmental stages helped the researcher identify the congruencies and incongruences of the theory and practice in Nigeria. The fourth stage also provided a blueprint of the inhibiting factors obtainable in the literature and practices. Therefore, due to the complexities in identifying the congruencies and incongruencies of the UIG practice in Nigeria, questions were raised for each stage which guided the data collection and analyses for the study. Figure 3.5 below depicts the conceptual framework for the study.



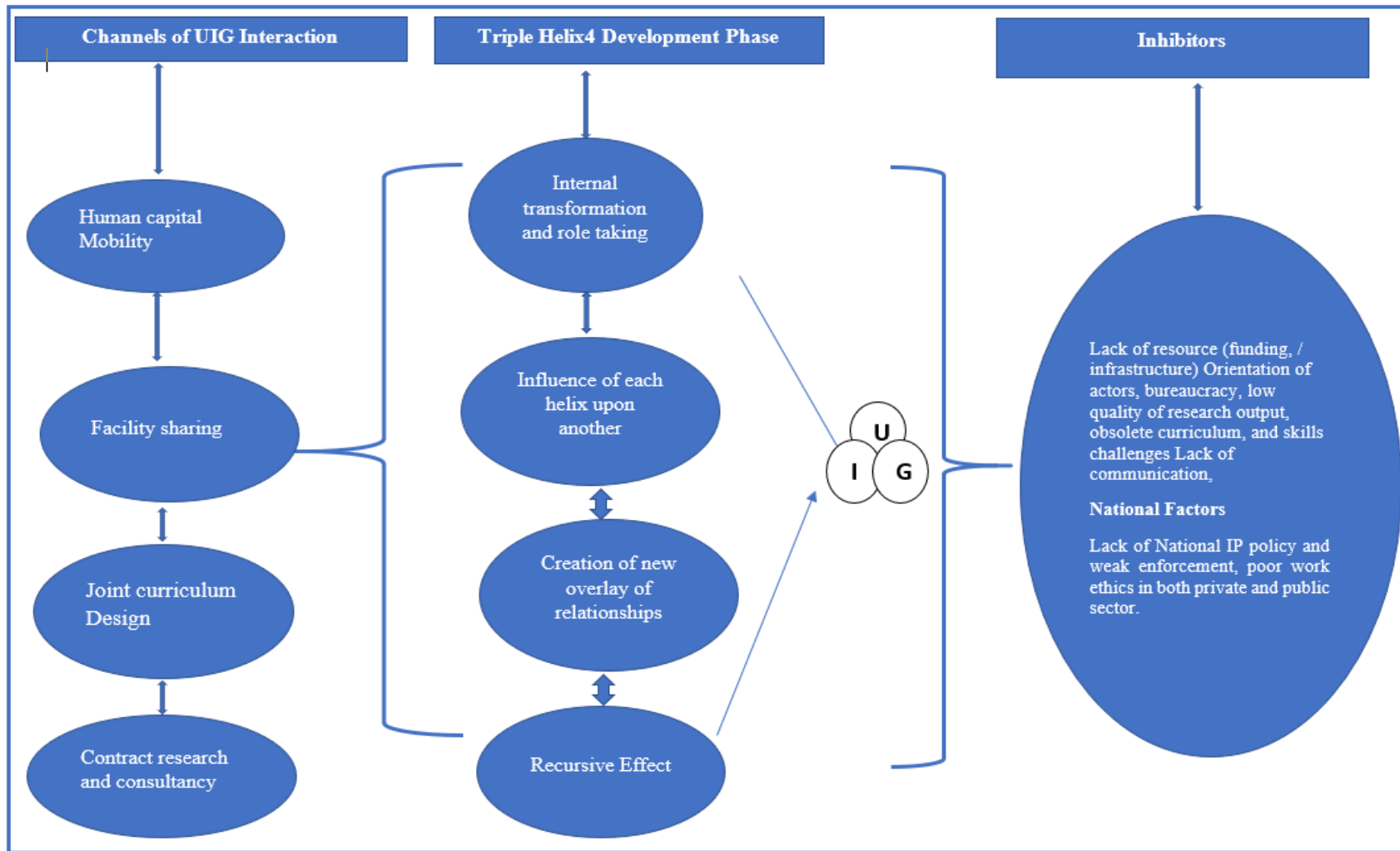


Figure 3 5 Conceptual Framework for the Study: Author

## 4 CHAPTER-FOUR

### 4.1 Research Methodology

The previous chapter provided a literature review of the study. The literature has guided the development of a conceptual framework based on which data was collected and analysed. This chapter describes the methodological framework and approaches adopted throughout the process of data collection and analysis. It also presents the justification for using these methods and approaches.

### 4.2 Research Aim and Objectives

The study aims to understand better the effectiveness of the UIG interaction in Nigeria, particularly in the knowledge-intensive firms and STEM-related areas in the universities.

### 4.3 Research Objectives

- 1) To examine the critical national factors inhibiting the effectiveness of UIG interaction in Nigeria.
- 2) To critically examine the UIG literature in order to identify and discuss the key theories of innovation, channels of interaction, enablers, and inhibitors of the collaborations.
- 3) To develop a conceptual framework from a critical and analytical review of the literature
- 4) To develop and evaluate a revised conceptual framework following an in-depth analysis of the fieldwork data and make a significant contribution to existing knowledge on UIG interactions.
- 5) To develop recommendations for the institutional spheres on measures to stimulate the UIG collaboration in Nigeria.

### 4.4 Understanding the Nature and Purpose of the Study

According to Saunders *et al.* (2009), a researcher's comprehension of the type and purpose of their research cannot be overemphasised. Having recognised that every study's result varies, the researcher must point out the kind of research that is being conducted and within which research field, whether basic or applied. This information will give the audience a clearer picture of the study to make the best use of the findings. In this regard, Saunders *et al.* (2009) argue that basic research is conducted by universities based on an academic agenda, while applied research is done and primarily by managers and practitioners. Basic research centres on the theoretical angle, and its significant consumers are the academic community, and it is also referred to as 'fundamental' or

'pure' research. Applied research is more practical in its approach and tends to address topical issues and is presented in ways practitioners and policymakers understand and act upon. It is sometimes referred to as real-world research. There is a mutual relationship of reciprocity, despite the differences in theoretical research and applied research. Applied research depends directly or indirectly on the conceptual apparatus developed by theoretical research, and in turn, the theoretical research constantly benefits from applied research findings to further refine the conceptual tools and sometimes even abandon some conceptual tools. In Table 4.1, an attempt has been made to highlight some of the differences between basic and applied research. The mention below to business and management/managers is to contextualise our research project, but the differences mentioned there have wider reach.

Table 4. 1 *Basic and Applied Research; Source: (Saunders et al. 2003)*

Basic research	Applied research
<b>Purpose</b>	
Expand knowledge of processes of business and management	Improve understanding of particular business or management problem
Results in universal principles relating to the process and its relationship to outcomes	Results in solution to problem
Findings of significance and value to society in general	Findings of practical relevance and value to manager(s) in organisation(s)
<b>Context</b>	
Undertaken by people based in universities	Undertaken by people based in variety of settings including organisations and universities
Choice of topics and objectives determined by the researcher	Objectives negotiated with originator
Flexible timescales	Tight timescales

Therefore, given the research questions, including the aim and objectives of this study, the researcher mirrors the fact that the study will examine the interaction between University-Industry-Government drivers for innovation in Nigeria. The research assessed the current collaboration based on the theories of innovation to uncover the significant barriers to cooperation in promoting technological innovation in the country. In this regard, the research serves both basic and applied because the study's outcome unpacked the congruencies and non-congruencies of the theory and practices. Consequently, the research can be considered within the basic and applied research spectrum. Collis and Hussey (2009) categorised research based on purpose, process, logic, and outcome. The purpose of a study is to ask whether they are moving from the general to the specific or *vice versa* as the case may be, while the outcome of the research asks the question about whether the study is trying to solve a problem or contribute to knowledge (Saunders *et al.*, 2003). Therefore, the purpose of this research is to study the University-Industry-Government interaction in Nigeria

based on four channels of interactions, four developmental stages of the Triple Helix Model and identify the factors inhibiting the interactions. The process of this study involved data collection, analysis and obtaining findings that will contribute to knowledge (outcome).

#### **4.5 Research Paradigms**

A paradigm is a set of beliefs, values, and techniques shared by members of a scientific community, which acts as a guide or map, dictating the kinds of problems scientists should address and the types of acceptable explanations (Neuman, 2016). Paradigm refers to a broad background of insights, perceptions and beliefs based on which theories and practice's function. It is a systematic set of assumptions or beliefs about the fundamental aspects of reality. According to Guba (1990), the research paradigms are categorised according to their ontology - the nature of the knowable; epistemology - the relationship between the knower and the known; and methodology - how knowledge should be sought. The terms paradigm means a scientific practice based on the people's philosophies and presumptions about the world and the nature of knowledge, and how research is carried out (Collis and Hussey, 2013). They are universally accepted models that offer a framework for an acceptable set of theories and methods of defining data. The values of research involving human participants are embedded in the nature and origin of knowledge and how knowledge is acquired (Denzin and Lincoln, 2000; Becker, Bryman, and Ferguson, 2012). In these values, there are assumptions about the nature of knowledge (epistemology), the reality of what is known (ontology), and the suitability of methodological approaches used in knowledge production (Shah and Corley, 2006; Saunders, Philip, and Adrian, 2009; Becker, Bryman, and Ferguson, 2012).

#### **4.6 Ontology**

Ontology is a Greek word meaning 'on' or 'being' (Thomas, 2004). It is concerned with the issue of the fundamental nature of reality (Neuman, 2016). It is the study of being and is concerned with what kind of world we are investigating, the nature of existence, and reality's structure (Crotty, 1998; Guba and Lincoln, 1982). Our exploration of the world is rooted in our ontological assumptions, while what we need to do to produce knowledge and what knowledge looks like falls within our epistemological assumptions (Guba and Lincoln, 1982). Ontology is connected to a branch of philosophy that is concerned with articulating the nature and structure of the world (Thomas, 2004; Norman and Yvonna, 2005; Antwi and Hamza, 2015). It precisely emphasises the nature of reality and what we know about reality. It determines whether or not we think reality exists entirely separate from our practices and understandings: this includes the research we conduct to find such things or whether we believe it cannot be separated from human practices (Braun and Clarke, 2013). Ontological assumptions describe different epistemological and methodological positions (Morgan and Smircich, 1980). Some ontologists believe that reality exists, which we may not be aware of due to our limited perceptual equipment. The reality exists, but we have no complete knowledge about it. Others argue that

only publicly observable phenomena are considered real and mental states are held not to qualify (Thomas, 2004). Based on these terms, ontology could generally be categorised into objectivism (realism) and interpretivism (constructionism) (Bryman and Bell, 2015)

## **4.7 Epistemology**

Epistemology is the nature of knowledge and what the researcher sees as an acceptable form of knowledge (Hammond and Wellington, 2012). Epistemology connects the investigator (the knower) and the object being studied (Antwi and Hamza, 2015). It deals with the nature of knowledge and how we know what we know (Crotty, 1998). Epistemological issues deal with what is (or what should be) regarded as acceptable knowledge in a particular discipline. It raises some fundamental questions about whether or not the world can be studied according to the same principles and procedures of natural science (Bryman and Bell, 2015). According to Collis and Hussey (2009), exploring research while applying its epistemological and philosophical position is of high prominence because it directly implies the research approach and data collection method. From an epistemological viewpoint, the researcher examines two further dominant paradigms—positivism and interpretivism (Bryman and Bell, 2011; Saunders et al., 2012).

### **4.7.1 Positivism/Empiricism**

The positivist believes that reality is fixed, can be directly measured, knowable, and studied from an objective viewpoint of reality (Dean, 2007). According to the positivist stand, there are universal laws that guide human behaviours, and as such, they can better be understood if the researcher is independent of what is being researched (Rahi, 2017). Positivism proposes that human societies, like the natural world, are subject to fixed laws (Crotty, 1998; Thomas, 2004; Bryman and Bell, 2015). They believe that only observable and measurable phenomena should be seen as valid and acceptable knowledge (Collis and Hussey 2009). Positivism is mainly associated with the quantitative method, where the objective of the research is to identify a causal link or relationship between variables and subjects through statistical data (Bryman and Bell, 2015). Positivism assumes that the researcher or the observer separates himself from the object being observed and demonstrate reality objectively and unbiased in the data collection process. Valid knowledge based on positivist perspective is obtained through the application of scientific methods that control variables and remove various forms of contamination and bias (Braun and Clarke, 2013)

### **4.7.2 Interpretivism**

Interpretivism is related to the seminal work of Max Weber (Crotty, 1998). It is sometimes described as Subjectivism or Constructionism. Interpretivism believes in multiple realities

where actively construct social reality by interacting and dialectically engaging with one another (Crotty, 1998). In this school of thought, individuals create theories that help them make sense of a scenario. Reality is socially constructed, and all human knowledge is developed, conveyed, and maintained in social situations (Hudson and Ozanne, 1988). Meanings do not have an independent existence; it is not objective or out there awaiting discovery. Instead, meaning is created through interaction with others and through historical and cultural norms in individual lives (Bryman and Bell, 2015). Social phenomena and their meanings are not only produced through social interaction, but they are in an endless state of adjustment (Bryman and Bell, 2015). Human behaviours generally could only be understood if the researcher recognises the meanings and those meanings which could also be interpreted according to the context within which they took place.

This research adopted the interpretivist paradigm; the research explores University-Industry-Government interaction drivers for innovation in Nigeria. The research participants are drawn from university, industry, and government institutions. The research is based on the broad principles and beliefs that realities are socially constructed, and knowledge is derived from such social constructions. This can be viewed as being interpretivist in its approach to accepting the views and perspectives of study participants (Schwandt, 1994). A significant feature of interpretivist paradigm is the understanding and acceptance that multiple realities exist, and that the construction of these multiple realities is fluid, relying heavily on the persons' perspective and experiences (Denzin and Lincoln, 2000). The researcher considers the social actors representing different organisations with diverse cultures, values, and interpretations of their organisational roles within the phenomenon being investigated. That means that multiple social and cultural realities exist surrounding the interactions. Therefore, participants perceive and interpret such interactions differently (Shah and Corley, 2006). Secondly, the researcher's worldviews are designed by his/her discipline area, his/her beliefs of the advisers and the faculty of the student's field and past research experiences' (Creswell, 2011). The constructivist paradigm postulates that social phenomena and meanings are created from the interplay between the perceptions and actions of social actors (Saunders and Lewis, 2014). To the interpretivist perspective, the meaning is not out there waiting for discovery, but the responsibility to attach meaning to reality depends on the social actors involved in its creation (Hudson and Ozanne, 1988; Saunders and Lewis, 2014). As knowledge is created with the interaction between the various actors involved, it is continuously in the state of a revision to reflect the socio-economic needs of the society. Interpretivism is constructed on a naturalistic approach to data collection, such as interviews and observations (Mackey and Gass, 2015).

## **4.8 Research Methods**

The technique is another critical aspect of the research because it provides the study with a clear choice of how best to design a study (Saunders, 2012). It refers to the different approaches that are combined to generate research data. As Saunders (2012), methodology implies the methods adopted by the researcher in conducting the research work from the beginning to the end. The methodological process involves general philosophies and an agenda that guides how research is carried out (Mackey and Gass, 2015). Methodologies could either be qualitative or quantitative. Collis and Hussey (2003) have provided a clear distinction between methodology and methods. They noted that methodology refers to the overall approach toward the research process, starting from the theoretical framework underpinning the research to collecting and analysing the research data. On the other hand, methods are the various means through which data could be collected or analysed. Bryman and Bell (2011) described methods as the techniques for data collection, which might involve specific instruments such as self-completed questionnaires, or semi-structured interviews, schedules, or participant observations where the researcher gets the opportunity to listen and watch others. The method is mainly concerned with the following issues:

- 1) Why are certain data collected?
- 2) What kind of data is collected?
- 3) When to obtain data?
- 4) How did you obtain the information?
- 5) How to analyse data?

### **4.8.1 Qualitative and Quantitative Research**

Qualitative research is a social inquiry method that emphasises the interpretation of a phenomenon (Braun and Clarke, 2013). It uses various approaches to understanding groups, cultures, or individuals (Braun and Clarke, 2013). Qualitative research is employed to study behaviours, perspectives, feelings, and individuals' experiences (Silverman, 2016). The foundation of the qualitative study lies in the interpretive method to social realities, describes human beings' experiences, and studies objects in their natural settings (Burns, 1997). In qualitative research, the interview is one of the ways through which data is collected. Suppose a researcher decides to engage in an interview. In that case, the researcher should be looking at information based on emotions, feelings, and experiences or information based on sensitive issues and information based on insider experience privileged and insights (Wisker, 2007). Creswell (1994) has given a very succinct description of quantitative research as a type of research explaining phenomena by collecting numerical data that are analysed using mathematically based methods. Quantitative methods employ questionnaires such as surveys, which deals with close-ended answers (Morse and Field, 1995). This method adopts a positivist worldview; typically, this method uses designs such as experiments and surveys. Quantitative research is the correlational design in which the research

design also uses a survey and numerical description of trends or attitudes of a population by looking at the sample of that population (Choy, 2014).

#### **4.8.2 Difference Between Qualitative and Quantitative Methodologies**

There are clear differences between quantitative and qualitative methods. These differences are mostly in their philosophical underpinning, data collection methods, procedures, analysis and ultimately, the findings. According to Bryman and Bell (2011), the difference between the two methodological approaches relates to behaviour and meaning. The significant difference between these methods also rests in their ontology and epistemology (Guba and Lincoln, 1994). The quantitative paradigm is based on positivism; its ontological position is that there is only one truth, objective reality exists independent of human perception; and epistemologically, the researcher and the researched are independent entities. On the other hand, a qualitative paradigm is grounded on interpretivism and constructivism (Choy, 2014). The quantitative methodology is also associated with the techniques of the survey in carrying out research. Both methods are interested in studying what people do or think, but they adopt different strategies in achieving that. Another noticeable difference between the two methods is that theories are developed in quantitative methods before the data collection and is generally driven by the theory testing approach (Tracy, 2019). The quantitative approach is more organised to determine the amount of a problem and have the purposes, design, sample, questions predetermined, while the qualitative method, on the other hand, allows flexibility in the data collection process, Bryman and Bell (2011) and Tracy (2019) state that qualitative method uses words and open-ended interview questions, while quantitative method use numbers, and closed-ended questions.

#### **4.8.3 Methodology for this Study**

The researcher has adopted qualitative research methodology for the following reasons; first, as an interpretivism inclined study, it will enable the researcher to conduct in-depth research into the participant's perceptions, experiences, emotions, beliefs, and attitudes in their natural work context (Yilmaz, 2013). The plethora of existing literature also drives the choice of this particular methodology in the research field and the researcher's motivation to make a rich and original insight on the state of interaction between government, academia, and industries in Nigeria. Patton (2002) submits that the qualitative research method allows predetermined analytical processes that will examine some problems in considerable detail and situate with contextually. Therefore, the qualitative method best suits this study to understand the different stakeholder's perceptions, experiences, and opinions on the University-Industry-Government Interaction in Nigeria. Secondly, this study seeks to gain a more in-depth insight into participants' subjective experiences of their relationship and the potential barriers affecting the collaborations. Therefore, the researcher believes that since individuals' perspectives about the phenomenon within



their social context vary, a qualitative approach, which examines life from multiple perspectives, is appropriate to provide an explanation for how this collaboration occurs and how the participants make sense of the world and how they experience events (Neuman, 2016). Thirdly, this research aims at providing a comprehensive assessment of the University-Industry-Government interaction and identifies the critical factors impeding such cooperation. Consequently, the best way to identify and uncover such complicated situations requires getting to know government officials' different minds and perspectives, decision-makers in the industry, and university administrators. Therefore, a qualitative method is the best way to get into the various organisations involved in the trilateral interaction and to get their different viewpoints.

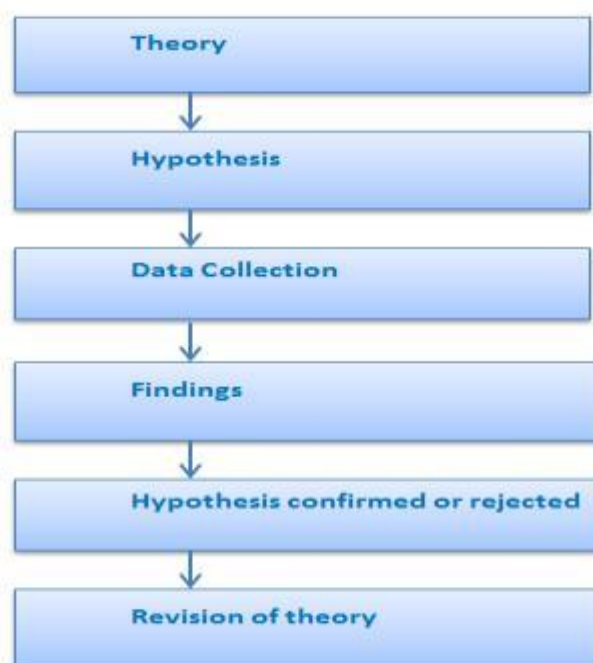
## **4.9 Research Approach**

This research encompasses theories, but the precise time when these theories become essential for consideration depends on the research approach adopted (Saunders, Lewis, and Thornhill, 2003). There are two broad approaches: deductive and inductive.

### **4.9.1 Deductive Approach**

As Bryman and Bell (2011) described, the deductive approach is the most common view of the nature of relationships between theory and research. In this approach, the researcher develops a theory and subjects it to a rigorous test and deduces a testable hypothesis or a proposition about relationships between two or more phenomena (Saunders, Philip, and Adrian, 2009). In the deductive approach, the researcher begins "with an abstract, logical relationship among concepts and then moves towards concrete empirical evidence (Ali and Birley, 1999). It mostly works around an existing theory which becomes the basis for drawing a hypothesis. It is generally adopted in qualitative and, in some cases, quantitative research (Saunders, Philip, and Adrian, 2009). Hence, this approach allows the study to create a hypothesis using theory and later approves or rejects the hypothesis through data analysis. The researcher, in this approach, can form a hypothesis of the phenomenon that must be subjected to empirical scrutiny. The research must skilfully deduce a hypothesis and then translate it into operational terms. The current research follows the deductive reasoning approach. Starting from the literature review and identifying the literature gap and available theories around UIG interaction and innovation studies, progressing into projecting the acquired knowledge into the framework based on previous research. The assumptions drawn from the theories are discussed and demonstrated in a conceptual framework (chapter three), proving the relevance and applicability of the model. Therefore, this research is deducting from already existing academic knowledge, creating a framework, and empirically examining the framework based on the UIG practices, its development, and the inhibiting factors in Nigeria. This approach aligns with Yin (1994), who notes that case study research should commence with a statement of propositions answers to "how" and "why" questions to be tested with the data gathered. Cases that confirm the

propositions enhance confidence in the validity of the concepts and their relationships; cases that disconfirm the relationships can provide an opportunity to refine the theory.



*Figure 4. 1 Deductive Approach; Source: Bryman and Bell 2011*

#### **4.9.2 Inductive Approach**

An inductive approach is the opposite of the deductive method, as the observation of the phenomenon is made before the theoretical formulation (Ali and Birley, 1999). This is a flexible approach because there is no condition of prearranged theory to gather data. The investigator gathers the data before a theory is developed. Hence, the researcher uses observed data and facts to reach the tentative hypothesis and define a theory as per the research problem (Membe and Doriza Loukakou, 2012). This approach is concerned with specific observations, and then the conclusion driven from the observations are generalised to a similar group, condition, or situation (Ali and Birley, 1999). In this approach, the generalisation of the observations is verified and confirmed, and others are rejected. Theories are built to explain the views in the end (Zalaghi and Khazaei, 2016). In the inductive approach, the researcher should not have predetermined results or bias in the phenomenon being investigated and shall register what is being observed. At the beginning of the research, a particular theory is not encouraged in the inductive approach. The researcher enjoys complete freedom regarding determining the course of the study. There are no presumptions of any outcome until the investigation is done (Zalaghi and Khazaei, 2016). It is important to note that although thematic analysis is now more prevalent (Willig, 2013). This study followed the deductive approach as it utilised a theoretically informed template (Saunders et al., 2012). The study designed a theoretical framework based on the literature review and identified the channels of assessing the University-Industry-Government (UIG) interaction. The first

parameters include the four channels of UIG interaction, including inter-organisational human capital mobility, facility sharing, joint curriculum design and contract and consultancy. The second parameters are the four developmental stages of the Triple Helix theory to examine the organisational practices of each institutional sphere and understand the congruencies and incongruencies between the theory and practice. Thirdly, to identify the inhibitors of the collaboration within the Nigerian context.

#### **4.10 Research Design**

As pointed earlier, this research has adopted qualitative methods with interpretivist epistemology. Churchill, Iacobucci and Israel (2010) describe research design as the framework or strategy for research that guides the study in collecting and analysing data. The research design is a framework that governs the investigator on how to go about the investigation process from beginning to end. Hence, a research design is a strategy that shows how, when, and where data are to be collected and analysed. According to Bryman and Bell (2011), a choice of research design reflects the decision as to the priority being given to various dimensions of the research process. These, among others, include:

- 1) the causal connection between variables
- 2) generalising to a larger group of individuals than the actual participants
- 3) understanding behaviour and meaning in its specific context and
- 4) having an appreciation of a social phenomenon over time and their connection to each other.

According to Yin (2014), a research design is a consistent strategy for getting from here to there, where here is described as the preliminary queries to be answered, and there is defined as the approximate conclusions (answers) about the initial set of questions.

##### **4.10.1 Case Study**

According to Yin (2003) case study is an analytical approach that involves a detailed description of the case, the settings of the case within contextual conditions. The case study builds on an in-depth contextual understanding of the case, relying on multiple data sources. Yin (2009) defines a case study as an empirical study that investigates a contemporary phenomenon within its actual setting; when the boundaries between phenomenon and context are not evident, multiple sources of evidence are used. The case may be a single business, group or workers, events, process, or person. Whichever is the interest of the study, detailed information is gathered about the phenomenon that is being investigated. Under this strategy, it is possible to study one or multiple cases (Collis and Hussey, 2013). Yin (2003) identified some attributes of a case study as follows. The case study strategy aims not just to study

phenomena but also to understand them within a particular context. The research does not start with a set of questions about the limits within which the study is going to take place. The strategy uses multiple methods for data collection, which may comprise either a qualitative or quantitative approach. For this current research, a case study strategy has been adopted to complement the methods mentioned in the previous section. The fundamental reason for choosing a case study strategy is that it enables the researcher to understand the various institutions, their perceptions, interpretations, and subjective experiences within the real-life context and from an insider perspective. This research tries to explore "how" the institutions of UIG interact. These questions are better answered with a case study research strategy. Moreover, Zainal (2007) notes that the case study strictly allows the researcher to examine within a specific context, and it explores contemporary real-life issues through detailed contextual analysis. The second reason for choosing the case study strategy is that it enables the researcher to access multiple sources of data collection to generate rich data to lay a perfect foundation for theory building. The case study provides the researcher with an opportunity to understand the actual happenings within its natural settings (Yin, 2009). The detailed qualitative accounts produced in case studies help in explaining the complexities of real-life situations, which may not be captured through experiments or survey research strategy (Zainal, 2007).

#### **4.10.2 Multiple Case Study Strategy**

According to Al Qur'an (2010), a case study design guides the process of collecting data and helps in the analysis and interpretation of findings. Yin (2003) identified four types of case study design: (a) single case (holistic), (b) single case (embedded), (c) multiple case (holistic) and (d) multiple cases (embedded). Primarily, the single case design suggests the planning of one case study, and it is holistic when it involves one unit of analysis or the case itself. However, it becomes embedded when a more complex sub-unit of analysis is involved. On the other hand, multiple case study design refers to several case studies or experiments. It can be holistic if it involves numerous holistic cases in which each holistic case involves only one unit of analysis. The embedded multiple-case design contains some embedded cases wherein each embedded case includes multiple units of analysis. Therefore, the current research has adopted multiple case (embedded) strategies, which is the appropriate design for this research. This is because the study involves various cases and various units of analysis within each case. The research is a case study of six universities, twelve IT-intensive companies and ten government institutions. According to Yin (2009), multiple cases study strategy enriches the theory-building process because it produces more robust evidence that helps theory building than a single case study strategy.

#### 4.11 Research Access

One of the most critical steps in case study research design is selecting a case (Marschan-Piekkari and Welch, 2004). However, the fundamental difficulty qualitative researchers confront is how to gain access to organisations. Researchers devote a significant amount of time and resources to this task, especially when such an investigation requires in-depth interviews or other data collection forms. It even becomes more demanding if the research focuses on sensitive issues (Shenton and Hayter, 2004). Thus, it is vital to take this into practical consideration before embarking on any research data collection stage. According to Easterby-Smith, Thorpe, and Jackson (2015), many political issues are involved in gaining access to the relevant organisation for data collection, such as formal and informal access. Formal channels encompass formal routes to the management of an organisation, while informal access to people and documents contain any opportunistic approach. Laurila (1997) points out three typologies for creating access to the organisation or its people.

**Formal access:** According to Laurila (1997) and Easterby-Smith, Thorpe, and Jackson (2015), preparing for contacting your potential participants require a significant amount of research to identify whom to contact and how to reach them. The authors also advised that researchers need to consider the fact that communicating with the participants in a realistic option should be helpful to have direct or indirect contact with the participants, e.g., through neighbours, family, or friends. Once the first contact is established, the authors recommended that the next step should be for the researcher to establish contact with either the individuals or the institutions through letters or other means of communication. If the researcher chooses a letter, that letter should be clear, short, and written in clear language. Accordingly, for the current research, the researcher, together with the supervisory team, have carefully drafted a letter of invitation to all potential participants and sent it to the participants through their official email addresses, which were obtained through family, friends, and acquaintances. The researcher got a positive reply from most of the participants within a few days after the email was sent, and that made the subsequent access very easy for the researcher.

**Personal contact:** another way for a researcher to establish contact with the participants is through personal communication. Once the first point of contact is established, the researcher can either appear in person or make phone calls. One way to obtain trust, according to authors, for example, is by making sure that the researcher is aware of the activities of the company either by visiting their websites to see what the company or the organisation prioritises. In line with this assertion, the researcher has established personal rapport with the companies, universities, and government institutions to be familiar with their current activities, projects, and future goals to have a friendly conversation when the first personal call is made. The researcher could get some personal phone numbers of the participants through family, friends, and well-wishers. Since then, until data

collection for the research, personal contact was consistently maintained with the participants, making the interviews easier. The researcher was in touch with most of the participants through phone calls and other online platforms.

**Fostering personal rapport;** The researcher maintained an excellent rapport with the contacts before, during and after the pilot and the primary data collection.

## **4.12 Sampling Techniques**

Sampling is the specific principle that is used in selecting participants to be included in the study. There are broadly two sampling methods, probability, and non-probability sampling methods (Saunders, 2012). Probability sampling dominating quantitative studies; the non-probability technique is primarily used in qualitative research. The probability sampling method is based on the survey; for instance, a sample is drawn from a random population where the researcher makes inferences from the sample of the population to answer the researcher question. Non- probability encompasses the choice of participants from a range of alternative techniques based on the researcher's subjective judgement. Purposive sampling is when the researcher chose a sample that best answers the research question and meets the research objectives, while snowball sampling is when the respondents help the researcher and lead the researcher to discover other relevant participants (Saunders, 2012). For this study, the researcher adopted the purposive non-probability sampling method in the primary data collection. The researcher selected the key stakeholders who know the UIG interaction. These participants were chosen because of their critical role in their various capacities as Directors of Research and Innovation in the various universities, Chief Executive Officers (CEOs) in the industry and the Directors of the relevant government institutions. Saunders (2012) further notes two types of techniques within purposive sampling: heterogeneous and homogeneous samples. For homogeneous samples, 10 participants will suffice, but the number of respondents should be 15 to 25 participants for the heterogamous. This research is based on a heterogeneous sampling because of the various stakeholders involved, which cut across the three cooperating institutions from diverse cultural backgrounds.

### **4.12.1 Selection of Research Participants**

The size of a sample is another crucial step in a qualitative study. Saunders, Philip, and Adrian (2009) suggest that a researcher cannot use the entire population when the population is enormous due to time and budget constraints. The sample size for the non-probability sampling technique is vague; what is essential is the logical relationship between the sample and the focus of the research. However, Saunders (2012) recommended that to have guidance and a sense of direction, researchers should have enough interviews by conducting additional interviews until data saturation is reached. It is not the sample size that matters but the ability of the sample to guarantee

the precision and richness of the data. In selecting the sample size of this research, careful consideration was given to those institutions that are directly responsible for technology development, tech-based firms, and research-based, first-generation universities. All the stakeholders involved in this trilateral relation are adequately represented in this study. The profiles of the participants are depicted in Tables 4.2, 4.3 and 4.4.

#### 4.12.2 Universities

Six universities participated in this research cutting across the six geo-political zones of the country, one from each geo-political zone of Nigeria was chosen. The criteria for selecting the universities include ages, ranking, and intensity of the Research and Development (R&D). Different departments handle cooperation within each university; Table 4.2 below shows the various universities that participated in this research.

*Table 4. 2 Research participants- Universities and Locations*

Geo-political zones	Towns	Name of the university	Department	Participants
South West	Ibadan	University of Ibadan	Research management office	Director
South-South	Edo	University of Benin	IPR and TTO	Technology Transfer officer
South East	Enugu	University of Nsukka	Directorate of Research, Tech, and Innovation	Director
North Central	Ilorin	University of Ilorin	Directorate of Research, Tech, and Innovation	Director
North West	Kaduna	Ahmadu Bello University, Zaria	Directorate of University Advancement	Director
North East	Bauchi	ATBU University	Directorate of Research and innovation	Director

#### 4.12.3 Industry

Twelve industry participants were selected, two companies from each region of the country. The samples were all from the Small and Medium Scale Enterprises of Nigeria, all of which are under Small and Medium Enterprises Development Nigeria (SMEDAN) one (1) decision-maker or CEO of technology-based firms was selected. For confidentiality and anonymity, this research does not refer to the industry respondents by name, nor does it disclose the names of the companies. The analysis has given a code to each respondent from the industry as

technology-based firms (TBF) based on their regional locations. Table 4.3 below shows the firms that took part in the study.

*Table 4. 3 Profiles of the Industry Participants and Locations*

Technology-based Firm 1 North West	TBF 1 NW
Technology-based firm 2 North West	TBF 2 NW
Technology-based firm 1 North East	TBF 1 NE
Technology-based firm 2 North East	TBF 2 NE
Technology-based firm 1 North Central	TBF 1 NC
Technology-based firm 2 North Central	TBF 2 NC
Technology-based firm 1 South West	TBF 1 SW
Technology-based firm 2 South West	TBF 2 SW
Technology-based firm 1 SE	TBF 1 SE
Technology-based firm 2 SE	TBF 2 SE
Technology-based company 1 North East	TBC 1 NE
Technology-based company 2 North East	TBC 2 NE

#### **4.12.4 Government**

Ten government institutions were selected based on the multiple roles they play in regulations, promoting ICT and innovation in science and technology, facilitating access to finance for start-ups and R&D roles. Table 4.4 shows the participants from the government



*Table 4. 4 Research Participants Government Agencies*

<b>Name of Institution</b>	<b>State</b>	<b>Position of participant</b>	<b>Number of participants</b>
National Information Technology Development Agency NITDA	Head office Abuja	Director of e-government	1
National Universities Commission (NUC)	Head office Abuja	Director of Research and Innovation	1
National Office for Technology Promotion (NOTAP)	Head office	Director Technology commercialisation	1
National Board for Technology Incubation	Head office Abuja	Director	1
National Centre for Technology Management (NACETEM)	Abuja office	Register	1
Federal Ministry of Science and Technology (FMST)	Abuja	Assistant Director of policy and research	1
Small and Medium Scale Enterprises (SMEDAN)	Abuja	Director	1
Federal Ministry of Communication and Digital Economy	Abuja	Director planning, research, and statistics	1
National Space Research and Development Agency	Abuja	Director Space Application	1
Federal Ministry of Science and Technology	Abuja	Deputy Director	1

### **4.13 Data Collection**

Irrespective of the methodology, qualitative or quantitative of a study, sources of data are broadly categorised into two (2), namely, primary, and secondary data (Collis and Hussey, 2009). Primary data are collected from human participants and for specific reasons. The secondary data comprise the information gathered from various sources, including electronically stored pieces of information and other publications online. Secondary data sources include books, journal articles, periodicals, magazine newspapers, published electronic sources, websites, and all forms of a database. However, both primary and secondary data are essential in that no one is superior to the other; both methods are complementary to each other, as they stand on their own.

Having highlighted the various sources of data, this research adopted both primary and secondary data. The essence of adopting various sources of data in this study is to answer the research question. The primary data sources include in-depth semi-structured interviews with the relevant stakeholders involved in the interaction between University-Industry-Government in Nigeria. Secondary data includes documentary data from the Nigerian Universities Commission, National Office for Technology Acquisition and Promotion, other publications by the Central Bank of Nigeria, National Bureau of Statistics, and the various universities.

#### **4.13.1 Interviews**

Interviews are discussions between two or more participants that are intended at gathering information. Interviews are prompting or probing mechanisms where interviewees are asked to express how they feel about a particular subject or phenomenon (Collis and Hussey, 2009). Interviews are a way for a researcher to understand the thought process inside, an inner look at why people behave the way they do (Yilmaz, 2013). Interviews are an instrument that allows a researcher to inquire deep into issues under investigation; this is how the researcher gets first-hand information. There are three main types of interviews: structured, unstructured, and semi-structured interviews (Collis and Hussey, 2009). There are different types of interviews in a qualitative methodology, including structured, unstructured, and semi-structured interviews. According to Yilmaz (2013), structured interviews are a predetermined set of questions with a limited number of responses categories. This type of question is usually short and looks like a job interview where the potential employer asks consistently the same kind of issues in an orderly manner. The interviews here are mostly questionnaire-based, and questions are predetermined and standardised or identical. They are referred to as interviewer-administered questionnaires (Saunders, Philip, and Adrian, 2009).

On the other hand, an unstructured interview refers to the informal questions used to explore an in-depth area in which a researcher is interested; it is often referred to as in-depth interviews. There is no specific list of predetermined questions here, but there is a need to be clear about the aspect of the data you want to explore (Saunders, Philip, and Adrian, 2009). The interviewee is permitted to express himself and herself without restrictions about events, behaviours or beliefs in the research or the interview. Sometimes it is described as an informal interview because the perception and opinion of the interviewee guide the conversation. In the semi-structured method, the interviewer sets the outline for the themes to be covered, but the response from the interviewee leads to how the discussion goes (Yilmaz, 2013). In this type of conversation, some questions are omitted within a specific organisational context. Generally, the order of the query may be varied depending on the response or flow of information. According to Collis and Hussey (2009), this type of interview enhances the quality of information, or the data collected because the researcher can obtain rich details and even explore some areas that may arise during the interview.

#### **4.13.2 Types of Interviews Adopted and justification**

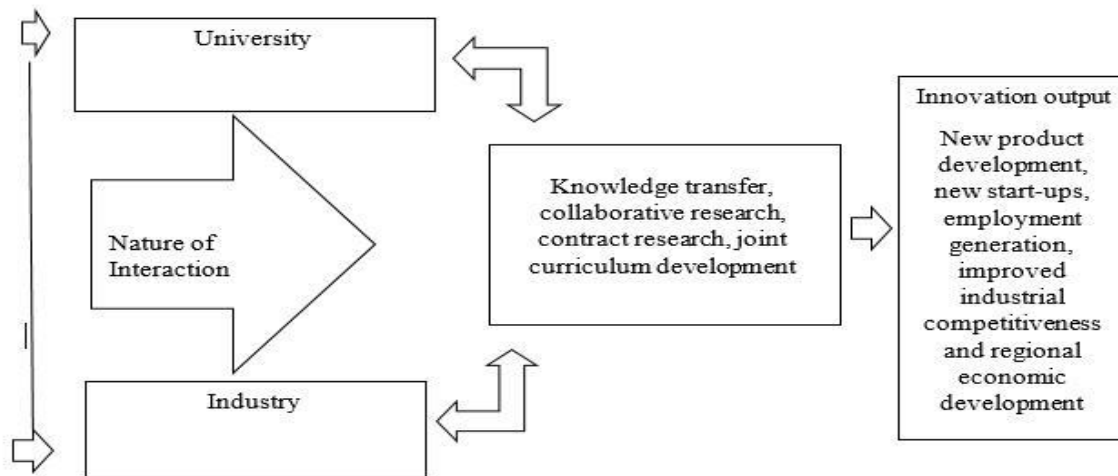
Having highlighted the various types of interviews, it is pertinent to point out the kind of interview adopted for this study as one of the primary sources of data collection. The semi-structured interviews were undertaken using the Interview Guide or protocol (Creswell, 2013). The justification for choosing the semi-structured interview is that it allows the researcher to control the interview process and the line of questioning (Creswell, 2013). The semi-structured interview also provides a researcher with the opportunity to investigate and probe for answers where the interviewee explains or build on their responses (Saunders, Philip, and Adrian, 2009). The interviewees here may use their words and meanings in a particular way; this will allow the researcher to probe these meanings and add significance and depth to the data collected (Saunders, Philip, and Adrian, 2009). Arksey and Knight (1999) restate that interviewing is a powerful way of helping people make explicit things that have hitherto been implicit- to articulate their perceptions, feelings and understanding. Arguably, it was essential to ensure this clarification provided that the findings from this research are adequately used and not misleading for further policy formulation and implementation. With the semi-structured interview, the researcher gains a rich and detailed knowledge from the wealth of experiences, opinions, and processes of the relevant stakeholders of the interaction between the key institutions involved in this trilateral relationship of University-Industry-Government in Nigeria (Rowley, 2012). The interviews with these stakeholders provided first-hand information and evidence of interaction and the inhibiting factors involved in Nigeria. According to DiCicco-Bloom and Crabtre (2006), a semi-structured interview allows the interviewer to delve deeply into social and personal matters. The semi-structured interview can be either one on one basis or one to many bases that could be carried out face-to-face or by telephone (Saunders, 2003). One on one interviews involve the interviewer and the interviewee engage in open-ended questions and answers, while the one-to-many interviews are like a focus group; this method allows multiple interviewers and interviewees at the same time. The one-on-one interview is suitable for this study because it enabled the respondents to speak freely on the interview's subject matter (Creswell, 2009).

#### **4.13.3 First Phase of Data: Pilot Study Conducted**

A pilot study was conducted as a preliminary method to gather the necessary information for the main study (Connelly, 2008). Following the generation of the three different sets of interview questions for the university stakeholders, decision-makers in the industry and government officials, which the researcher structured after consulting with the supervisory team, the researcher undertook a trip to Nigeria between October and November 2016. The trip was to conduct a pilot study and explore the interaction between universities and industry. A set of 13 semi-structured questions were designed based on the critical review of the literature

and focused on the variables identified in the pre-pilot study conceptual framework. A separate set of questions was prepared for the university and industry participants. The pilot interviews were conducted with 10 participants, five Heads of Department in the science and engineering-based courses, three from the University of Maiduguri and two from Aminu Kano University, Kano. The Heads of Departments in both universities were in Computer Engineering and Electrical and Electronics Engineering. The industry participants include five knowledge-intensive firms, precisely, entrepreneurs operating in software and hardware development in Maiduguri and Kano. According to Saunders, Philip, and Adrian (2009), the essence of pilot testing is to refine the questionnaire so that the respondents will have no problems in answering the questions. Quinlan et al. (2011) note that the essence of the pilot study is to verify the rigorousness and the validity of the research design by testing it in the real-life situation of the research with a smaller number of participants before the actual study. The essence of the pilot study was to check the quality of the questionnaire, the process, confidence, and the clarity of the questions.

Therefore, when the researcher finished the pilot study interviews, feedbacks were received from some respondents. After the interview, some respondents raised some concerns about the interview process. They felt that the mode of the interview was more structured than a semi-structured line of questioning. It is important to note that in the semi-structured interview, the researcher has control over the sequence of the questions, which means the questions should be flexible based on some emerging issues from the interview. However, during the pilot study interview, the researcher kept reading the questions one after another in a structured manner. Another concern was some little spelling errors from the questionnaire, which the researcher acknowledged instantly and corrected for the subsequent interview protocols. All the concerns raised during the pilot study were duly corrected, and the researcher made an extra effort to study interview protocols before going ahead to the primary data collection stage. Before the pilot study, a pre-pilot study conceptual framework indicated in Figure 5.2 below were developed based on the National Innovation System model.



*Figure 4. 2 Pre-Pilot study Framework*

After the pilot study, the conceptual framework was refined to integrate government agencies into the study. The justification for integrating government agencies was informed by the critical role of the government in promoting innovation. Therefore, the most relevant theory that examined the innovation from the three essential partners in the Triple Helix Model. Thus, the conceptual model (chapter four) also changed from NIS to the Triple Helix Model.

#### **4.11.3.1 Initial Findings from Pilot Study**

The pilot studies' initial analysis revealed a low level of interaction between the university and industry within the knowledge-intensive and ICT-based entrepreneurs. The evidence obtained from the representative of the University of Maiduguri showed limited collaboration between universities and industries on the institutional level. Most of the cooperation is informal and based on social interactions. Evidence from the industry showed that the industry does not have confidence in the quality of research conducted in Nigerian universities due to the lack of cutting-edge technologies and fully equipped laboratories. The pilot study also revealed that universities maintained their traditional teaching and research function but remain weak to change their policies and orientation to become more entrepreneurial universities and impact the region's development and the country. Moreover, after the pilot study, the conceptual framework was refined again for the primary data collection held between 17 July 2017 and 17 September 2017.

#### **4.13.4 Second Phase of Data Collection One on One Interview and Telephone Interviews**

The second phase of data collection was carried out between 17 July 2017 and September 2017. During this phase, all the sampled participants were contacted; preliminary arrangements were made with participants for the time and location of the interviews. They also agreed that the

interviews should take place in their offices to make them more relaxed and freer to give their opinions. Before conducting the interviews, each participant was provided with the invitation to participate in the research, Participant Information Sheet, and a consent form which contains the purpose of the interview and the reason they were purposively selected for the interview (see appendix 5, 6 and 7). Given the sensitivity and the need for confidentiality of information primarily from the government and the industries, some interviews were carried out one on one while others were carried out through telephone and audio recording with the participants' permission. Frey (1983) defined telephone interviews as a conversation and interactional sequence without visual contact. Carr and Worth (2001) further clarified that the parties involved in this interview must construct an encounter setting the context only with their voices. They must be able to identify themselves and define the situation where the dialogue will take place. The authors maintain that the telephone interview is an interactive engagement and approach for gaining information without a face-to-face meeting. In other words, this data collection method is devoid of filmic signals but creates an interactive sequence whereby the context of the conversation is established mainly by the interviewer and the interviewee's voices.

The complimentary telephone interview was chosen for the following reasons. The target respondents for this research were the CEO of companies, Directors in the government agencies and Directors of Research and Innovation in the universities. Some of the respondents were unavailable when the researcher was on the field to conduct the primary data collection. Some of them have either travelled out of the country or were on official assignments. The researcher requested a sky/telephone interview. All the participants who have initially agreed to participate in the research but were absent during the interview period accepted a telephone interview. The researcher conducted 22 face to face semi-structured interviews and 6 telephone interviews with participants. The 6 telephone interviews were conducted with the university and industry participants. They include 1 participant from the University of Ibadan, 1 from the University of Nsukka, and the 1 from University of Benin and 1 CEO from each of the three companies in the Southern part of Nigeria. During the telephone interviews and considering their busy schedules, the researchers were mindful of the fact that these interviewees could be exhausted or suddenly engage in other duties. To mitigate this, the interview time was intended to be flexible such that it could be easily rescheduled to accommodate the respondent's availability. The researcher had pre-anticipated this, and some participants cut the interviews midway, and the interview had to be rescheduled at their convenient times. According to Garbett and McCormack (2001), interviewees may be exhausted during a lengthy telephone discussion, but McCoyd and Kerson (2006) dismissed this claim asserting that at maximum, telephone interviews last one hour or two hours with very limited or no fatigue. During my interview with the participants, each interview lasted between 30 to 50 minutes.

However, the interviewees showed a high level of passion without displaying fatigue in their voices and responses. Burnard (1994) believes that the interviewer should take time to chart and familiarise with the participant before the interview. Given this, the researcher maintained constant communication with the respondents on various semi-formal and informal topics before the main discussion. It is also appropriate for the interviewer to use the proper intonation that suits the respondents. In this regard, the researcher observed the line of communication in line with their intonation to have a smooth and challenge free interview. Also, the researcher was mindful of the language tone used in both public and private organisations in Nigeria and played along these lines to have the maximum cooperation of the respondents. For instance, the participants were senior and management executives in various organisations and workplaces; such people are highly respected. Consequently, the researcher was cautious about using a suitable language for acceptance and about ensuring that the responses obtained were not distorted in any form. Another factor that helped the researcher was that the researcher had prior information about some of the participants from their institutions' websites to know their job descriptions, which helped pose questions and talk to each of the respondents. In addition to cultural issues, the researcher also considered that telephone manners in Nigeria significantly differ from the other nations where this study is being carried out, and this was also taken into full consideration. Another issue why the researcher chose the telephone interview was location; these respondents are in several locations around Nigeria, travelling to conduct face-to-face meetings may be time-consuming, costly, and risky considering the terrain and the security challenges in Nigeria. These growing fear of security challenges ranging from kidnapping to herdsman crisis and the poor road transportation network was a serious concern; that is why the telephone interview was appropriate for some respondents.

#### **4.14 Documentary Data**

Another form of data for this research was documented analysis. Payne and Payne (2004) describe this method as one which involves categorising, investigating, identifying, and interpreting the limitations involved in physical research. Bowen (2009) defines document review as a systematic procedure for reviewing and evaluating documents. Such documents include written materials such as notices, correspondence that contains emails, minutes of meetings, reports to shareholders diaries, transcripts of speeches and administrative records. The documents can also include books, journals and magazines, newspapers, and even voice and recordings, pictures, drawings, and television programs (Saunders, Philip, and Adrian, 2009). Document analysis is an orderly procedure for studying or assessing documents—both printed and electronic (computer-based and Internet-transmitted) materials (Bowen, 2009). Like other critical approaches in qualitative research, document analysis entails that data be

studied and understood to produce meaning, gain understanding, and develop empirical knowledge (Bowen, 2009)

The researcher chose the use of documentary data for two reasons; 1) It compensated for the limitation that was encountered during the primary data collection (semi-structured interviews) and 2) for triangulation which helped in enhancing the validity of the result that was obtained. Gaborone (2006) Identifies two types of documents that are frequently used in documentary analysis. These are the primary and secondary materials; the primary document is the eye-witness report or account produced by people who experience specific events at a time. Secondary documents refer to the document provided by people who were not present but who receive eye-witness accounts to compile the document. This study carefully selected various types of relevant documents from both primary and secondary sources. Specifically, the study used documents obtained from National Universities Commission, (NUC) National Office for Technology Acquisition and Promotion (NOTAP), National Information Technology and Development Agency NITDA, reports from the universities, and annual statistical bulletins from the Manufacturer Association of Nigeria (MAN). The document analysis was mostly used in chapter two.

#### **4.15 Data Management**

The researcher adopted a flexible but thorough process before and after the data collection, which consisted of two main stages: recording, transcribing, coding, and allocation of themes. All study participants gave their informed consent for the interviews to be recorded using audio devices, and the data collected was immediately transferred to Oxford Brookes University secured drive. Other materials from the interview, such as field notes, participants' information sheets and consent forms, were locked in a personal cupboard that was only accessible by the researcher.

##### **4.15.1 Recording and Transcribing Data**

The reason for recording interviews is to allow the researcher to remember all that was deliberated and discussed throughout the interview. Bryman (2008) considered the recording of the conversation as mandatory. Therefore, the researcher got the consent of the participants to record the conversations. The researcher found it valuable because it helped to focus on the interview without the distraction that may be caused by taking notes. According to Green and Thorogood (2009), transcribing conversation is, of course, a translation process; the choices of punctuation, spelling and detail of the transcript all affect how it is read by those analysing it. Therefore, for the current study, the transcriptions were done verbatim (solely by the researcher). Although the process was hectic and time-consuming, it was helpful since it brought the researcher closer to the data during the transcribing stage.



### **4.15.2 Data Analysis**

The process of data analysis in qualitative research encompasses working with the primary data, arranging it, breaking it down into themes, synthesising it, searching for patterns matching, discovering what is essential and what is to be learned, and deciding what to tell others (Lawrence and Tar, 2013). Huberman and Miles (1994) mentioned that qualitative data and analysis is made up of data reduction, data display, and conclusion drawing/verification. Data analysis has been described as the “most difficult phase in case study research” (Rahman et al., 2003:34). It was certainly a challenge to make sense of the raft of rich qualitative data that had emerged from the interviews, observations, and document analysis. The researcher adopted thematic analysis for this study. The decision to use thematic analysis to analyse the data seemed to be in keeping with other qualitative data analysis methods (Ericsson and Kovalainen, 2008). Defined by Willig (2013:57) as a method for “recognising and organising patterns in content and meaning in qualitative data,” thematic analysis offers researchers a flexible research tool through which they can identify themes that emerge from the literature and data that are important to describe the phenomena under study (Daly et al., 1997). The analysis in this study aimed to explore the data collected from 28 participants from University-Industry-Government institutional spheres. As mentioned in the earlier section, the data collection and analysis were driven by a conceptual framework. A manual transcription was used by the researcher using a pen and paper.

### **4.15.3 Thematic Analysis**

According to Guest, MacQueen and Namey (2012), there are many methods to qualitative data collection and analysis indicating varied choices of epistemological, theoretical, and disciplinary standpoints. Thematic analysis is the method of finding patterns or themes within qualitative data. There are numerous approaches to qualitative data analysis, and these have been extensively contested in social science literature. Welsh (2008) identified three approaches to qualitative data analysis: literal, interpretive, and reflexive (Welsh 2008). The literal analysis refers to the exact use of the language or grammatical structure; the interpretive approach relates to making sense of the research participant's account of the phenomenon and attempting to interpret the meaning. The reflexive approach means the involvement of the researcher throughout the research process and his contribution to the data creation and analysis. Welsh (2008) conclude that depending on the appealing approaches. The researcher chooses to use either manual, or computer-assisted qualitative data analysis software (CAQDAS) assisted data analysis methods. Braun and Clarke (2006) outline a six-phase approach in the analysis and presentation of data. The summary of the thematic data analysis phases is presented in Table 4.5 below.

*Table 4. 5 Thematic analysis; Source: Braun and Clarke 2006*

<b>Phase</b>	<b>Description of the Process</b>
<b>1. Familiarise with data</b>	Transcribing data (if necessary), reading and re-reading the data, noting down initial ideas.
<b>2. Generate initial codes:</b>	Coding existing features of the data in a systematic fashion across the entire data set, collating data relevant to each code.
<b>3. identify Themes:</b>	Collating codes into potential themes, gathering all data relevant to each potential theme
<b>4. Review Themes:</b>	Checking if the themes work about the coded extracts (Level 1) and the entire data set (Level 2), generating a thematic 'map' of the analysis.
<b>5. Defining and naming themes:</b>	Ongoing analysis to refine the specifics of each theme, and the overall story the analysis tells, generating clear definition and names for each theme.
<b>6. Producing the report:</b>	The final opportunity for analysis. Selection of vivid, compelling extract examples, the final analysis of selected extracts, relating of the analysis to the research question and literature, producing a scholarly report of the analysis.

#### ***4.15.3.1 Phase 1 Familiarisation with The Data***

Familiarisation of the data entails reading the transcripts and engrossing the content of the data (Braun et al., 2014). According to Braun and Clarke (2006), the immersion of the data generally involves 'repeated reading' of the data probing for meanings and patterns (Braun and Clarke, 2014). This approach is suitable for this research because it goes in accordance with the research design, the interpretive, thematic analysis. The approach was chosen as the most appropriate method for the data analysis. It allows the researcher to identify the pattern within the dataset and the themes from the narrative told by the participants (Alhojailan, 2012). The researcher read the transcripts multiple times to ensure rigour and methodical understanding of the data. In this stage, the transcripts were initially read on a computer and handwritten paper; hence observations and annotations were used to underline colour and highlight chunks of sentences to generate initial ideas

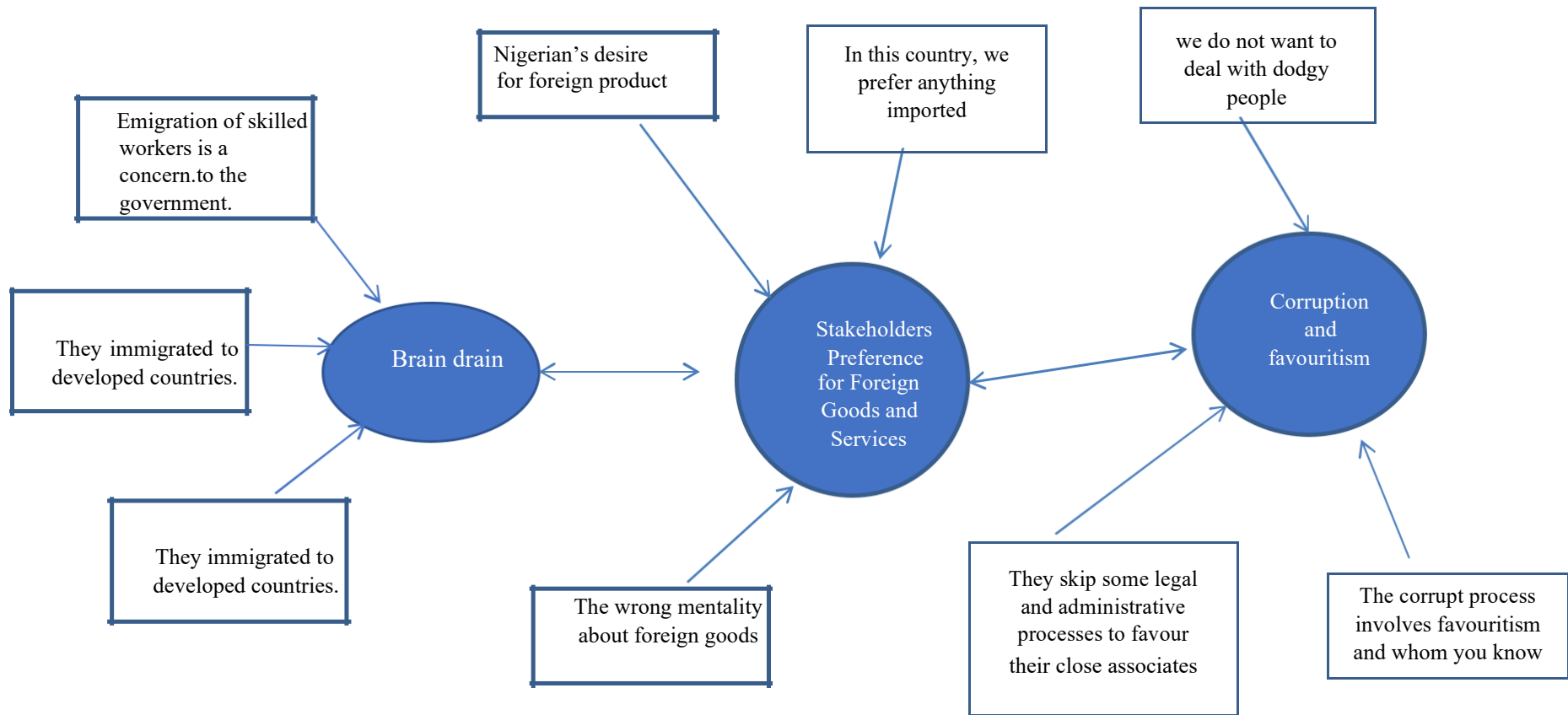
#### ***4.15.3.2 Phase 2 Coding the Data***

The coding process starts after the researcher has read through and became immersed with the data. Braun and Clarke (2006) urge that the initial coding begins when the researcher has read and familiarised with the data and have produced a preliminary list of ideas about what is in the data and what is interesting in it. They further argue that at this stage, the initial codes from the data emerge.

#### ***4.15.3.3 Phases 3 Searching for Themes***

According to Riger and Sigurvinsdottir (2016), once the codes have been identified and brought together, a search for the theme may begin. Braun and Clarke (2006) note that a theme captures

something vital about the research question and represents some pattern or meaning. For this research, the overall research study followed a deductive approach (Willig, 2013), it employed a theoretically informed design through which the data was coded, and further themes derived from it (Crabtree *et al.*, 1999; Braun and Clarke, 2006; Riger and Sigurvinsdottir, 2016). Some of these themes presented in the conceptual framework were derived from existing literature, and they were used to shape the semi-structured interview questions, analysis and discussion as outlined earlier in this chapter. Thus, the researcher had an idea of the type of 'themes' that was to emerge from the data. Figure 5.3 below shows the themes that emerged from the data.



*Figure 4. 3 Thematic: Showing Themes That Emerged from The Data*

#### **4.15.4 Phase 4 and 5 Reviewing, Defining, and Naming Themes.**

Riger and Sigurvinsdottir (2016) note that they can be reviewed and refined once the potential themes have been identified. When the thematic map has been produced, the themes are refined further. The critical point at this stage is to provide a name that captures all the idea and make sense of the data. The themes should be coherent (Braun and Clarke, 2006) and should be distinct from each other (Delahunt, 2017; Maguire and Delahunt, 2017). The researcher then revised the data and the themes to check for consistency and made sure all appropriate data were captured in the themes. Defining the themes helped identify their real meanings and determine what aspect each theme represents (Braun and Clarke, 2006; Clarke and Braun, 2014). Having theoretically driven themes in mind, the researcher probed more into the data and refined the codes to make sense of it. After the initial codes have been generated and organised, the researcher re-arranged the list of the various codes identified in phase two into potential themes. The researcher had a start list of the themes that emerged from the literature before the interview began. These themes as graphically represented in the conceptual framework, such as the four themes on assessing the UIG network, four themes on the developmental stages that asses the organisational practices and the main theme as the general inhibitors. However, further sub-themes (Institutional and social factors) with many sub-themes were analysed. Figure 5.4 shows the thematic map of all the themes that were analysed.

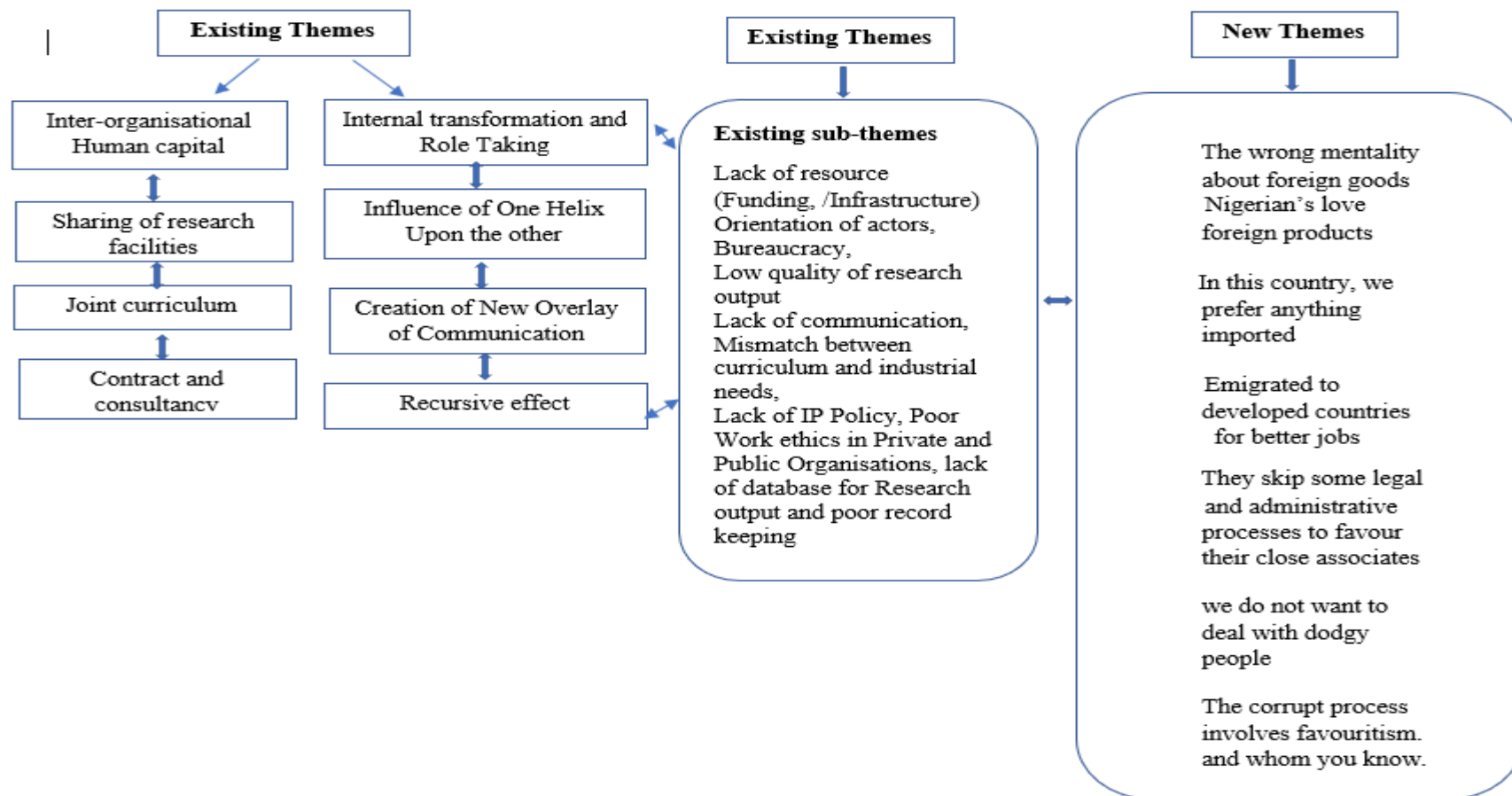


Figure 4. 4 Merging the themes Author

#### ***4.15.4.1 Phase 6 Producing the Report***

At this stage, the themes and their interrelationships were identified; a research report was written. This report may lead to a thorough account of the outcomes, and accurate data is presented with a solid argument rather than a descriptive account (Braun and Clarke, 2013). The story of themes is expressed accurately, consistently, logically, without repetition (Javadi and Zarea, 2016). Furthermore, to ensure vigour, descriptive outcomes were complemented by quotations demonstrating the narrative in a more symbolic and all-inclusive way. For this study, ten main themes were identified, and further sub-themes were identified under institutional and social factors. The themes in Figure .5.5 indicate the final reviewed themes that will guide the analysis.

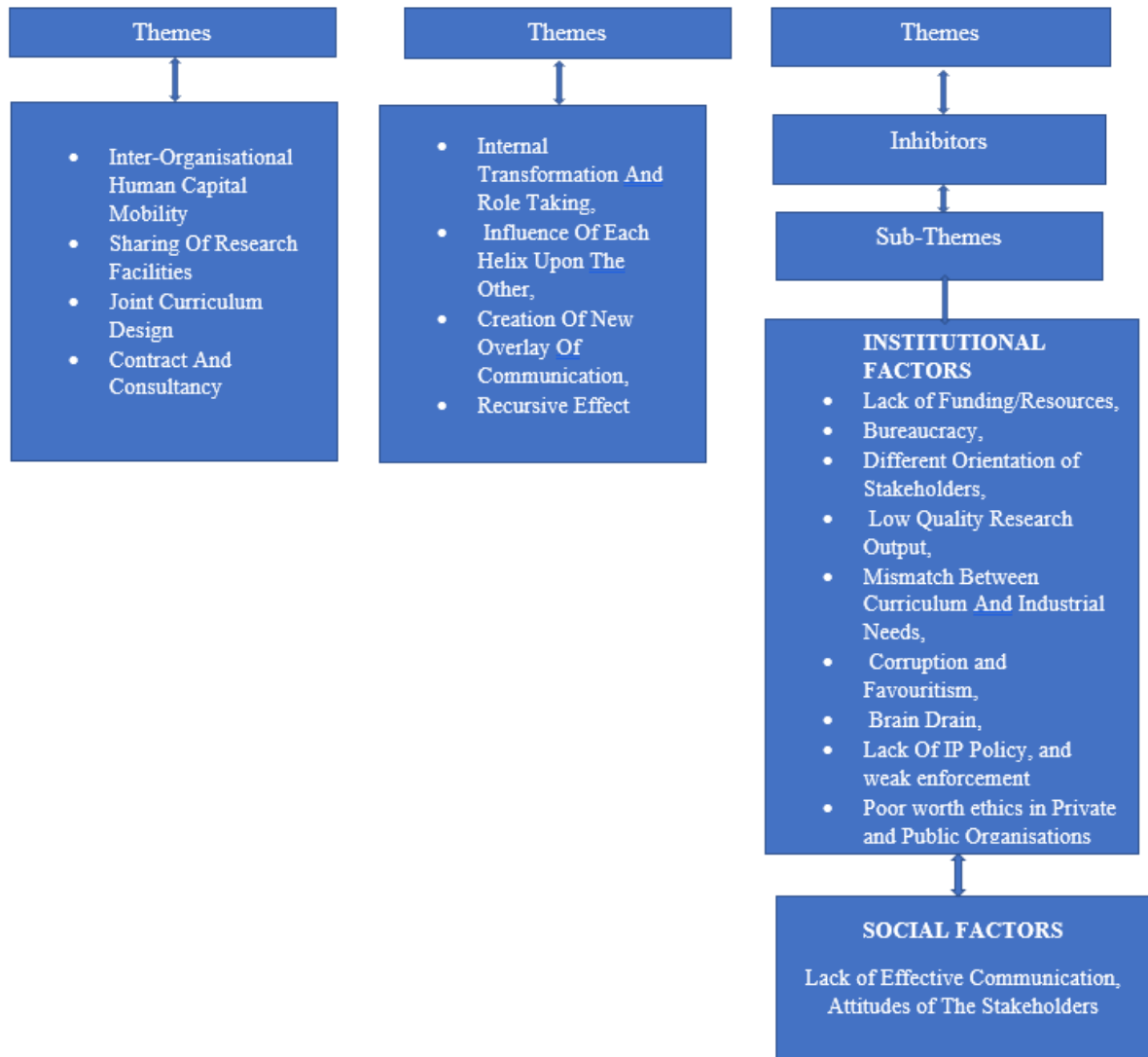


Figure 4. 5 Thematic Map: Source: Author

#### 4.16 Validity and Reliability

There has been a scholarly debate on the helpfulness of validity and reliability in qualitative research (Kelle, 1997). The author argues that while these terms are unsuitable in qualitative research, preferring to use terms such as "trustworthiness", "rigorousness", or "quality" of the data, it is, however, vital that qualitative research and data analysis are carried out thoroughly and transparently (Welsh 2008).

According to Golafshani (2003 p.897), “like reliability and validity as used in quantitative research are providing a springboard to examine what these two forms mean in the quantitative research paradigm, triangulation, as used in the quantitative research to test the reliability and validity, can also illuminate some ways to test or maximise the validity and reliability of a qualitative study”. Hence, a researcher needs to reflect on these concepts regardless of the



method adopted. According to Veal (2005), reliability is how the research findings will be consistent if the research study were to be carried out again later with the different subjects. Bryman (2012) has identified some validity categories, including face validity, concurrent validity, and predictive validity. While concurrent validity means the researcher sought to gauge the concurrent validity of the phenomenon, another type of validity is convergent validity, which involves using various tools to collect data that give the same result (Blumberg, Cooper, and Schindler, 2005). The first critical step in the thematic analysis is to evaluate the themes to ensure they represent data (Alhojailan, 2012). This study exploited the six steps to conduct a thematic analysis proposed by Braun and Clarke (2006) for data analysis. The step-by-step guide, as mentioned earlier, shows that the data was comprehensively analysed. For instance, the data were transcribed appropriately and checked several times against the tapes to ascertain the accuracy before analysis. The researcher has made considerable efforts to absolve himself entirely from the data collected to avoid any bias. Besides, the process of data handling was carefully thought through before the data analysis commenced. Overall, the researcher adopted a flexible but thorough pre-and post-data collection process, which consisted of two main stages- recording and transcribing: and coding and allocating themes.

#### **4.17 Trustworthiness and Dependability**

The detailed step-by-step guide to conducting thematic analysis by Braun and Clarke (2006) was used in data analysis. As detailed in the section above, following the guideline ensured, the analysis process was thoroughly conducted. Another effective method used to guarantee trustworthiness in data analysis was that the researcher involved the PhD supervisors during each analysis and interpretation phase. These regular debriefing sessions provided the researcher with an avenue to ensure his biases and perceptions were adequately captured in her reflexivity account, and the voices of the research participants were given prominence (Shenton and Hayter, 2004; Lincoln and Denzin, 2000; Lincoln, 1995). To ensure trustworthiness in terms of the credibility of claims made from the data produced in this research, the criteria recommended by Lincoln (1995) are used. In interpretivist based qualitative study, Lincoln (1995) submits that to guarantee trustworthiness (or rigour), data generated must be dependable, and findings must rely on data generated by drawing a line of demarcation between the voices of the research participant and the researcher. It is also necessary to ensure study processes are documented to facilitate audit trail and replicability (Shenton, 2004). Thus, the researcher has tried to ensure the findings from the research were primarily the voices of the research participants using the thematic analysis technique. Thus, chapter five of this thesis gives a detailed account of the methods employed in the conduct of the study, ensuring the trustworthiness criteria of dependability, transferability, and credibility of the research process.

#### **4.18 Ethical Considerations and Self Reflexivity: Incorporating the Researcher's Role In The Research Process.**

The study was guided by ethical guidelines on the process of data collection that involves human participants. Hence approval was obtained from the Oxford Brookes University's Ethics Committee after satisfying all the conditions laid down (see Appendix 1). In qualitative research, reflexivity is essential in striving for objectivity and neutrality (Lewis, Ritchie and Ormston, 2003). The researcher's concern is how bias might creep into the qualitative research knowing that the researcher's beliefs can interfere with the quality and outcome of the data (Finlay and Gough, 2008). Reflexivity stresses the appreciation of the researcher's input to the development of meanings throughout the research process. It acknowledges the impossibility of remaining outside of one's subject matter while conducting research (Willig, 2001). The researcher should reflect on the effect of personal and epistemological reflexivity that shape the research. Personal reflexivity includes how our beliefs, personal values and experience, identities and status could influence the study's outcome, and how the research could also change or affect the researcher (Willig, 2001). In reflecting on the research outcome, the researcher was aware of his position in the research process to minimise any potential bias that could affect the research outcome. The subjectivity of the qualitative research technique may make it challenging for the researcher to be divorced entirely from the phenomenon under study. It is vital that the researcher curtails bias and approaches the phenomenon under study with an open mind. This study is based on a Nigerian case study where the researcher comes from. All the participants were well educated and spoke fluent English. Understanding and speaking in English helped me phrase the questions. The researcher had prior experience and perception of the people and the environment in Nigeria. The pre-existing knowledge about the situation and understanding the socio-economic and behaviours of the people was useful during the fieldwork. My experience and knowledge in the Nigerian civil service helped overcome the bureaucratic bottlenecks, especially from the government and universities circle. Before I embarked on this research work, I had contacts and personal rapport with participants, which made the access very easy.

Nevertheless, I was concerned from the beginning that my prior knowledge and insights about the people and the environment might lead to some personal bias and preconceptions. My effort toward maintaining neutrality was to adopt a standard procedure of data collection method during the interview process. The interview process was also guided by a standard procedure, for instance, asking no leading questions and consent from the participants and employing the rigorous data collection and analysis process. Secondly, during the interviews with the university participants, I noticed the attitude and feeling that I was a privileged person studying abroad and possibly had some network within the government circle. I also noticed that this notion might affect how the participants' responded. I eventually had to play along, respect their opinions, and feel I am also

not different. That feeling among the participants gave them some comfort and confidence to participate.

#### **4.19 Chapter Summary**

This chapter discussed the methodological approach of the study. It started by explaining the research philosophy, involving ontological epistemology and methodological underpinning of the study. The chapter also spelt out the methodological approach and the justification for opting for chosen methodologies. The various strategies of data collection were also outlined, which included interviews and document analysis. The chapter also briefly discussed the pilot study conducted and the issues during the pilot studies. The researcher carefully selected the sample size, which reflected all the stakeholders involved in the trilateral relationship between University-Industry-Government. The aspect of reflexivity was also critically incorporated.

## 5 CHAPTER-FIVE:

### 5.1 FINDINGS ON THE ASSESSMENT OF THE UIG NETWORK

This chapter presents the findings on the assessment of the University-Industry-Government interaction. The finding is based on the themes identified from assessing the UIG interaction through inter-organisational human capital mobility, facility sharing, joint curriculum design, and contract research and consultancy. These findings followed the conceptual framework, as shown in Figure 6.1, to provide a guide on the four developmental stages of the Triple Helix and the inhibiting factors that prevent the interaction. Whilst this chapter provides the findings on the assessment of the UIG interaction, the next chapter (chapter seven) will analyse the findings on the four developmental stages and the general inhibitors of the UIG interaction. Data collected for this research came from three primary sources. First, semi-structured interviews were conducted across three different stakeholder groups, including the Directors of Research and Innovation in six universities across the six geopolitical zones of Nigeria: - two CEOs of technology-based firms in each of the zones and ten Directors/Assistant Directors from government organisations. The respondents were selected because they were considered relevant in answering the research questions. The second dataset was from various credible documentary sources, including reports from government agencies, industry reports, research reports and annual statistical bulletins from the Central Bank of Nigeria, (CBN) National Bureau of Statistics, and (NBC) Nigerian National Petroleum Cooperation (NNPC) National Office for Technology Acquisition and Promotion (NOTAP). The third source of the data was fieldnotes and informal discussions. For confidentiality and anonymity, this research does not refer to the industry respondents by name, nor does it disclose the identity of the firms as per request from the industry participants. The analysis has given a code to each participant. Figure 6.2 also indicates the thematic map indicating the codes and themes both emerging from the data and driven by the conceptual framework. The researcher did the transcription of the data verbatim, and that has significantly helped in becoming familiar with the data and the narratives told by the respondents.

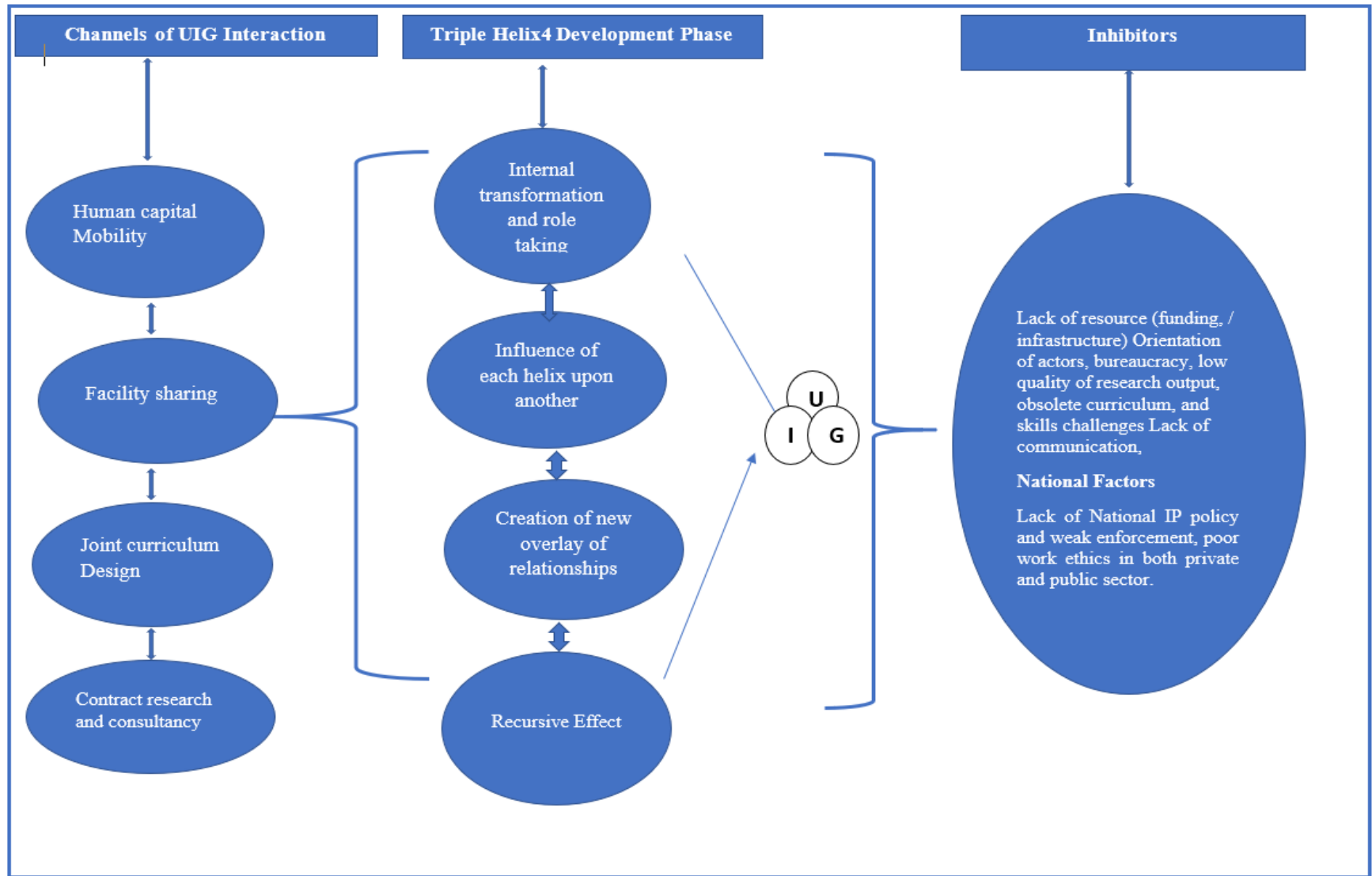


Figure 5.1 Conceptual framework for the Study

## 5.2 Profile of the Participants

### 5.2.1 Universities

As mentioned in chapter four (methodology chapter), six universities participated in this research, one university from each geo-political zone of Nigeria. As highlighted in chapter four (methodology chapter), the selection criteria for these universities were based on their age, relative engagement in research and development (R&D) activities, and regional or geographical spread across Nigeria. Table 6.1 shows the profiles of the universities and their locations.

*Table 5. 1 Profiles of the Universities*

<b>Geo-political zones</b>	<b>Towns</b>	<b>Name of the university</b>	<b>Department</b>	<b>Participants</b>
South-West	Ibadan	University of Ibadan	Research management office	Director
South-South	Edo	University of Benin	IPR and TTO	Technology Transfer officer
South-East	Enugu	University of Nsukka	Directorate of Research, Tech, and Innovation	Director
North Central	Ilorin	University of Ilorin	Directorate of Research, Tech, and Innovation	Director
North-West	Kaduna	Ahmadu Bello University, Zaria	Directorate of University Advancement	Director
North-East	Bauchi	ATBU University	Directorate of Research and innovation	Director

### 5.2.2 Government

The second group that participated in this research consisted of the Ministries, Agencies and Parastatals of government who have direct regulatory and research roles in enhancing indigenous technological capabilities. A total of ten respondents, one Director or Deputy Director from each government agency in the relevant departments of policy, planning, e-

government, and commercialisation of the R&D department, took part. Table 6.2 shows the profiles of government agencies.

*Table 5. 2 Profiles of the Government Agencies*

<b>Name of Institution</b>	<b>State</b>	<b>Position of participant</b>	<b>Number of participants</b>
National Information Technology Development Agency NITDA	Head office Abuja	Director of e-government	1
National Universities Commission (NUC)	Head office Abuja	Director of Research and Innovation	1
National Office for Technology Promotion (NOTAP)	Head office	Director Technology commercialisation	1
National Board for Technology Incubation	Head office Abuja	Director	1
National Centre for Technology Management (NACETEM)	Abuja office	Register	1
Federal Ministry of Science and Technology (FMST)	Abuja	Assistant Director of policy and research	1
Small and Medium Scale Enterprises (SMEDAN)	Abuja	Director	1
Federal Ministry of Communication and Digital Economy	Abuja	Director planning, research, and statistics	1
National Space Research and Development Agency	Abuja	Director Space Application	1
Federal Ministry of Science and Technology	Abuja	Deputy Director	1

### **5.2.3 Industry**

The third stakeholder group that participated in this research comprised technology-based firms listed within Micro, Small and Medium enterprises. As depicted in Table 6.3, a total of 12 firms participated in this research, two from each geo-political zone of Nigeria, represented by their CEOs.

*Table 5. 3 Profiles of the Industry*

<b>Industry</b>	<b>Reference Code</b>
Technology-based Firm 1 North West	TBF 1 NW
Technology-based firm 2 North West	TBF 2 NW
Technology-based firm 1 North East	TBF 1 NE
Technology-based firm 2 North East	TBF 2 NE
Technology-based firm 1 North Central	TBF 1 NC
Technology-based firm 2 North Central	TBF 2 NC
Technology-based firm 1 South West	TBF 1 SW
Technology-based firm 2 South West	TBF 2 SW
Technology-based firm 1 SE	TBF 1 SE
Technology-based firm 2 SE	TBF 2 SE
Technology-based company 1 North East	TBC 1 NE
Technology-based company 2 North East	TBC 2 NE



The responses have been examined from a thematic approach based on the pre-existing themes and themes and emerging themes from the data. Figure 6.2 indicates the thematic maps of the themes and sub-themes.

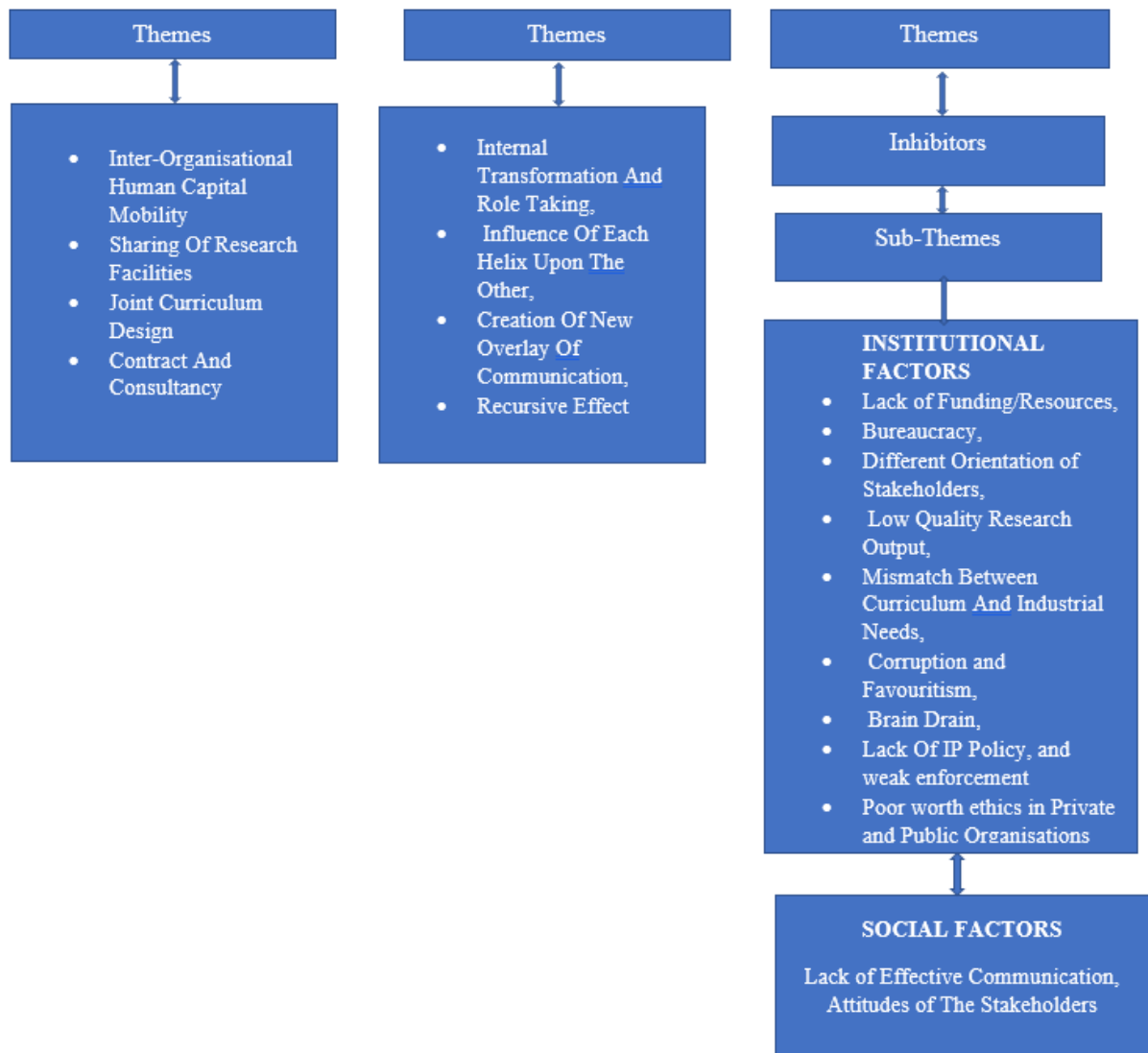


Figure 5. 2: Thematic Map for The Research

### 5.3 Addressing the UIG Network

#### 5.3.1 Findings from the Universities

This section presents the findings of the data obtained from semi-structured interviews on the questions relating to the four channels of UIG interaction.

##### 5.3.1.1 Inter-Organisational Human Capital Mobility

Human capital mobility or staff transfer from one organisation to the other is a channel of University-Industry-Government collaboration that enables the flow of skilled human capital and facilitates organisational competitiveness (Marques, 2017). It is about the movement of people from one organisation to the other transferring skills embodied in them and contributing to the organisation's capacity (Feldman, 2003). A question was asked to understand how this flow of knowledge occurred: *in what ways does inter-organisational human capital mobility from the university to industry and government occur?*

Five (5) out of the six university respondents have acknowledged that many university staff voluntarily transfer service from universities to the government on a secondment, permanent, temporary, sabbatical or contract basis. The respondents mentioned that the transfer of service by faculty members or staff had proven to be an effective way of transferring knowledge from universities to the government. According to the respondents, staff who transfer their services to the government come back to the university after serving in the government.

Some of our staff transfer their services to the government through secondments, which could either be permanent or they work for some years and come back to complete their remaining years in the university (UNIBEN)

Findings show that 95% of the faculty members who transfer their services to the government are highly skilled and learned, up to PhD or professorship level. Findings also show that the channel of knowledge flow from universities to the industry occurs through the Student Industrial Working Experience Scheme introduced by the Nigerian government to the universities. This channel of knowledge transfer has been proven to contribute to the stock of institutional knowledge and enhance the efficiency of government institutions. The university respondent ATBU confirmed this:

One of the effective ways to transfer skills to the government is through a transfer of service by our staff on secondment, contract, sabbatical, temporary or permanent basis. Many of those who leave the university and work for the government are highly qualified people who are either PhDs or professors (ATBU)

According to another respondent, UNILORIN, many faculty members have transferred their services to the government in recent years. This transfer was on secondment or permanent bases, and the staff that moved their services to the government played crucial roles in the government:

Our staff are changing their workplace and getting appointments in the government on a sabbatical or permanent basis and are playing key roles in the government.

However, findings show that faculty members prefer to transfer their services to the government rather than the industry. This could be due to the advantages of working for the government. These advantages include job security, career progression, pensions, and other

related benefits. Faculty members do not frequently transfer their jobs to the industry because they believe it is risky because of the uncertainty.

Working for the government has many advantages, including getting pensions, gratuities, and many other benefits on retirement. I will personally prefer to work for the government than companies that do not even guarantee my sustainable monthly wages (UNN)

However, an interviewee at UNIBEN noted that faculty members who transfer their services to industry prefer the oil-based companies:

There are faculty members attracted to the oil companies to undertake some secondment and sabbatical positions because of the monetary incentives involved. Trust me; you cannot resist such pay; I know many university employees and IT experts who have moved to Shell (UNIBEN)

According to an informal discussion with the Director of Academic Planning at ABU University, about four to six faculty members who were once working for the university are now working for NITDA, NATOP, NBTI and many other government-owned research institutions. He pointed out one example where a university employee transferred his service from the University of Maiduguri to a government agency and is now the Director-General. Regarding the University-Industry channel of human capital mobility, the respondent identified Student Industrial Work Experience Scheme (SIWES) as the means of UIG collaboration. SIWES is a scheme established to encourage students to gain practical knowledge and experience from the industry, which helps collaborate. The respondents have confirmed this:

Government-created Student Industrial Work Experience Scheme (SIWES) and made it mandatory for all universities to utilise it and exchange skills with the industry (UNILORRIN)

According to the university respondents, the SIWES programme is not an effective practice and does not lead to a proper transfer between the university and industry. The concern from the university is that growing numbers of students do not have industries to do their industrial attachments and lack proper monitoring from the universities and the place of industrial attachments.

There are inadequate monitoring from the originating university and the industry where they are undergoing the SIWES programme. Sometimes students cook up reports, and the tutors have no time to verify those stories, which is one reason why the knowledge flow is not very useful (ABU).

The findings on the knowledge flow between university and industry through SIWES shows some challenges that have contributed to the skills gap and students' lack of understanding of the industrial environment.

### **5.3.1.2 Facility Sharing**

This theme analyses the sharing of complementary research facilities or infrastructure between the three institutional spheres as a bridge linking the trilateral network. The theme examines

how University-Industry-Government complements each other in the areas of strength in terms of sharing facilities. A question was asked to the university respondents: *How does the university share research facilities/equipment with the industry?* The respondents frequently mentioned the government-owned Technology Incubation Centres (TIC) under the National Board for Technology Incubation (NBTI) as an enabler of joint facility utilisation among the three institutional spheres. They mentioned that utilisation of these facilities promotes formal and informal collaboration and mutual understanding between the universities and industries.

We collaborate and work together mostly at the Technology Incubation Centres. We do fabrications together using research facilities at the TICs (ATBU)

if we need anything that we do not have in our facilities, we utilise the TIC facilities. That gives us the chance to meet and interact with some companies. On that basis, we can create some personal relationships where we work together (ABU)

Government facilitates this collaboration through the incubation centres where we meet with the industry (UNIBEN)

However, some universities lamented that due to lack of facilities in the universities, they are constrained to use the TICs.

Since we do not have most of the facilities, it is better to use the NBTI facilities since it does not cost anything (UNIBEN)

The absence of facilities has hindered the entrepreneurial orientation of the universities. The only university that has established an incubation facility or Science Park in Nigeria was the University of Nsukka (UNN). Respondents from UNN mentioned how they utilise their university-based Science Park, which was launched in 2018 in sharing facilities with some companies and promoting knowledge flow:

The university has had an incubator facility for a long time, and now we are one step ahead. We have created a well-equipped Science Park, enabling us to collaborate with external organisations, including the government and companies. We continuously upgrade the facilities so that we can meet the industry needs, especially in the IT and automobile sector (UNN)

Some universities are just conceiving the idea of developing university-based incubation centres. According to the University of Ibadan, the Federal government has recently approved some funds for the university to establish an incubation centre which will hopefully allow them to intensify their interaction based on sharing facilities with companies.

We have received funding from the government, and very soon, we will establish its incubation centres. In the meantime, we are using the facilities of the government or private owned incubation centres when necessary (UI)

The university respondents attributed the growing lack of university facilities to the government's inability to fund the universities adequately. This scenario is evident with the unending strikes by universities due to the failure of the government to fulfil its promises. Some universities had made a concerted effort to search for some facilities when the government refused to release some funds. These efforts included seeking help from NGOs and other international donor agencies.

### 5.3.1.3 Joint Curriculum Design

This theme analyses how UIG collaborates in the design of a higher education curriculum in Nigeria. Respondents were asked:

*Does the university solicit input from the industry and government in designing the curriculums?*

These days joint curriculum design has been recognised globally to produce well equipped and professionally skilled human resources that could fit in the 21st-century world of work. The quality of curriculum should get the great emphasis of educators, authorities and stakeholders (Tessema and Abejehu, 2017). The contributions of all stakeholders, especially those in industry, are critical in equipping students with needed technical knowledge (Bektaş and Tayauova, 2014). Findings revealed two critical curriculum design processes for the universities in Nigeria; the first is a joint stakeholder meeting for curriculum reviews held by the government at the national level through the National Universities Commission (NUC). At this stage, NUC meets with stakeholders, including private and state universities, and discusses the need for reviews and updates. NUC issues a benchmark serving as guidelines that would drive the review and monitoring of programmes at undergraduate or postgraduate levels. The government is empowered by the provision of section 10 (1) of the Education (National Minimum Standards and Establishment of Institutions) Act, Cap E3, Laws of the Federation of Nigeria 2004, to lay down minimum standards for all programmes taught in Nigerian universities. In 1989, NUC, in collaboration with the universities and their staff, developed Minimum Academic Standards for all the programmes taught in Nigerian universities. The findings suggest limited involvement of all stakeholders in the curriculum reviews at both stages. This has been confirmed by the research participants from the universities who noted that the collaboration is weak due to the lack of platforms for proper consultation:

Generally, the involvement of stakeholders in the process of curriculum reviews is limited. the universities and government collaborate because of their mutual interest, but the industry is out of the picture in both stages of the design (ABU)

ATBU further corroborated this position:

The curriculum design is in two stages, one by the government inviting university and industry, and secondly within the university itself. Surprisingly, in both stages, the linkage is almost non-existent (ATBU)

In the second stage of the curriculum review, findings show that the university reviews its curriculums internally by adopting the Minimum Academic Standard set by the government. Out of the six universities, only one university (UNN) mentioned that they have recently begun to consider the industry and other professional bodies to input the curriculum reviews. UNN's recent consideration of the industry could be due to the recent success in launching a university-based Science Park in the region.

Yes, we invite the industry representatives during curriculum review meetings and hear their views and input; in fact, we do not just invite the industry but also their professional bodies (UNN).

On the other hand, the remaining universities confirmed that they do not invite the industry during their curriculum reviews.

The industry is not invited for the internal university curriculum reviews. NUC should create a platform for the university and industry to collaborate and design the curriculums (UNIBEN)

In my view, curriculum reviews or designs need a thorough consultation. In this country, we do not consult before we design curriculums. Not industries or even other critical stakeholders are being notified before the reviews are undertaken (UI).

The lack of participation of the industry in curriculum reviews has brought about a skills gap between the universities and industry; this gap constitutes a barrier to the flow of knowledge between the three stakeholders. All industry respondents have acknowledged that lack of industry participation does not create the right channel of knowledge flow between university and industry. This is partly responsible for the growing concern regarding the disconnection between university knowledge and industrial needs.

#### **5.3.1.4 Contract and Consultancy Research**

A substantial body of work underscores the importance of contract research, consulting, and informal relationships for university-industry knowledge transfer (D'Este and Patel, 2007; Perkmann *et al.*, 2013). Consultancy and contract research conducted by the faculty members to the industries and government plays a critical role in linking the UIG stakeholders (Dutrénit and Arza, 2010). The finding shows universities consult for the government in various areas, including research on IT regulations adoption and application policies. The university also consults for the industry when the industry needs a solution to its problems. The consultation or contract research between universities and industry is mainly facilitated based on proximity and social contacts.

When the government needs extensive studies on policy on regulation of IT-related issues, the university comes in and helps. We also train some companies, especially since we created the Science Park. When both universities and industries are having a problem and need our intervention, we intervene and work together to solve their problems. We know each other very well, so it makes communication and understanding much easier (UNN)

Contract and consultancy are still growing, we hope to have the capacity to make them more robust in the future, but as it is now, it is not very strong (ATBU).

Our collaboration on contract or consultancy relationships with industry and government is good. When we discover that the companies can handle some technical problems, we contract it out for them to handle. This may require building software or automation of payment systems (UNIBEN)

We relate with the firms and the government very well. For the industry, it depends on the kind of company that is involved. If it is a larger company, we sometimes sign a contract, and if it is a smaller company, we can deal with them at an individual level. With the government, it mostly relates to policies on science and ICT. For some companies, we establish a personal relationship based on social interactions (UI)

Many universities have established various offices for consultancy services, where they offer a range of consultancies. These offices are located either within or outside the university. They specialise in human resources development, training, seminars, and workshops for private and public organisations and professionals in specialised areas such as Engineering and Sciences. However, despite these efforts in collaboration, there are issues of lack of confidence in the quality of university research.

The doubt in the quality of research and disbelief in our capabilities to handle research is the reason why we do not make progress in this aspect of collaboration. There is often mistrust, in the sense that the industry does not believe we can handle their research. Trust me, we can do what the industry expects from us, and that will shock them (ABU)

The findings suggest that informal contacts strongly facilitate the interaction between the UIG based on contract research and consultancy through conferences and other social contacts.

### **5.3.2 Findings from the Industry**

#### **5.3.2.1 Inter-Organisational Human Capital Mobility/Movement of People**

The industry respondents have different views about inter-organisational human capital mobility among the institutional spheres. Findings show a formal platform where the movement of people between university and industry is coordinated by the government. As mentioned in the previous section, the Students Industrial Work Experience Scheme (SIWES) is a formal and institutionalised form of knowledge transfer channel where students, mainly from Science Technology Engineering and Mathematics (STEM) departments, spend 3 to 12 months in the industry. The student industrial attachments aim to improve the flow of knowledge between universities and industry and expose them to the practical aspect of the theories they have learnt in the university. The SIWES is a scheme that was created in 1973 and coordinated by the government through the Industrial Training Fund (ITF). Before the scheme, there was increasing concern among Nigerian industrialists that graduates of institutions of higher learning lacked adequate applied related skills essential for employment. While respondents have agreed on the positive impacts of the scheme, they also lamented the inefficiency associated with the scheme.

Through SIWES, we receive students who come for industrial attachment and then go back and complete their studies. Even now, I have two students that are working in the office. This program is to provide undergraduates with practical knowledge of the industry. But many things are not right with the scheme. SIWES needs an overhaul because its importance to the industry is minimal (TBF 2 NC)

Another industry respondent TBF 2 SE, corroborated:

The SIWES program is designed to help the students with some basic practical skills so that when they finally graduate, they will have all the skills. This is a good policy to expose the students to what is happening in the industry and how they help the industry. But the university students doing IT in the industry do not bring proper knowledge or skills to the industry due to the poor university quality of our university education (TBF 1 SE)

Furthermore, the industry experts also work for government or universities, especially when essential practical experiences are needed. For instance, industry experts provide practical experience to the universities by teaching or working in support groups, thereby establishing relationships that can lead to research collaboration.

Many friends that were software experts have become government and university employees and have become a key resource. The government has also tried linking industry with universities through the SIWES programme (TBF NE)

Further findings also suggest that the university employees go on secondment into the bigger oil companies.

There are some university lecturers who deliberately go to the oil industry due to funding from the extractive industry. I can generally say, transfer of services is a good channel of knowledge flow both to the university and the government. (TBF 1 SS)

The university staff or lecturers need the money, and the oil industry pays well. I do not blame them. The government is underfunding the universities lecturers, so they must do what they need to do to survive, even if it means permanently joining the oil industry (TBF 1 SW)

That could be because these oil companies are financially buoyant and can afford to pay the university staff very well. That is why university employees do not hesitate to work for the oil industry. Many industry respondents have noted that they quickly seek employment within the government agencies during uncertain times for their businesses. Due to their experience in the industry, they add value to the government through skills acquired in the industry.

### **5.3.2.2 Facility Sharing**

The industry respondents were asked; *how does the industry collaborate with universities based on sharing research facilities?* Different views emerged from the participants. Industry respondents have agreed with the university participants on the roles of government through its Technology Incubation Centres. Some firms acknowledged their inability to have research facilities or laboratories to conduct research. Therefore, they rely on the government's platform through National Board for Technology Incubation (NBTI) to connect with the universities and jointly use facilities and work together. According to the respondents, apart from the facilities available for researchers and entrepreneurs to utilise for their various researchers, the centre runs a three-year programme to nurture entrepreneurs on business development, training with full access to government-organised SME seminars and exhibitions.

Besides the sharing of government facilities promote this linkage, there are many training opportunities for the companies such as business development, writing a proposal and even peaching training on how to convince investors at the TICs. (TBF 2 SS)

However, before being accepted as incubatees (depending on space availability), entrepreneurs need to have registered their businesses under the Corporate Affairs Commission (CAC), gotten all necessary certifications and have a business plan. Many respondents see this as an opportunity to learn new skills and promote their ideas using the available facilities at the TICs.



This training opportunity presents an opportunity for us to collaborate, innovate and thrive. It will also give us the opportunity to learn new skills that will help grow our businesses (TBF 2 NW)

However, companies differ in their capabilities, both in terms of human resources and facilities in their offices. Some firms are fully equipped with technologies and research facilities while others are not. For companies who lack the necessary facilities and equipment, the government strongly encourages them to utilise the TICs.

Some companies go to the TICs where the government helps in linking them to universities so that they can use government facilities jointly, but as for us, because our office is big and relatively equipped with technologies, we try to help university researchers who want to use some computers or software. (TBF 1 SW)

The government encourages researchers and companies to use research facilities like computers and HD printers at the TICs. They have introduced a programme where the TIC attaches a researcher to a company for guidance and support (TBF 2 NC)

However, some respondents, especially those who do not go through the government-owned incubation centres or programmes, disagreed, noting that they are on their own operating without the support of the government or universities.

I do not utilise any facility either owned by the universities or the government. I mostly collaborate with other companies when I need something urgent. Besides that, the university facilities are outdated, and some universities do not even have up to date libraries or laboratories. (TBF 1 NE)

The intensity of the collaboration through the sharing of facilities depends on the size of firms and the availability of resources at their disposal. Many firms do utilise the facilities at the TIC and collaborate with universities.

### **5.3.2.3 Joint Curriculum Design**

The industry participants were asked whether they get an invitation from the government and universities to give their input during curriculum design or reviews. The findings from industry respondents point to the fact that the industry stakeholders are not included during this critical process. According to the TBF I SW: the industry has made several attempts to be part of the curriculum designs, but the government does not give them the chance to be part of the process; instead, it directs them to handle professional certifications:

We have made several attempts to be part of the curriculum reviews so that we can make a significant input into the university's courses, but NUC does not give us that opportunity. They think that curriculum design is their prerequisite and their sole responsibility. They do not want the industry to be part of the design. The NUC will even tell you that whatever you want to do, go and do it at the level of your professional certification (TBF 1SW)

Other respondents further noted that they have never been invited to such a meeting. The universities and government handle curriculum reviews within their borders without the industry:

I have never been invited to any curriculum reviews or development by the government or the university. I think the universities and government are handling all the issues of the curriculum on their own. The industry does not have a say in the curriculum reviews in Nigeria (TBF 1 NE)

I have never been invited to curriculum meetings; some people say the government invites our professional bodies, but I am not sure (TBF 1 NC)

Other respondents attributed the neglect of the industry to lack of genuine commitments from the government and universities

I think there is a lack of genuine commitment from the universities, government. For me, I do not have any say on what happens either at the university or the government level. What I know is that there is a problem in the curriculum problem (TBF 1 SE)

The dynamism in knowledge production has put pressure on the universities and government to carry the industry on board so that all stakeholders will jointly fashion the knowledge system (Tessema and Abejehu, 2017). However, there seems to be no synergy during this curriculum review. This might have been caused by communication problems or a lack of commitment from either side. On the second stage of the curriculum reviews, where the NUC empowers universities to review their curriculum based on their priorities, findings show no collaboration between industry and university because universities do not invite the industry.

No, the university does not invite us for any curriculum design; they do it through their Senate within the universities. This is very bad for the education system in this country. How can a university develop its curriculum without industry representatives? (TBF 2 SS)

Findings from the industry further revealed a communication gap between the stakeholders. For a long time, the collaboration between universities and industry has existed, but the rapid increase of global knowledge has strengthened the demand for strategic relationships. To make the chemistry work, both sides should overcome the communications and the divide that tends to impair university-industry relationships of all categories and undercut their potential. According to the research participants, the industry is always ready to design curriculums if given the chance and invitation. However, because the government does not consider their input vital in shaping graduates' skill sets in the country, the invitation is not extended to them.

We are always ready to be part of the curriculum designs and contribute toward shaping our educational system. But that is only possible when the opportunity is given to us. We have tried our best to be part of the team or at least some of our members to be part of the curriculum review team, but no invitation has been coming through (TBF 1 SS)

Nevertheless, TBF 2 SW noted that the NUC invited professional bodies to participate in the process. Still, due to the uncoordinated activities of the private sector, it becomes difficult to identify who to represents the private sector:

Yes, I believe they collaborate, but I also think that we have too complicated private-sector representation with overlapping duties. For instance, in the ICT sector, we have The Computer Society of Nigeria, (CSN) Council for the Regulation of Engineering (COREN), Indigenous Software Developers of Nigeria (ISPON), you begin to think who should represent the industry (TBF 2 NW)

According to the above respondent, the lack of invitation by the university and government to the industry could be due to the numerous professional bodies representing the industry which could lead to complex consultation or communication.

#### 5.3.2.4 Contract and Consultancy

The industry respondents identified the flow of knowledge between the UIG through contract and consultancy as good and flowing very well. They stated that university consults for the industry when the firms are facing some challenges.

Normally we consider the universities as our last hope because when we encounter some challenges, the university comes to our aid and help solve whatever problem we have. Consultancy and contract provide a good opportunity for our company and the industry at large to gain knowledge and create goods and services (TBF 2 SS)

We collaborate on a contract basis for developing software and training. We have worked for the Federal Industrial Research Organisation (FIRO), and I still consult. So, I can say this interaction is strong (TBF 1 SW)

Additionally, the participants also noted that the government award contracts to indigenous software companies for developing a solution to some problems in government operations. This will promote the indigenous capacities of local companies and enhance their production capabilities and create multiple opportunities. The industry participants have also identified areas where the government is consulting for companies through NOTAP and NITDA on patent applications, processes, and procedures of research commercialisation. They further noted that companies are contracted by the government and universities in software designs and development and staff training on the applications of the technologies they have created.

The government is consulting for companies through NOTAP on issues of commercialisation. We develop software for the universities and government and train their staff afterwards. I can remember, we trained the University of Benin in coding and web design three years ago, and the relationship was cordial. If we sign any contract, we try to deliver based on the exact terms and conditions to avoid legal issues (TBF 2 SS)

Government consults for the industry on procedures of commercialisation. We also consult for the NBTI zonal office here in the South-East (TBF 1 SE)

Some participants noted that the collaboration based on contract and consultancy starts on personal relationships and later mature into a mutually beneficial institutional collaboration. According to TBF 1 NE, they often meet university researchers at conferences and exchange contacts leading to a sustainable and beneficial interaction.

Our company collaborates with some university researchers on a personal basis. There is a professor I met in the Nigerian Innovation Annual Conference and Exhibition in Lagos, he happened to be from Bauchi State, where I come from, and we relate very well. When I need some expert advice, I do contact him anytime (TBF 1 NE)

I do collaborate with the university, but I co-operate with the government more often because I have personal contacts in the government circle (TBF 2 SW)

However, some industry respondents opined that universities have low-quality research output and cannot help the industry solve their problems. According to the respondents, innovation in Nigeria takes place in the industry, not in universities. The universities are trapped in the linear

model of innovation, and no technological progress comes out of the universities. TBF 2 NW has confirmed this.

The quality of research output from the universities are poor, which is the biggest challenge. The research from our universities is not commercially valuable, so they are still left behind; all the innovation you hear about in Nigeria comes from the industry without the input of the universities. So, the industry consults for the university instead of university consulting for the industry (TBF 2 NW)

Findings show an excellent relationship between UIG on contract and consultancy. The knowledge flow plays a key role in bringing new knowledge into the organisations from the outside and help create new organisational practices.

### **5.3.3 Findings From the Government**

#### **5.3.3.1 Inter-Organisational Human Capital Mobility**

Responding to the same question, government interviewees acknowledged that inter-organisational human capital mobility is an active channel of knowledge flow between UIG. This channel has proven to be effective. Like the university respondents, the government interviewees have rated staff mobility from one origination to the other as having a positive impact on the government's stock of institutional knowledge. The responses show that the government has recorded more flow of personnel from the university than the industry. University and industry staff transfer their services to the government on either contract, sabbatical, secondment, or permanent. This finding has been confirmed by research participants who were once university staff and now working for the government. One of the respondents who work for NITDA noted that he had worked for a university for many years, and he recently transferred his services to the government.

It is common for academics to transfer their services to the government. I worked for the University for many years, and I decided to transfer my services to the government. I am now a director here at NITDA (NITDA)

The Director-General of NBTI was from university; he transferred his services to the government and still holds a part-time teaching position (NBTI)

Some respondents from the government have identified reasons to work for the government. They stated that when they work for an institution for many years, there comes a time when a changing environment will be necessary. The respondents said that the environment in the industry is unstable and fragile. Other participants supported this view:

Sometimes you must change the environment you work in after putting in many years of active service (NASRDA)

Many of those who move to the government on sabbatical or contract are PhDs and Professors and have been contributing to the effectiveness of some government agencies due to their knowledge and expertise.

Sometimes the Federal Ministry relies on the expertise of the sabbatical staff for training, workshops, and seminars for the rest of the staff (FMCDE)

Many university lecturers and people from the industry are working here under the Ministry of Science and Technology. Many of them joined us and parastatals under the Ministry with good qualifications, mostly PhDs, and they have put in their best. But I think there is a need for more sensitisation for both university and industry to switch working environments (FMST)

The findings also show evidence that there is some level of movement of staff from the government to university, especially those who joined the government on sabbatical, contract, and short-term arrangements. Some respondents believed that the academics on sabbatical or secondments find it challenging to adapt to civil service. Thus, they exhibit some attitudes negating knowledge transfer activities.

Many university staff who come to work for the government sometimes come with some negative attitudes which are adversely affecting the whole knowledge transfer activities (NACETEM)

Universities contribute to government policy through the pursuit of knowledge. The universities are one of the vital sources of evidence and expertise available to policymakers. They offer in-depth knowledge and research that can help to inform, design, improve, test, and scrutinise government policy. Universities are also well-known for their practice of producing research that benefits millions of people. When it comes to policymaking, university research is believed to be more dependable than other sources.

### **5.3.3.2 Facility Sharing**

Respondents from the government have also identified the sharing of research facilities as a channel of UIG interaction. Government participants were asked; *How does the government promote the sharing of research facilities among universities and industry?*

The findings from government respondents show the efforts of the government at encouraging the trilateral network through the sharing of research facilities and other vital resources to help knowledge creation. One of the key factors identified by the government respondents is the establishment of the National Board for Technology Incubation (NBTI) as a deliberate institutional framework to share resources and help entrepreneurs and university researchers in the early stages of their careers. Although the government respondents acknowledged that not all entrepreneurs are trained or incubated by the government-owned Technology Incubation Centres, they mentioned that many entrepreneurs and university researchers utilise physical space and other vital resources within the government-owned Incubation Centres. These incubator facilities offer office space and support services to accelerate the development of start-up companies.

We have established at least one Incubation Centre in each geo-political zone of the country, and the number will increase very soon. These centres will provide the facilities, equipment and other infrastructure that will help universities and industries to work together (NBTI)

The government has a robust policy on the incubation of entrepreneurs; this incubation is based on shared facilities and office space. So, the government also invites the universities

to teach, and some centres were even established near the universities. I am sure this is an excellent initiative that will bring the stakeholders together to interact (NOTAP)

The establishment of these Incubation Centres is an excellent platform that promotes this interaction. This enables the actors to share research facilities and conduct some research together (NUC)

However, some respondents have faulted the government led incubation centres for inadequate facilities. The inadequacy of the facilities has been attributed to the lack of enough funding and infrastructure.

There are quite a few challenges on infrastructure in the government led incubation centres. The incubation centres have not lived up to expectations due to the challenges and lack of funding (FMCDE)

NASRDA agreed on this position:

There is not cohesive collaboration due to the lack of enough funding. When you present a reasonable budget, and they cut it down by half, how are you going to achieve your objectives? (NASRDA)

NASRDA questioned whether sharing of facilities is enough to spur innovation between the parties. He mentioned that rather than focusing on the collaboration, the government should investigate the output of the partnerships.

### **5.3.3.3 Joint Curriculum Design**

Answering the same question as to the universities and industry, the government respondents acknowledged that joint curriculum development is a channel of UIG interaction. This channel of interaction aims to streamline the higher education curriculum based on the new frontiers of knowledge. When the government respondents were asked whether the government seeks the input of the university and industry during curriculum reviews, the government respondents claimed that the government always invites the university and the industry to participate in curriculum review meetings. For instance, NUC stated that the government invites all the stakeholders from the industry, including professional bodies and manufacturers associations, for the joint stakeholder meetings. Still, the participation of the industry is not encouraging.

In the curriculum design process, we normally gather subject matter experts from the universities in each of the disciplines and say, look, this is state of the art in this discipline in terms of our current curriculum. Tell us as experts, teachers, and researchers, what new courses ought to be integrated into the curriculum when we want to review them. What are the skills that our students need to have so that they are graduates that are suited to jobs? From that perspective, we get all the experts from across the universities at a stakeholder workshop. We work in groups of subject experts to design a curriculum in terms of content, asking what the anticipated outcomes are, what competencies are needed, what skills, knowledge, and abilities will our graduates be expected to have. When they go through a series of courses in that process of curriculum review, it is traditional for us to invite other stakeholders, including the private sector and even individual companies. Let me tell you, and I have worked for 20 years here at NUC; in all these years, I can say that often when you call the stakeholder meetings, no matter how much notice you give the industry, they are hardly represented, and just a few of them will attend (NUC)

The above view was contradicted by the industry (presented earlier), where they maintained that neither government nor university invites the industry for curriculum reviews. Therefore,

it is clear that miscommunication between the stakeholders led to the lack of collaboration. These views are confirmed by the responses below:

Obviously, there is a communication gap between these organisations because NUC confirmed to us that industries and other stakeholders are invited for the reviews, but the industry, on the other hand, are saying the invitation has not been sent to them. I think there is a communication problem (NBTI)

Informal discussions and field notes show that there is a communication gap between the government and the industry. A government respondent who stated that he had discussed this communication gap with the government noted that it will affect its national graduates' skills if this lack of proper consultation and communication continues.

I have noticed this communication gap, and I have discussed it with the NUC on many occasions. The government needs to reach out to the industry, and if there is a communication gap, they should try to sort it out because this is a national issue (NITDA)

It is a matter of misunderstanding in my view; the government needs to communicate with the industry and carry them along. It is because of the communication gap that this collaboration does not exist (NASRDA)

On the second stage of the curriculum reviews, where the NUC has empowered universities to review their curriculum based on the needs and priorities of the university, findings show there is no collaboration between the university and industry to discuss the curriculum jointly.

#### **5.3.3.4 Contract Research and Consultancy**

The respondents from the government have stated that consultancy and contracts help the flow of knowledge among the UIG. This type of knowledge exchange is very critical in contributing to the organisational objective. The government promotes SMEs and improves their competitiveness by promoting local content by awarding contracts and consultancy jobs. According to the respondents, many firms consult for the government in web design, database creation, and other IT related solutions. The government and universities also use their expertise to consult for firms, especially on issues relating to patent registration and the process of commercialisation of research output. This channel of interaction is promoted through informal interaction.

Government consults for the companies on many issues, such as raising their business into digital integration and innovation, including commercialisation of their research (NITDA)

We facilitate the contract and consultancy services between the university and the industry. We do this based on a mutual interest to help them to reach an agreement. When the incubation programme is finished, we attach each entrepreneur to the university and sometimes help them negotiate their needs before they engage in any contract or consultancy services (NBTI)

However, NUC believes that collaboration based on contract and consultancy between the stakeholders is inadequate to promote collective knowledge creation and dissemination.

Contract and consultancy collaboration is weak; even if it is happening, I believe it should be more pronounced between university and industry (NUC)

According to FMST, from the contract being awarded to the companies to develop software and apply them locally, the government had saved leakages and reduced corruption. Many of these companies build software and later train staff on how to operate the technologies developed.

From these contract and consultancy jobs awarded to the companies, corrupt tendencies of some government officials are cross-checked, and many leakages patched (FMST)

I know a company that has been consulting for the Ministry of Finance for years. This firm has come up with a solution to the government's auditing software. This company has also trained our staff in handling the software and is consulting for them. The company is collaborating with the IT department of the Ministry to improve on the application (FMST)

We have a dedicated office for consultancy to the companies and universities. The universities and companies consult for the government on training staff. I think that is a good way to improve contract and consultancy services. The only challenge we have is mostly the issue of trust and continuity. Building trust will make the collaboration a continuous one, but establishing trust is a huge challenge (NOTAP)

Findings show that in the same manner, industry helps the government in consulting and executing some contracts research; academia also consults for the government in various areas. In implementing these contracts, government staff get trained through working together with the contractors or consultants. This consulting relationship primarily emerges from informal discussions and then translate into a large-scale collaboration. According to government respondents, there are many instances where the government invites universities to make a presentation, and these presentations translate into contract or consultancy jobs.

Government engages with university researchers for consultancy jobs. We sometimes end up employing them permanently. This collaboration is initiated through informal channels, we organise workshops and seminars frequently in the office, and we invite them. when they come and see the presentations they are interested in, they communicate with the people presenting, and I think that is where the communication starts (FMCDE)

Findings show a good knowledge and information flow between University-Industry-Government based on contract and consultancy. Personal relationships facilitate this channel of interaction and social interactions enabled by conferences, workshops, or seminars.

## **5.4 Chapter Summary**

This chapter presented findings from semi-structured interviews from University-Industry-Government respondents on the assessment of UIG collaboration based on four channels of interaction. The interaction channels include inter-organisational human capital mobility, facility sharing, joint curriculum design and contract and consultancy. The findings from inter-organisational human capital mobility show good knowledge flow through the transfer of service among the three institutional spheres based on sabbatical, contract, or permanent transfers of service. The findings also indicate a platform for promoting human capital mobility through Student Industrial Work Experience. However, the findings show some challenges with the SIWES scheme due to a lack of proper monitoring placements or irrelevance of the field of studies of students. The findings from facility sharing also show strong relationships promoted by



the government through NBTI, where University-Industry are encouraged to utilise, facilities procured by the government for research and development. Findings from joint curriculum design show a lack of collaboration partly due to a lack of proper communication. The lack of collaboration in curriculum design has contributed to the growing skills gap between university graduates and industrial needs. Findings from contract and consultancy indicate an excellent flow of knowledge between the three institutional spheres. Universities consult for both industry and the government and government consulting for universities and industry. The industry also engages in contract and consultancy for both universities and government through software development, web design and other means. The next chapter (chapter 7) will present findings on the four developmental stages of the Triple Helix network and the general practical inhibitors of the collaboration.

### 6.1 FINDINGS ON THE FOUR DEVELOPMENTAL STAGES AND INHIBITORS OF TRIPLE HELIX NETWORK

Linked to the findings on the four channels of UIG interactions, this chapter presents results on the four developmental stages of the UIG collaboration based on the Triple Helix Model. It examines whether or not the organisational practices of the institutional spheres are congruent or incongruent with the theory. The chapter will also present the findings on the general inhibiting factors of the UIG interactions. The four stages of the model include the internal transformation and role-taking of each institutional sphere, the influence of each helix upon another, the creation of new relationships and recursive effects. This section also presents the findings on the general inhibiting factors of the trilateral network of the University-Industry-Government (UIG) interaction. It will analyse the empirical results of the UIG interaction in Nigeria based on the four stages of the Triple Helix developmental process (Etzkowitz, 2003). The four developmental stages of the Triple Helix Model are a guide to the production, exchange and use of knowledge between UIG. Scanning the organisational practice of UIG with the four developmental stages of Triple Helix theory will help identify gaps between theory and practice. Questions were created for each step of the developmental process to understand each helix's internal dynamics and mechanisms to push for establishing the relationship. These questions were linked to the trilateral interaction of UIG in Nigeria, theoretically and in practice. Addressing these questions through interviews, field notes, informal discussions and documentary analyses will reveal the overall state of the UIG interaction.

As discussed in chapter 4, the Triple Helix interactions have three different routes; the first route is the Statist model, where the government controls academia and industry. From the statist model perspective, academia and industry are weak, and the government appears to be the strongest helix driving the innovation process. The second route is Laissez-Faire, where the three institutional spheres are separate and interact moderately across borders. The third is the Hybrid route, which is the close interaction of the institutional spheres with overlapping or intersecting institutional roles. Scanning these interactions through the four developmental stages of the theory will give a perspective of the state of the Triple Helix network in Nigeria.

### 6.2 Findings from the Universities

#### 6.2.1 Internal Transformation and Role-Taking (University Perspective)

The first stage deals with individual internal institutional transformation, cultural, behavioural, and organisational change in achieving an optimum UIG interaction. The first developmental stage presupposes that each institutional sphere assumes the role of the others, creating inter-reliant and interdependent relationships. This means that each organisation makes an internal transformation.

In addition to performing its primary responsibility, each helix takes up another role as its secondary responsibility whilst still maintaining its unique and distinct identity (Shinn, 2002; Dzisah and Etzkowitz, 2008). Therefore, the changes may be a significant indicator in the emergence or development of the Triple Helix relationships. The university is expected to redefine its missions and mandates and broaden its responsibilities to integrate research, entrepreneurship, and commercialisation of knowledge through academic spin-offs (Etzkowitz, 2003; Etzkowitz and Ranga, 2015). Therefore, the study raised a fundamental question; What are the transformative initiatives introduced in the university?

Findings indicate that many universities have made some internal transformations as part of the efforts to expand their missions. Some measures are government-driven, whereas others are university initiated. The government-driven initiatives include the introduction of entrepreneurship courses in the universities to bring about the commercial goals of the universities. The university-driven internal transformation strategies include establishing the various centres of entrepreneurship within the universities and domesticating the Intellectual Property and Technology Transfer Offices (IPTTOs) in the different universities. According to the university respondents, since the establishment of these Centres of Entrepreneurship, and in some cases Centres for Entrepreneurship and Innovation, there has been an improvement in entrepreneurship training, capacity building, conferences and other R&D programs directed at the commercialisation of university research. These centres promote linkages between the university and the private sector through research, consultancy, training and building networks and alliances. The universities established these centres to complement the efforts of the government with its diversification of the economy. According to the respondents, the university can do that by embracing entrepreneurial practices within the university. The interviewees have confirmed this.

Our university has developed a robust University-Industry-Government relationship through organising Annual Research Summits, e.g., Ibadan Sustainable Development Summit organised by the University Centre for Sustainable Development in collaboration with the United Nations Sustainable Development Solutions Network, University of Ibadan Research and Development Fair (UIRESDEV) and Centre for Entrepreneurship Development. The other initiative is the effort to include entrepreneurial spirit into our mandates that encourage ourselves to be part of the government's plan for private sector-led economic growth. These initiatives were to make an internal effort to include entrepreneurship spirit into our mandates and encourage ourselves to be part of the government's plan for private sector-led economic growth on the issue of an academic spinoff. I will say it is a hard one until we can understand the whole essence of applied research (UI)

Another respondent echoed this.

The university has created a Centre for Entrepreneurship Development recently which encourages the culture of entrepreneurship among the lecturers and researchers. I think that is a good start for collaborating with the external stakeholders. Yet, there are challenges of perception from our faculty members, changing that perception on academic entrepreneurship and commercialisation of research is a big problem that we must deal with (UNIBEN)

Various reforms have brought in some changes, which I consider as transformations. Such reforms include autonomy, internal auditing, the introduction of entrepreneurship in the

curriculum and the establishment of various Centres of Entrepreneurship. The administrative changes were all part of the system to upgrade the universities and make them more responsive to the needs of the people. The challenges are a perception of the people, how to change their understanding of the commercially biased research and entrepreneurship (UNILORIN)

Moreover, internal transformation is not just limited to the structural transformation of the university policy or administrative structures; it is also about changing the awareness and perception of the faculty members, researchers, and university staff. This transformation means that faculty members must engage in academic spin-offs and conduct more applied research to bring about an actual tangible output, product, or process innovation. However, findings show that the perception and awareness on the academic spin-off are weak, and researchers are still engaged with the “*publish or perish*” syndrome where recognition, reward and promotion are attached to publication rather than market-based and technologically driven research. Based on an informal discussion with the Director of Research and Innovation of the universities, it was revealed that one of the challenges is the inability of the research output to attract financial investment. However, some Directors noted that awareness is growing among the universities to change their perception and understanding of the importance of the applied and demand-driven research. Findings show that internal transformation and the uptake of the other institutional sphere’s role is partial, and the entrepreneurship culture within the university is low. There is a growing awareness of the need for universities to engage with academic spinoffs. For instance, ATBU university respondents described how a spin-off-firm AKIM was created from university-based research and used to commercialise their research output. The university evaluates students’ projects, selects those with high-quality commercial value, and then incubates them for commercial purposes

As part of the effort for transformation, we have recently established a Centre for Entrepreneurship and Industrial Training unit. We commercialise our research output throughout spin-off called Akim. Under the supervision of my Directorate, we are trying to establish a Science Technology and Innovation Park to commercialise research that has commercial value. We try to get them close to the academic community and the university itself so that we can nurture the firms, monitor their growth, and try to empower them to work effectively. We have sent NITDA a proposal to help us with the establishment of the Science Park where we want to boost software developers and IT-based intensive knowledge firms, and the proposal has been receiving attention from NITDA authorities (ATBU)

Not all universities are moving in the same phase; some universities have established spin-offs and university-owned Science Park while others are just conceiving the idea and beginning to work on the modalities of creating them. For instance, according to UNN, the commercialisation process is carried out through its Science Park and spin-off company:

Roar Nigeria is a university-based tech start-up incubator created by the administration of the University of Nigeria to strengthen innovation and UIG collaboration among scholars, students, and academics in the university. This spinout aims to proffer technology solutions to the problems facing the immediate community and society in general. The introduction of the curriculum on entrepreneurship is also an indication of a change in the direction of the university. ROAR Nigeria is hosted within the University of Nigeria Nsukka (UNN), with a student population of nearly 40,000 and 12 institutions of higher learning within an hour’s drive from Enugu city. The Hub is a hotbed of ideas, invention and market induced solutions created with the concept of a Triple Helix innovation model (UNN)

Another respondent has confirmed this.

As part of the university strategy for transformation, the university has its internal approach through the Directorate of University Advancement. We organise competitions nationally and internationally with the most innovative student projects. This is a policy that the university has adopted recently; we have travelled to the US and sat down with some experts to see how the business could be incubated in our university. We are also evaluating the student projects that have market potential to see how we can convert them into a business. We have solar-powered technology. We also have some university consultancy services, and through them, we are trying to strengthen and make viable contributions to the university. So, I can generally say that there is some level of transformation, and we are making progress on changing our research priorities, and hopefully, we shall be there. But these transformations are not enough to bring about the change that we desperately needed (ABU)

The findings indicate some partial internal effort by the universities to introduce the culture of entrepreneurship in the students and faculty members. However, the lack of adequate funding for the universities and inadequate infrastructure presents a significant challenge to the university transformations.

### **6.2.2 Second Developmental Phase; Influence of One Helix Upon Another**

This stage refers to the changes initiated by one helix influencing or creating new opportunities that will stimulate the emergence of UIG collaborations in a Hybrid model. For example, when the government presents new policies, which inspire new initiatives of knowledge transfer and cooperation in the university and industry or influence their behaviours toward more active collaboration. This could be establishing Technology Transfer offices, Science Parks, or university-based incubation centres (Etzkowitz, 2003). As the facilitator and enabler of the UIG interaction, the government is responsible for creating policies that will influence cultural, institutional, or behavioural change. This section examines how the introduction of government policy changed the behaviours of the other actors in moving toward more collaborative relations. In doing that, a question was raised below.

How does the action of the government influence the behaviour of universities/  
companies?

### **6.2.3 Influence of Government on University**

The government's action has a direct or indirect influence in promoting knowledge transfer activities and driving the stakeholders toward collaboration. For instance, since the introduction of the National Economic Empowerment Strategy (NEEDS) policy by the government in 2007 and introducing an entrepreneurship curriculum in 2007/2008, the universities have responded by creating Centres for Entrepreneurship or similar centres where UIG interaction is promoted. Respondents described the introduction of entrepreneurship courses influenced by the NEEDS initiative as a factor that raised some awareness of commercialisation and entrepreneurship among staff and students. A university respondent has confirmed this:

The Introduction of curriculums on entrepreneurship courses and IPTTOs made the universities create the Centres for Entrepreneurship. Since then, there has been a slow, but growing awareness of entrepreneurship (though in theory) among the lecturers and even the students” (UNIBEN)

The major influence of these policies, especially the IPTTOs, is that the universities now have a point of contact on issues relating to the commercialisation of research outputs. Even though the utilisation of the office is minimal due to the challenges of poor research output and other related issues (UI)

The introduction of IPTTO and a curriculum on entrepreneurship on the universities are considered very vital steps toward collaboration and technology transfer for us. (ABU)

All respondents agreed that these policies have influenced the university entrepreneurial spirit but did not significantly impact the faculty members and students to embrace entrepreneurship. From 2006 to date, NOTAP has created (38) Intellectual Property Technology Transfer Offices (IPTTOs) in universities, Polytechnics and Research Institutions. Since the establishment of the IPTTOs offices by NOTAP, all universities have created units and appointed coordinators to spearhead the affairs of the offices. Since the establishment of these units, commercialisation potential within the universities has been growing. These IPTTOs were created to encourage collaboration and to reinforce the relationship between UIG. The office was designed to develop a robust intellectual Property Rights portfolio through patent, copyright, technology licensing; to support the Institution's initiative in developing patent culture. The IPTTO also produces an appropriate arrangement of motivations and rewards that inspires the researchers to be involved in partnerships.

Since the creation of the IPTTOs, we have an institutional structure on the ground; we are working on raising awareness for staff to embrace commercialisation and improve their culture and knowledge of the patent. The government has appointed directors of these IPTTOs, who serve as a link between the university and the outside world. This will hopefully improve the universities’ orientation and knowledge toward the commercialisation of research and the creation of revenue. We are not there yet, because the programme kicked off recently, but hopefully, we will begin to generate more revenue through the commercialisation of our research (ATBU)

Another respondent had acknowledged the role of the IPTTOs in enhancing research and commercialisation prospects within the university. But he differed on the efficiency of the office in terms of influencing the behaviours of the faculty members.

I think the government has done an excellent job by establishing the IPTTOs; these offices have a major influence on the universities’ orientations on knowledge transfer activities. The commercialisation of research is beyond the issue of IPTTOs. It is about applied research with an industrial application; it is about incentives and motivation for the researchers” (UNILORIN)

The approach from our university is different in the sense that the IPTTOs play a limited role. the University Science Park is doing the major work of the IPTTOs (UNN)

However, despite the establishment of the IPTTOs, findings show that intellectual property awareness among scientists and researchers is limited. This could be attributed to the low commercialisation potential and the low quality of research outputs from Nigerian universities. Consequently, through the Ministry of Science and Technology and NOTAP, the government recently issued seven guidelines for the commercialisation of research output emanating from

the universities. These guidelines will help convert the R&D outcomes from the tertiary institutes and research institutions into valuable products and services to meet the needs of the people, making them market-driven to accelerate industrialisation.

#### **6.2.4 Third Developmental stage: Creation of a New Overlay of Networks and Organisations among the Three Helices**

At this stage of the UIG linkage, each institutional sphere is expected to create external organisations, platforms, or networks such as region clusters, Science Parks, or business incubators referred to as the innovation system intermediaries. The intermediaries also include governmental or non-governmental bodies that enable platforms that bring the actors together (Etzkowitz 2003). Therefore, the research has raised some questions to examine the role of each institutional sphere in creating new intermediaries that will create external platforms to strengthen the UIG network and innovative capacities of the regions or nations at large. For the universities, the researcher raised questions based on two key features. The question attempted to understand the roles of the universities in the emergence of Science Parks or regional clusters in each region. Findings from the universities revealed that higher education institutions have limited functions in regional development initiatives such as Science Parks or clusters through which the firm's formation or spin-offs develop. For many years, Nigerian universities have become invisible in contributing to the development of a region or nation. According to UNILORIN, the public university system had been handicapped by successive governments who have not done enough to promote the economic roles of the university system through the provision of adequate funding. Also, the respondent apportioned blames not only on the political leaders but also on university management who, according to him, have not realised the essence of Science Parks and technology incubation centres.

The contribution of the universities in terms of economic development is limited due to the absence of Science Parks and fully functional university-based incubation centres. That is because for so long, the system has been led by people who have no clue how things like Science Parks can contribute to economic development. We do not invest in Science Parks, which are platforms that will make a visible contribution to the emergence of clusters. So, we do not play a major role in the incubation of high-tech industries, and it is about time we have this paradigm shift (UNILORIN)

Another respondent corroborated this respondent:

Universities are not fully equipped to make any visible contribution through the clusters or incubations. That is partly due to the failure of the education system and a lack of foresight from the universities. I can tell you not many university leaders or government officials fully understand the essence of these clusters and science parks. The university leaders need to focus on how universities can make an economic contribution to the nation (UNIBEN)

Ideally, our contribution to the economic development or prompting UIG collaboration will be stronger if we had a platform like well-functioning university-based incubation centres. With these facilities, the university's role toward collaboration and economic contribution will be enhanced (ABU)

On the other hand, a participant from UNN noted that the university had made an enormous contribution toward the success of the Nnewi cluster based in Enugu south-eastern part of

Nigeria. The University of Nsukka is the only University in Nigeria that has a university-owned Science Park. This Science Park has contributed to the Nnewi cluster located in that region by providing them with training and a supply of skilled human capital. The university respondent confirmed this:

The university has contributed a lot toward the formation and eventual success of Nnewi cluster in terms of training of human capital and other research in the field of science and technology. Recently we have collaborated on many projects with INNOSON Motors, which is one of the biggest indigenous companies in the country (UNN)

University of Ibadan (UI) has also started the process of building its incubation facilities with help from TETFUND.

Several bodies like the Nigerian Economic Summit Group and other professional bodies like the Manufacturers Association of Nigeria (MAN), the Council for the Regulation of Engineering (COREN) are trying to encourage collaboration through brainstorming. But it is still at its infancy stage (UI)

Findings show minimal roles of the universities in the formation or promotion of cluster development in Nigeria. This has been attributed to the nature of the universities, poor leadership, and the inability of the government to provide enough funding for the universities.

### **6.2.5 The Fourth Developmental Stage: Recursive Effect of the Trilateral Network**

This developmental stage emphasises the formation of advanced UIG interaction where each institutional sphere assumes the role of the other in producing goods and services. Varied responses emerged from whether the current organisational practices within each institutional sphere constitute a Hybrid Model of UIG interaction. The responses from the university participants indicate that the ideal condition of a Hybrid organisational model has not yet been achieved due to the enormous challenges facing the universities. The respondents attributed these challenges to the government's attitude towards the university, leadership failure and lack of political will and weak IPR policy: For instance, ABU noted that

The perfect UIG interaction is a product of the government's commitment. When the government says one thing and does another, then problems are bound to occur. Universities cannot function properly when they are not funded. The facilities in universities are dilapidated, and everything about the incentive of staff is in a mess. How do you expect our practices to follow the right path to development? It is not possible (ABU)

UNIBADAN and UNIBEN corroborated this position:

This network cannot be achieved without adequate budgetary allocation, facilities within the universities and motivation for researchers. In every country that has succeeded in developing successful collaborations, there is a huge investment in universities and research institutions. Unless we can invest in our universities, we cannot achieve this perfect collaboration we are yearning for (UI)

If you look at the university policies, goals, and visions, they look beautiful on paper, but when you think about how we go about implementing them, that is when you understand everything is not right. These problems arise from the government. For example, the autonomy of the universities is reconciled, and the government has an invisible hand in the selection of university leadership. What do you expect? I do not want to sound too critical, but that is the sad reality of things. Everything has been politicised, including the education system (UNIBEN)



Other universities described the weakness of all stakeholders in the process of building this partnership. ATBU described it as non-functional industries and the government's lack of proper attention to developing technology-based economic growth.

I admit we have challenges in the university, but what about the industry that cannot conduct research or rely on their indigenous universities? How can we develop this country with this attitude (ATBU)?

We are still far from the perfect situation for this interaction. The challenges are with all organisations' whether it is the industry or government and universities. We all are not functioning the way we are supposed to work. I think I can blame the government for that, a country's ability to grow depends on the investment in its knowledge infrastructure; look at how universities have been funded? That is a pity (UNILORIN)

However, UNN expressed optimism that the country will gradually grow if the implementation of policies and funding streams for the universities are provided by the university's leadership and the government.

I think we are making some progress; the major issue is leadership. If policies of government toward improving the universities and industries are implemented without any delays and funding provided, this partnership will work (UNN)

Findings indicate a weak role of universities in the formation of clusters. This is mainly due to the universities' challenges, preventing them from functioning as engines of regional and national economic development.

## **6.3 Findings from Industry**

### **6.3.1 Internal Transformation, Role-taking (Industry Perspective)**

This stage from the industry perspective means that the industry takes on the role of the university while it maintains its role of producing goods and services. The industry to act as a university means that the industry provides specialised training as a university while maintaining its primary focus (Etzkowitz, 2008). This developmental stage was applied to examine the organisational practices within the industry and whether or not the practice within the industry enables the development of the Triple Helix network. Therefore, the following fundamental questions raised here are:

*Has there been any transformative initiative from the firms that drives them toward taking the role of the university while maintaining their primary identity?*

This theme identified two critical issues in the organisational practices of the firms. One is the growth and improvement in the firms' innovative capacities, and secondly, the ability of the firms to provide certain critical services, especially in training individuals and organisations. The findings revealed an impressive growth and transformation of the industry through private innovation hubs; however, there is a regional disparity among the companies. Some companies,

especially in Lagos, South-West Nigeria, have transformed from small firms into fully-fledged private incubators producing software training and incubating individuals and organisations:

We are considered as African best both in terms of producing software and incubating young start-ups. We train people and corporate bodies, especially on software design and incubation. Sometimes people referred to Lagos as the African Silicon Valley, especially when you look at companies like Co-Creation Hubs and IDeA (TBF 2 SW)

We have companies that are developing exactly as advanced companies in developed countries. These companies incubate firms, train people in a very appropriate and gainful way. That is why the government supports them (TBF 1 SW)

There has been steady improvement and growth in the industry, especially in tech-based firms. We are into many business activities ranging from software production, incubating new firms and providing them with various training. If the government can concentrate on these hubs and invest in the innovation hubs, I think the tech industry can replace the oil sector in Nigeria and drive the economy (TBF 1 SE)

There is noticeable progress in places like Port Harcourt, and Lagos due to the market opportunist (TBF 2 SS)

The growth and improvement of companies producing goods and services are being supported by the Federal Government and some State Governments. That explains why the developments of these firms are not uniform across the six geo-political zones. For instance, in the South-Western states of Nigeria, firms tend to grow more than the Northern part of the country. That is due to the concentration of firms, available infrastructure, and investment opportunities in the Southern States, especially the South-West. Many respondents have confirmed this position:

The State Governments in the North do not care about the progress or growth of firms. Here in the North, there are no infrastructures, electricity, or internet connectivity. We must pay for all these things from our operational cost. How do you expect us to be competitive? We cannot be anywhere near the perfect UIG network when we do not have the basic and necessary tools to compete. Go to other developing countries like Malaysia or Indonesia and see how competitive their industries are (TBF 2 NW)

Another respondent supported this view:

The biggest challenge for us here is that we do not have an infrastructure. The infrastructure is very poor, and we do not have supporting research institutions (TBF 1 NC)

Generally, the industrial environment in Nigeria is very delicate, and the government needs to do a lot. The security challenge here in the north and lack of investment opportunities coupled with a low level of awareness by our people are factors responsible for the low industrial output (TBF 1 NE)

From the responses, field notes, and informal discussions with the respondents, firms located in the South are stronger than those in the North. This has been attributed to the advantages of the Southern States, which have relatively improved infrastructures. The interviewees pointed out that the innovation hubs in the South are working closely with the government in nurturing start-ups and helping regions and the country at large. An informal discussion with a manager from one of the innovation hubs in Lagos confirms how his company is working closely with the universities and how they jointly create knowledge; provide facilities and intensive training for companies and individuals. The manager described how the company was established with the mindset of

networking among peer companies and other external bodies in the production of goods and services.

### **6.3.2 Second Developmental Phase: Influence of One Helix upon Another**

#### **6.3.2.1 Influence of Government on Industry**

This section analyses the government's targeted effort to improve the industry's capacity through its various policies, incentive, and initiatives. The concept of the second developmental phase is applied to examine how government policies influenced some changes in the industry toward collaborative relations with other institutional spheres. Respondents mentioned numerous targeted government interventions that have impacted on improving the capacities of the industry. Such interventions included the establishment of the Small and Medium Enterprise Development Commission, (SMEDAN) National Office for Technology Acquisition and Promotion (NOTAP), the Office for ICT Innovation and Entrepreneurship (OIIE), and several other initiatives through the government-owned financial institutions such as the Central Bank and the Bank of Industry. Respondents have mentioned that the government has done a lot; however, they expressed concerns that the innovation ecosystem's challenges have outweighed the government's efforts.

SMEDAN has provided many companies with funding and training opportunities. Even though it is not enough, and there are still companies that are facing financial challenges'' (TBF 1 NE)

The responsibility of the government for improving the innovation ecosystem is yielding some results. For example, the establishment of SMEDAN, OIIE, and NITDA, and NOTAP and above all, the National Council on Innovation chaired by the Vice President are all steps that were taken to help the industry (TBF 1 SW)

Through the activities of SMEDAN and OIIE, the government is doing a lot on the innovation ecosystem. Many funding opportunities have been introduced, even though accessioning them is a big hustle (TBF 2 SE)

Findings from the responses show that the government, through (NOTAP) renders many technology-related services to industries, entrepreneurs, inventors, and innovators. Some of the services include monitoring technology and transfer agreements to protect the interests of the local firms, providing technical information, promotion of IP, commercialisation of R&D results from consultancy and extension services: - technology advisory services and linking industry with the universities. The technology transfer agreement is helpful to the firms since NOTAP' issued guidelines that stipulate that a minimum of 40 per cent of the annual technical maintenance fee paid to a foreign software-technology retailer should go to an indigenous partner.

Government intervention through NOTAP is saving the cost of Technology Transfer Agreements (TTA). They help in providing relevant information to us on how we can go through with patenting innovation and inventions. (TBF 1 SS)

There was minimal information or culture of patent not just in the industry alone but also in universities. So, I think the intervention of NOTAP has helped (TBF 2 SW)

The Technology Transfer Agreement (TTAs) target was to promote local vendors involved in maintaining the software businesses in the country and hence cut the price of involving expatriates in indigenous processes and improve the capability of nationals. However, some firms are not even aware of these services due to the lack of clear communication channels. This lack of a proper communication channel has created an information gap among the government agencies rendering these services to the firm creating an information gap and blurring some of the services available to the MSMEs by the government.

There are many issues of non-proper communication by the government because, for some companies that live far away from Abuja, this information hardly reaches us. So, the government should create channels of communication so that companies will know the services available to them by the government (TBF 1 NC)

Additionally, through SMEDAN, the government has created a Sub-contracting and Partnership Exchange (SPX) programme between local firms and international companies. The government did this in partnership with United Nations Industrial Development Organisation (UNIDO) to provide a technical cooperation program that links domestic enterprises in the country to the supply chains of large local or international companies. This programme was intended to raise awareness amongst SMEs, buyers, and government institutions. The goal is to support SMEs in Nigeria to advance a viable advantage to partake in the international supply chain through recognition, participation, and involvement of domestic and foreign buyers. These initiatives have a positive impact on the skills and capabilities of the companies in their collaborative efforts.

### **6.3.3 Third Developmental Stage: Creation of A New Overlay of Networks**

The industry respondents were asked to identify the private sector's efforts in establishing platforms/ organisations or bodies that stimulate UIG collaboration and knowledge transfer activities. Notably, these private organisations included some non-profit and non-partisan organisations like the Nigerian Economic Summit Group (NESG) and other philanthropic organisations such as the Tony Elumelu Foundation and the Nigerian Innovation Summit. The Nigerian Innovation Summit is an annual event that partners the world's leading innovation providers from the academic community, the government and industry with Nigerian businesses and international innovators of ecosystems.

Organisations like the Nigerian Economic Summit Group (NESG), Tony Elumelu Foundation are doing their best. These bodies organise meetings and workshops to discuss the importance of collaboration. The Tony Elumelu Foundation is the main funding body that helps the capacities of the firms by giving them funds and linking them up with other entrepreneurs and institutions of higher education (TBF 1 SW)

NESG has recently held a meeting in Lagos, where they invited the participants from University-Industry-Government and brainstormed on how they can promote the collaboration (TBF 1 NE)

Industry respondents have also mentioned other private organisations influencing the collaboration between industry and government by promoting collective learning, organising workshops and other means of information flow between the stakeholders. For instance, the Young Innovator of Nigeria (YIN) was mentioned by seven respondents. The organisation influences innovation networking through ICT adoption and application. This organisation was established in 2013 with the support of the government through NITDA. The organisation promotes the products of firms through national and international exhibitions. The national exhibitions include the annual exhibition of science and technology held every year in Nigeria, international platforms such as the Gulf Information Technology Exhibition (GITEX) in Dubai annually, and the Nigerian annual ICT conference (e-Nigeria).

Young Innovators of Nigeria (YIN) is one organisation that has also created some avenues for us to come together through some training, workshops, and annual exhibitions nationally and internationally. I happen to have participated in this exhibition for over two years now, and I was also in Dubai for the GITEX exhibitions. Through the national and international exhibitions, I have established links with many university researchers, both national and international'' (TBF 2 NW)

Another respondent also shared the above position:

There are several bodies, both governmental and non-governmental organisations that have an interest in the promotion of this collaboration. YIN is one of these organisations; they promote exhibitions of innovation by companies and create relationships between firms and universities'' (TBF 1 NC)

However, despite the role of private organisations in promoting the UIG network, there are still gaps that need to be filled. Most private organisations, especially those not linked to the incubation centres or have limited interaction with the government, believe that these platforms are only for privileged companies.

Well, I believe that these organisations need to be more open to all companies when it comes to favours, they have preferred companies to push, and not all companies will be treated equally (TBF 1 SE)

We are not being carried along, and they do not invite us to their meetings or allow us to be part of the collaboration. These organisations, especially the NESG, tend to be more elitist initially when it started. (TBF 1 SS)

Findings show existing private platforms encouraging the creation of a new overlay of communication. These groups fill the gap between the three institutional spheres and bring the parties together for mutually beneficial cooperation.

#### **6.3.4 The Fourth Developmental Stage: Recursive Effect of the Trilateral Network**

The industry respondents were asked whether they think the current industrial practices constitute a perfect University-Industry-Government interaction to create, disseminate and apply knowledge to attract value. The responses expressed mixed feelings ranging from those who expressed optimism for achieving the Hybrid UIG network to those who thought that the country was far from achieving it. The respondents mentioned that Nigeria's failure to industrialise was mainly due to its lack of the basic infrastructure, a relevant educated

population, and the necessary skills to advance the application of Science, Technology, and Innovation in the country. According to (TBF 1 NC)

Nigeria has always had the right policies, just like any other country, but one of the greatest challenges is the implementation. The leadership in Nigeria know that no country can industrialise, develop, and apply its Science and Technology without the required infrastructure, focused leadership, and knowledge and skills. We need to get an educated population and robust policies that will help to galvanise the process of industrialisation by investing and developing massive knowledge-based industries. That is what I think the country needs to have a perfect situation of UIG interaction (TBF 1 SE)

First, there are challenges of leadership and secondly, not utilising the talent rightly. We have tried many development plans, but all the development plans failed because of bad leadership. We have talented young people without jobs. How can you deploy these young people to the right jobs that will benefit this country without proper planning (TBF 1 SW)

Another respondent, TBF 2 NW, corroborated this position:

With the recent progress in the ITC, both private and public sectors, which is driving the level of incubation programmes, there is hope that we will get there. We need the right innovation ecosystem, infrastructure and above all, competitive higher education institutions that will help produce the relevant critical human capital (TBF 2 NW)

Another respondent further confirmed this position:

I believe we are making some progress; we just need better economic policies and infrastructure in the universities and research institutions. The firms are getting more digitally integrated, and I think the government needs to play its role sincerely and transparently so that we can get there one day. (TBF 1 SS)

On the other hand, TBF 2 SW expressed lost hope in the country, noting that despite the lessons learnt from other industrialised countries, Nigeria's journey to industrialisation through the application of knowledge has not been successful. Other respondents mentioned that the organisational configuration of the UIG in Nigeria is faulty since the 1960s. The respondents described institutional weakness and non-compliance to rules and regulations where elites either choose not to impose the rules or fail to gain societal cooperation.

The yardstick to measure any scientific and technological progress depends on the higher education functions and how supportive the government is to its institutions. In Nigeria, the government does not invest in education or the industrial sector. Look at how industries are closing everywhere in the country. For us to have a perfect situation of the UIG interaction, we must have the right political leadership'' (TBF 2 SW)

The perfect situation of UIG interaction has not been achieved because of the institutional weakness in the country. The situation where elite and political leaders deliberately choose not to follow the rules and regulations and instead protect their interest in the government as opposed to the interest of the public (TBF 1 NC)

The situation cannot be as perfect as we want unless we change our institutional configurations. The government should implement the right policies and make the collaboration productive for all, but we are not yet there (TBF 1 NE)

The interactions are facilitated by many factors such as leadership, political will, quality of the institutions, education, and skills; therefore, the proper implementation of policies is not effectively implemented. The availability of these elements enables the interaction between the UIG, and their absence affects the interactions. From the various responses, it could be

concluded that a lack of the fundamental elements identified above has prevented the Nigerian innovation environment from being in a Hybrid model of the innovation system.

## **6.4 Findings from the Government**

### **6.4.1 Internal Transformation and Role-Taking (Government Perspective)**

This section presents the findings on the general activities of the government in promoting the UIG network toward the Triple Helix direction and the overall innovation ecosystem in the country. The role of the government within the Triple Helix theoretical perspective assumes promoting the network on the one hand and becoming an active collaborator on the other hand. The fundamental question regarding the government's role in the internal transformation was.

*What initiatives or efforts are being made by the government to promote the general situation of the UIG network?*

The question tries to examine the practical initiatives of the government, through its Ministries, Agencies and Parastatals, and whether or not its activities in promoting innovation and stimulating the UIG network is in line with the theory. Most respondents clearly described the regulatory responsibilities and other incentives provided by the government as contained in the mandates of the government agencies. However, many respondents believed that investment in the tech firms by the government-owned bank amounts to assuming the roles of the industry.

The role of government is to collaborate, regulate and support this collaboration by funding and providing incentives. The government is doing all that through Central Bank (CBN) and Bank of Industry (BON) (NACETEM)

The essence of the incubation programmes is to help encourage innovation to stimulate entrepreneurship and make Nigeria an innovation-driven economy. That is why we established these incubation centres. Also, we now have NRIC that provides funding for innovation for these activities (NBTI)

We have a centre called the Innovation Support Centre that was established with the support of WIPO; researchers can access over 100,000 off-patent items of information. They can also access about 30,000 specialist science and technology journals. All these are provided to Nigeria by WIPO through our collaboration to enhance technological development and other areas of need. We are yet to utilise this opportunity (FMITI)

Others also described the government's establishment of an intervention fund aimed at improving the research capacities of the universities:

All practical efforts to encourage innovation and collaboration is for the utilisation of indigenous knowledge. The government has established the National Council on Competitiveness recently. This is in addition to the help from TETFUND to our universities. These efforts of the government are making an impact in my view and encouraging collaboration (NOTAP)

Findings also revealed that the government is making further efforts by introducing different policies to strengthen the UIG network and national R&D capacities. For instance, in 2014, the government established the National Research and Innovation Council to accelerate innovation-based entrepreneurship in the country and pave the way for the commercialisation

of present and future research results in Nigerian universities and research institutes and industry. The NRIC Bill was formally passed two years after the council's inauguration, which comprises the President and Vice President and ministers and various apex bodies of private organisations.

The introduction of innovation into the 2011 STI policy and the establishment of the National Research and Innovation Council NRIC indicates a milestone in achieving innovation. The Ministry has 17 Agencies under it, and in all these Agencies, our role is to regulate and collaborate. For instance, through NOTAP, we regulate the inflow of foreign technology and the registration of technologies. The government provides incentives to companies through CBN, Bank of Industry and the Ministry of Finance (FMST)

The government has introduced many reforms to enhance industrial competitiveness. These reforms include the establishment of the National Research and Innovation Council, TETFUND, and the National Council on Competitiveness. Despite this progress, we are yet to see any positive impact from the establishment of these institutional supports (SMEDAN)

Government has different approaches to encourage the development of innovation, science, and ICT in Nigeria. I cannot remember all, but the few ones I can remember including National Innovation and Research Council, the National Council on Competitiveness created by the government to encourage universities to engage in research with industry (NITDA)

The government has recently created funding opportunities for SMEs in the country. For instance, The establishment of the Small and Medium Enterprises Equity Investment Scheme (SMEEIS) in 2001 through the Central Bank. Under the scheme, all banks in Nigeria were obliged to set aside 10 per cent of their profit after tax (PAT) for equity investment to boost young, small, and innovative start-up companies (CBN, 2019). The respondents described this initiative as a failure because its process was stringent for the beneficiaries. The latest stream of funding recently introduced by the government was the various Start-up packages in 2019. These funding streams encourages Nigerians with innovative ideas to come forward for funding and training by the government. There are many other funding opportunities from the various Ministries, Agencies, and Parastatals of government to nurture young people toward innovation and entrepreneurship.

## **6.4.2 Second developmental stage: Influence of one Helix upon the other**

### **6.4.2.1 Influence of Government on University**

Government respondents also agreed that the introduction of entrepreneurship courses at the universities had influenced the universities entrepreneurial spirit. The respondents noted that they would want to see faculty members switch their focus from teaching and research to engaging in academic entrepreneurship. SMEDAN confirmed this:

The policy on entrepreneurship education has made some impact on the student' orientation and understanding of entrepreneurship. This is because we see some students engaging in their business after graduation and becoming successful. Although this is not always the case, we are beginning to see some progress. But we are still concerned that the lecturers and other members of the faculty are still not changing their perception and engaging in academic entrepreneurship (SMEDAN)

Another government respondent further supports this position:



The students' understanding of entrepreneurship is changing gradually; I cannot say they have embraced the concept of entrepreneurship entirely, but I am sure there is an improvement. As for the university lecturers and staff, you know how they behave; it is hard to know if they understand the importance of being a lecturer and entrepreneur at the same time. It is hard for me to say if the lecturers are into the idea of entrepreneurship because I have not seen any of them doing it. Yes, they teach the theory to some of the incubates, but for them, it is hard to say (NBTI)

Another respondent acknowledged the role played by IPTTOs in enhancing research and commercialisation in the universities and other research institutions but differed on the efficiency of the office in terms of influencing the behaviours of the faculty members.

The government has done an excellent job by establishing the IPTTOs, but the commercialisation of research is beyond the issue of IPTTOs. It is about incentives and motivation for the researchers. If a whole university does not have better internet, electricity, transportation systems or well-equipped library and laboratories, then how can we carry out impactful research and commercialise it? It is difficult (NACETEM)

The introduction of a curriculum on entrepreneurship and the establishment of IPTTOs are the key things that the government has put in place, driving universities and industries to engage in this collaboration. But some challenges need to be addressed, or else we cannot achieve what we want'' (NITDA)

Respondents from the government further noted that the inability of university researchers to engage in entrepreneurship is due to a lack of motivation.

I know the government is doing its best, but there is no financial motivation in academic entrepreneurship. The university system cannot work without a proper motivation system or incentives (FMITI)

Results also revealed that establishing the Intellectual Property and Technology Transfer Office (IPTTO) in the universities and research institutes as a government initiative had influenced the immediate change of behaviour in the universities. Since its establishment, universities replicated the idea by establishing units and appointing coordinators to spearhead the affairs of the IPTTO offices. Since the establishment of these units in the universities, the awareness of commercialisation has increased:

I can tell you that since the establishment of the IPTTOs, the university managements have taken the issue of commercialisation of research seriously. The IPTTOs led them to allocate spaces and appoint Directors in collaboration with NOTAP. I can say this is a good initiative and a positive effort (FMST)

These IPTTOs were created to encourage collaboration and reinforce the relationship between University/Research Institutions and Industries. The IPTTO was designed to develop a robust intellectual Property Rights portfolio through patent, copyright, and technology licensing; to support the Institution's initiative in developing patent culture. The IPTTO also produces an appropriate arrangement of motivation and reward that inspires the researcher to be involved in partnerships. A government respondent confirmed that the creation of the IPTTO had improved the commercialisation of research and Technology Transfer from the universities to industry.

The government has made numerous efforts to encourage the commercialisation of research, technology transfer, and entrepreneurship since 2006. With the help of WIPO, we started a programme called the IPR and Technology Transfer Offices. To date, we have about 38 of those offices across research institutions and universities and sometimes even in medical labs. These offices are designed to establish a formal way of linking universities with the industry. We were hoping that they would have coordinators who would liaise with the universities, government and with industry. We hope to increase the efficiency of the offices and make them work more effectively (NOTAP)

However, despite the establishment of the IPTTOs, most respondents have complained that intellectual property awareness among scientists and researchers within the university and converting research into the product has been disappointing.

#### **6.4.2.2 Influence of Government on Industry**

The findings from the government indicate that since the formation of the National Policy on Small and Medium Enterprises Development in 2004, activities in the firms have been coordinated and encouraged to utilise indigenous knowledge from universities and government-owned research institutions. This institutional framework has helped the SMEs create optimal human, technical and managerial capacities to improve the production of goods and services. One of the frequent themes cited by the respondents is access to financial incentives. For instance, one respondent gave an example of the Federal Government Special Intervention Fund for MSMEs, the Bank of Industry and the Central Bank of Nigeria's Intervention Funds:

Since the establishment of SMEDAN and other incentives by the government, I think SMEs have improved their capacities, knowing that an agency of government has been established to coordinate their affairs. This Agency is good at linking SMEs to universities, and even government-owned research institutions (SMEDAN)

We do everything possible to raise the entrepreneurship skills of the IT companies and expose them nationally and internationally (NITDA)

By our mandates, we register, administer, and protect the results of research outputs. We are doing all we can to educate the industry and universities on patents registration and protection IPR portfolios (FMITI)

Apart from the incentives and funding opportunities, the Ministry is annually organising a Science and Technology Expo to allow entrepreneurs to showcase their talent and their work so that they can attract investment'' (FMST)

When you talk about how government policy or programs are influencing the behaviour of the industry, I can say that the training and incentives structures provided by the government to the industry are very pivotal in upgrading our capacities (NBTI)

Findings also show that the government, through SMEDAN, has created a database for the MSMEs providing information about private and government organisations that provide funding for the MSMEs. The government respondents think that this database will improve information flow to industry and the chances of the SMEs getting loans without going to the conventional banks. However, loans from less conventional banks and other commercial institutions come with specific conditions. Despite this, findings show that SMEs prefer going to these alternative financial institutions rather than banks. One of the government respondents noted that the interest rates of

the traditional banks alone significantly reduce the chances of ever making a profit from their business due to the high operational costs.

The database for funding opportunities created by SMEDAN will help the flow of information among companies, and I think this is helpful. It enables firms to avoid those banks with high-interest rates (NACETEM)

Also, findings show that the government, through NOTAP, helps the innovators, inventors, and entrepreneurs with many more technology-related services:

NOTAP has many programmes to help the industry, but unfortunately, many do not even know services offered by NOTAP exist. The lack of information costs them a lot. The government decided to create some services, especially those related to the agreements, to save the firms from exploitation by foreign companies (NOTAP)

Findings revealed that the government has recently unified trade, industry, and investment under the Federal Ministry of Industry, Trade and Investment domain, which shows Nigeria's objective to efficiently coordinate these three essential areas to develop its trading and investment environment. These efforts identified by the various government respondents are some of the practical steps introduced by the government to stimulate the capacities of the industries. They are provided through multiple agencies, and they include, among other incentives from tax relief for R&D, export incentives for non-oil sector companies.

#### **6.4.3 Third Developmental stage: Creation of a New Overlay of Networks**

Findings show some efforts made by the government to encourage the establishment of various platforms to stimulate UIG interaction. These initiatives include cluster strategies, incubator facilities and technology innovation hubs. For instance, the government has created Industrial-Development Centres in different locations in Nigeria (NEDP 2014). Based on the Industrial Development Act 1971, the Federal Ministry of Industry, Trade, and Investment, set up 23 industrial-development centres (IDCs). These IDss were abandoned and are currently non-functional; however, the government has renewed its efforts through various Ministries, Agencies and Departments to develop other solutions and link the private sector and universities for joint knowledge creation. According to NITDA,

We do not have a clear policy on clusters, but we try to support those clusters through the various innovation hubs we have established recently. We do everything possible to raise the entrepreneurship, technology transfer capabilities and skills of the IT-based entrepreneurs with training and capacity building, mentoring even providing them with certain equipment. We have a target to spread the idea of innovation hubs throughout the country (NITDA)

Although Nigeria does not have a clear cluster policy, there are different clusters spread across the country. These clusters are primarily informal and developed naturally with less support from the government.

We have some supporting structures for the cluster's development through the Incubation Centres and Innovation hubs established by NITDA. But the government has limited support for the clusters, which is why they are not visible (FMITI)

In addition to the innovation hubs established by NITDA, the government is also working with the private business incubators to support collaboration and joint knowledge creation. According to the respondent from NBTI, the government supports the clusters through its various centres spread across the federation.

We try to support clusters through our facilities and expertise, but that is not a cluster strategy. We are just supporting the firms and universities. The government needs to do more to bring these stakeholders together by getting a cluster policy to drive the formal cluster strategy. (NBTI)

According to another respondent, the government is helping the clusters through incentives and export processing zones established recently:

The recent effort by the government in rejuvenating the cluster strategy is made through Ministries of Communication Digital Economy, Ministry of Science and Technology and Ministry of Investment, Trade Investment. For instance, we have established Innovation hubs through NITDA, and about 33 industrial free zones and export promotion policies were created (FMST)

The Free Trade Zone is a scheme that was proposed to help the diversification of the economy and stimulate export-oriented business enterprises. Additionally, some states governments like Kaduna State have established innovation hubs to bring together entrepreneurs and academics to share ideas and knowledge to foster collaboration. Although the effort of Kaduna State has not been replicated in the other Northern States. According to the respondents from SMEDAN,

Strategies like clusters should be well-coordinated efforts by local, States and Federal governments. What we see in Nigeria is that development initiative comes only from the Federal Government instead of all stakeholders including the private sector'' (SMEDAN)

There should be complementary platforms from Local Governments and States. The states and local government should be active in attracting talents; they should replicate what is happening in countries like Malaysia (NACETEM)

The Federal government is promoting the idea of the One Village One Product (OVOP) initiative to boost the local and community productivity level through SMEDAN. This project is another strategy for helping the cluster in Nigeria. The project is yielding some results, but there should be a clear cluster policy in this country to identify what each level of government can do about it to contribute to its success (NOTAP)

The government has put in place different approaches through the Ministries to help the idea of clustering. Moreover, the findings also show that the government-owned financial institutions are playing their role in supporting the concept of clustering through financial and non-financial incentives. However, due to the lack of clear a cluster policy, cluster strategies have not yielded the much-anticipated results.

#### **6.4.4 The Fourth Developmental Stage: Recursive Effect of the Trilateral Network**

At this stage of the UIG network development, it is expected that smooth interaction between the University-Industry-Government will lead to identifying opportunities and creating an avenue where the flow of knowledge will enhance industrial competitiveness and enhance regional and national development. Like the university and industry respondents, government

respondents are also divided on whether the institutional practices within the government institutions lead to forming a Hybrid Triple Helix network. According to the FMST,

We are making progress, but we are not yet there compared to the developed countries. Gradually, we are beginning to see changes from what we have been used to. Innovation is one of the top priorities of this administration. The Minister of Science and Technology has made it clear in one of his presentations that by the year 2020 and beyond, if Nigeria will dedicate budgetary allocation to the STI, the country will be an innovation-driven economy (FMST)

Another respondent FMITI corroborated this position:

I think we have made some progress compared to the previous years. I said this because we have seen for the first time an improvement in the business environment and the establishment of a National Research and Innovation Council that implements the STI and provide adequate funding. I remain positive that in the next few years, we will be able to have the network right in Nigeria (FMITI)

Most of the respondents, however, disagreed with the view shared above. The following respondents argued that achieving a Hybrid network requires a considerable effort from each institutional sphere, especially the government. According to NOATAP:

We are not yet there, and we have a lot to do. I have always told people the truth, and it is bitter, but let us tell ourselves the truth. In Nigeria, we do not have an IP policy at all; secondly, our research funding is disappointing. The commercial content of our research is abysmal; then tell me how we can achieve the perfect UIG practice in Nigeria? Our organisations are not result-oriented, and making UIG interaction work perfectly, as you described, is very hard within this present setting (NOTAP)

Another respondent, NACETEM, agreed with this position:

I am not sure if we can achieve the perfect UIG interaction. We are not even near there because we all work in silos. The government has not adequately fulfilled its promises, and the universities are being underfunded to the extent that they cannot even perform their primary duties efficiently (NACETEM)

Despite all the positive things happening, we are not yet there; we still have a long way to go, our institutions are not ripe, and the government has caused this. The government does not care about research, nor does it invest in the capacity of its universities to conduct research. We need leaders who will work deliver in Nigeria (NBTI)

NITDA, on the other hand, highlighted the developments in recent years and showed that these are signs that the country is making progress.

I know that there are many challenges with the economic, social, and political settings, but we are making the right decisions and interventions. The only area I have a concern about is whether or not the policies will continue when the present government leaves (NITDA)

These challenges have been identified, and solutions will come in the next few years, so I remain positive that in the end, we will have a perfect situation of UIG interaction (SMEDAN)

Findings from many of the respondents show a pessimistic view of Nigerian's vision to become one of the top 20 economies in the world by 2020 through the application of science, technology, and innovation.

## **6.5 Findings on the General Factors Inhibiting the UIG Network**

In the second section (7.5), the researcher presented the results of the four developmental stages of the Triple Helix theory to examine the practices of the University-Industry-Government relations and identify whether the organisational practices of the three institutional spheres conform to the theoretical propositions. This section (7.8) will present the empirical findings on the general factors impeding the UIG practice within the universities, technology-based firms, and government institutions that deal with technology development in Nigeria. These factors are divided into two broad categories, including institutional and social factors.

### **6.5.1 Institutional Factors**

#### **6.5.1.1 Lack of Resources/ Funding**

Funding is a multi-dimensional factor whose availability can be an enabler and whose absence can be considered an inhibitor. This section will analyse the lack of funding as a general inhibitor to the UGI interaction from all stakeholders' perspectives. Starting with universities, lack of funding has been frequently mentioned by university respondents as a factor inhibiting UIG interaction. Funding Federal universities is the sole responsibility of the Federal government. There are two primary sources of funding for the universities: government sources and non-governmental sources. Government funding comes from annual budgeting and is divided into capital allocation, meant to deal with projects like buildings, repairs and other big projects, and recurrent allocation, covering salaries, maintenance, travelling, and transport expenses. The government provides another stream of funding called the special grants to improve services and conduct research in the universities. The government allocates funds to universities through the National Universities Commission (NUC). The Commission is expected to collect all budgetary requests from the Federal universities and examine them to ensure compliance with the laws of funding parameters. After consideration, the proposal is sent to the Federal government for approval. A budget defence session at the National Assembly committee follows where each university is expected to appear before it to defend its proposal before the Federal Government approves. Over the years, insufficient funds to settle salaries, arrears, pensions, and grants have been a primary source of contention between the government and universities, leading to constant strikes. Due to insufficient funds for universities and the inability of the government to provide more funding, tuition fees were increased by many universities sparking protests and counter-protest by the students. For instance, in November 2018, the Academic Staff Union of Universities (ASUU) began a strike due to inadequate funding of federal institutions and the government's failure to fulfil its promises. Some university respondents have described how this tedious process of funding affects regular duties and limits the ability of the university to initiate research and engage in any collaboration.

The interaction has not been cohesive up till now; again, we have an issue of inadequate funding for the universities and other STI activities. Sometimes you have a good idea to execute, and the financial means to do it is not there, then the project will be hampered, and there is nothing you can do about it (UNILORIN)

The funding we are getting from the government is not enough to enable us to carry out any function. How can you expect us to collaborate and innovate without giving us enough funding in terms of grants and other incentives? It is not possible (UNIBEN)

The government made a policy for Nigerian companies to pay an education tax of 2% of their quantifiable profits into an education fund to address these funding issues. The fund was created to encourage research, infrastructural development, and staff training in Federal, state, and local educational institutions. Primarily, the fund was dispersed between the different tiers of educational institutions, including higher institutions, primary and secondary schools. However, this funding framework was replaced by the Tertiary Education Trust Fund (TETFUND) in 2011, which now grants only higher institutions access to the fund. The findings revealed that the general impression among all university respondents is that the government has not funded research vigorously in the universities compared to the developed countries. The respondents have confirmed this:

The government has not provided enough funding compared to the developed countries. The researcher does not have the incentive to collaborate or even do their research because of the funding issues. This needs to be adequately addressed. Do you see the constant strikes and their effects on the students and the education system in general? It is horrible (UI)

Just like the funding processes for the higher education sector, all government agencies go through the same constitutional procedure before funds are allocated. The heads of the Agencies present an annual financial request to their Federal Ministries and appear before the joint National Assembly committee to defend their budgetary proposals. This is subject to delays in the release of the funds due to the new government's policy on the Treasury Single Account (TSA) introduced to check the corrupt tendencies of all government institutions. Although delay existed before the introduction of the TSA, the policy has compounded the issue of the timely release of funds:

Lack of funding or underfunding from the government and delays in the release of funding is a challenge. The government does not release funds in time to enable us to conduct our functions efficiently. Due to reasons unknown to us, the Federal Ministry of Finance always delays the release of funds. You cannot do anything without these funds being released to you (FMST)

Underfunding of government institutions has a political perspective related to the agendas/slogans identified by the government as critical for achieving their political objectives. For instance, successive governments in Nigeria come into power with specific political programmes, considered essential to making their policies and promises to the people. Examples of such promises include, for instance, the 7-Point Agenda 2003 to 2007 and the Transformation Agenda 2011 to 2015. These agendas were targeted to be achieved through some government agencies. Consequently, any government agency that does not fall under the

identified programme receives minimal government attention. A respondent has confirmed this assertion.

The utmost challenge is that if an agency of government is not among the policy identified by the current government, it does not get the required attention and proper funding (NASRDA)

The funding challenge has a negative effect not just on the universities and government agencies but also on firms. The respondents from the industry have also mentioned a lack of access to funding and credit, stifling the industry's ability to initiate or carry out any collaboration.

I know how easy it is to have access to funding in developed countries, but here in Nigeria, access to finance or credit is a significant challenge. That is why collaboration or even engaging in research is hard for indigenous companies (TBF 1 SW)

Despite the availability of these government agencies, respondents described the near impossibility for SMEs to access credit facilities. The firms are left with no option other than to approach the commercial banks with their exorbitant interest rates, which require expensive collateral, thus creating a significant barrier for the industry to cross to develop and engage in any form of research collaboration with the universities. This challenge is a considerable barrier to their growth and the ability to conduct research, thereby affecting partnership and ultimately affecting national and international competitiveness.

#### **6.5.1.2 Bureaucracy**

Bureaucracy encourages delays in a system and hinders out of the box solutions (Moeliodihardjo *et al.*, 2012). Several respondents from all stakeholder groups have said that one of the critical elements that hamper the UIG linkage is the bureaucratic bottleneck associated with public institutions, including the universities. Respondents have identified several ways that bureaucracy affects UIG interactions. According to TBF 1 NC

I have made several attempts to collaborate with one of the government agencies to develop software, but because of bureaucracy, I could not get that contract (TBF 1 NC)

Delays in the decision-making process of government institutions are primarily due to large files, registration of documents and paperwork to be read and recorded before a decision is taken. This may stifle collaboration potentials with the industry. The bureaucratic process has many dimensions; some relates to the procurement process; others relate to documentation in the release of funds as confirmed by the respondent below:

The procurement process is long involving the process of bidding, acceptance, documentation, and a lot of other unnecessary delays before decisions are made. This may potentially affect the contract process because not everyone bears those long delays (TBF 2 NC)

First 'it takes time to register a recognised with Corporate Affairs Commission and get certification from NOTAP in case you intend to import technology. Secondly, you must go through a long bureaucracy before you get any consultancy job (TBF 1 NC)



Furthermore, the industry participants have also attributed the challenges of setting up or sustaining this collaboration to the inability of the government agencies to fulfil their financial responsibilities in releasing funds promptly. The process of fund release in Nigeria is tedious. The Federal Government recently introduced the Treasury Single Account (TSA) to all Ministries, Agencies and Parastatals (MDAs) of government after discovering that its agencies operate multiple bank accounts illegally to syphon money meant for federal projects. The government introduced the TSA to enhance efficiency and eliminate corruption in the public service. The strategy meant that there is a lengthy process to complete before the release of funds.

The TSA has caused many disadvantages; I know the government is trying to promote transparency and accountability, but as far as the industry is concerned, our government should find a way to bypass certain things. The government agencies take ages to pay for the services rendered to them, this is a problem (TBF 1 NW)

There are challenges, of course, our language in government is all about bureaucracy, for example, the TSA (Treasury Single Account) and all the issues it comes with have a negative and positive effect, but that is a huge problem to any form of collaboration (FMCDE)

Other respondents are concerned about the bureaucratic elements of setting up a business, such as difficulty registering a company, paying taxes into the different organisations, and difficulty getting approval. However, there is no easy solution to the problems of a bureaucratic bottleneck, where rules and regulations are widely applicable in all agencies of government and universities. However, enhancing the efficiency of the organisations might comfort the parties involved.

### **6.5.1.3 Different Orientations**

Orientation related barriers to University-Industry-Government collaboration refers to the different cultural differences and orientations of the stakeholders. The difference in mission between the partners, where the university focuses on generating knowledge and industry focuses on profit maximisation. The difference in mission and orientation sometimes sets the actors in different directions and presents a conflict of interest.

I can confirm that there are differences; for instance, there is usually a delay in the release of funds to execute projects agreed between government and industries. And this discourages the industries from collaborating with the government. TBF 1 SW

Surely there is the issue of different cultural orientations; the industry is desperate to get paid for services rendered, delay in the payment or not releasing their funds make them too agitated, and this led to a clash in one way or the other (ABU)

The government respondents noted that to avoid a potential conflict of interest due to organisational differences, Ministries and Agencies of government encourage various mechanisms of continuous communication through the IPTTOs.

The government understands the potential conflict over institutional differences; that is why we established various IPTTO and try to push them to collaborate in more than one channel. I think the frequency of the collaborations from different channels and proper communication will help resolve this conflict (NOTAP)

The IPTTOs intervene when there are potential dangers of a conflict of interest between the University-Industry. However, findings show that different missions and orientations present a significant barrier to collaboration.

#### **6.5.1.4 Low-quality Research Output**

Respondents have identified low quality of research output as another critical inhibitor of University-Industry-Government interaction. According to NUC, the government is concerned about the decline in the quality of research institutions and HEI in Nigeria. The Nigerian University Commission (NUC) noted that the gradual decline in the quality of research began in the late 1980s, noting that Nigeria used to have the best-rated research output in Sub-Saharan. However, the quality research output is a product of investment in research, training, motivation, availability of equipment and library facilities (Chiemeké *et al.*, 2009). The findings show that the ability of many firms to convert research into commercial products is limited.

As a scientist, I can tell you that the quality of research output we have in this country is inferior. I know the feedback mechanisms; it may be possible that others who have done research will have had negative feedback, and that might affect their motivation and confidence. Many companies cannot even convert this research into commercial products. This is because, from the university side, the motivation for researchers and investment in R&D is shallow. You cannot expect to get a good result when your research system is defective (NUC)

I agree that most of our research has no commercial content, but which company can even convert this research into products? This is a result of a lack of interaction between the university and industry. When the government was considerate of the education system before the 1980s, everything was okay; why now? (UNIBEN)

The other factors contributing to low-quality research output also include the fact that universities do not engage in demand-driven research and attract. That is why the industry finds it difficult to see viability in the research outcomes conducted within universities and government-owned research institutions.

For most universities and research organisations, the research is not demand-driven; we do not conduct research to fulfil a market gap. Our companies cannot convert the outcome of the research into products. I think that is the issue we are confronting (SMEDAN)

Industry respondents also narrated the same issues of low-quality research output from the universities and the research agencies.

The issues of concern are the lack of market-driven and less impactful research being conducted at the universities. Universities are supposed to do research that will attract commercial value, make inventions and innovations that will identify the niche and solve societal problems. What we see here is different. Everyone wants publication, and that is it (TBF INC)

Respondents agreed that current research conducted in universities is not based on domestic demand, and therefore, the potentials for commercialisation will remain uncertain. Research output from tertiary institutions must impact industrial, commercial, and administrative processes on all fronts.

### 6.5.1.5 Corruption and Favouritism

Corruption in Nigeria is a considerable challenge affecting society. Many respondents mentioned corruption as one of the factors that impede UIG collaboration. The respondents noted that corrupt leaders are responsible for the current economic and technological backwardness in Nigeria. The corruption manifests in many ways, but the critical one that affects the trilateral network of UIG relates to the procurement process or award of contracts involving monetary transactions from the government to universities and industry or from universities to industry. The industry respondents stated that the industry needs credible institutions with a reputation for collaboration, not institutions with a corrupt image or lack credibility in their research output.

Corruption in some government institutions and universities is a big challenge. The industry considers the credibility of the institutions before going into a research collaboration; we do not want to deal with dodgy people who do not have a track record of credibility and transparency. If you do not have a political connection, even the limited access to funding some companies get is not available. So, it is all about favouritism and connection (TBF 1 SW)

Based on the observation and field notes, it was clear that the corruption cases were being under-reported by the universities and government respondents. This could be due to the fear of exposing individuals and being victimised for exposing corruption. Some individuals occupying positions under whose directives or knowledge the unethical practices are being perpetrated. Respondents stated that the one-way government supports firms is by patronising their products, goods, or services. Therefore, firms or universities are engaged by the government based on contracts or consultancy for vital issues, including the building or installation of indigenous software. The award of such a contract is one of the best channels of interaction between the institutional spheres. However, respondents from all stakeholder groups described the process of awarding contracts as rigid, corrupt, and less transparent. They labelled it as a subject of favouritism and who you know syndrome. This is a situation where who you know and where you come from as opposed to competence, qualification, and ability to deliver influences decisions. According to industry respondents, many universities and government institutions prefer to award contracts to their proxy companies, their friends, or close associates or those that come from their clan or tribe.

The corrupt process involves favouritism and whom you know or which language you speak. I am telling you based on what happened to me on many occasions. This is how we struggle to be entrepreneurs in Nigeria. I have applied for consultancy work with the Nigerian railway, and I was screened out. A company that was recently registered got the job to build a ticketing application. I know the guy, and I know his relationship with the manager of that place” (TBF 1 NW)

Nothing is done according to the law in this country; they consider your tribe, where you come from and whom you know, they must skip some legal and administrative processes to favour their close associates and their proxy companies (TBF SW 2 NE)

On many occasions, I remember how we were screened out of a job we wanted to do for the university. Those that got the job are from my area, and I know what they did, I cannot say it here (TBF 2 SE)

The interviewees from the industry mentioned that officials would subject any program created by the government to favour domestic firms to favour their close associates and friends at the expense of those who deserve it. They identified this as one of the significant challenges in establishing collaboration with the government and universities. Moreover, it is a policy in Nigeria that any award of a contract by the university or any government agency must align with the Public Procurement Act 2007, stipulating that every contract must be awarded transparently and subjected to competition. According to the respondents, ideally, when a contract is to be awarded, it follows the normal bidding process where qualified companies will be identified and awarded with contracts from the government or the universities. However, this process has been corrupted; rather than considering competence, and qualification, the who you know factor plays out prominently. The university respondents also confirmed this view and added that corruption is not just limited to the government agencies but also to the universities. There have been many complaints about some elements of favouritism in the procurement processes in the government and the university.

There has been a lot of corruption cases in the higher education system. The diversion of funds meant for building laboratories, libraries, and other critical university facilities disappear suddenly due to a few people's greed. I think this directly or indirectly affects any form of collaboration (UNILLORIN).

There are times when contractors come from the Ministry of Education. The leaders in universities will protect the image of the Ministry and pretend as if these contracts are awarded to deserving people. In a real sense, it is not. This is a challenge, and it is all over the country (UNIBEN)

On the other hand, other government respondents noted that corruption used to be a big issue in every section of the country. However, with the intensification of the anti-corruption agencies like the Economic and Financial Crimes Commission (EFCC) and Independent Corrupt Practices and other Related Commission (ICPC), the government has put checks and balance mechanisms in place. The findings indicate agreement among the stakeholders that corruption is one of the factors inhibiting UIG collaboration in Nigeria.

#### **6.5.1.6 The Mismatch Between Graduates and Industrial Needs**

It is believed that after many years of continuous neglect of the higher education sector, Nigeria lacks the necessary tools to teach applied knowledge and skills of the 21<sup>st</sup> century to its students. It is also widely believed that the curriculums being taught at the universities are disconnected from the practical needs of the national and global economies. This was a fundamental question put to all respondents from University-Industry-Government, and it raised an in-depth discussion about the challenges emanating from an ineffective curriculum and the mismatch between the industrial requirement and the Nigerian graduates. One of the first questions raised by the industry respondents was the issue of a skills gap. The industry respondents said that Nigerian graduates are not employable because they lack skills and practical industry knowledge. According to some respondents, the industry invests a

tremendous amount of money in training graduates to become relevant to the industry. When graduates are employed in the industry as researchers, scientists or engineers, their ability to cope with the industrial environment is minimal and disappointing. This problem lies in the quality of education

There are obvious weaknesses in the education system. If we must make these graduates cope with the industry needs, we need a reform in the education system. what happens now is that universities give the industry some students who lack basic skills. For the industry to employ any graduate, the industry would be prepared to provide them with at least 1 or 2 years of continuous training before becoming relevant to the industry. I think this is a challenge (TBF1 SW).

Another industry respondent TBF 2 NW, agreed on this position:

With all due respect to the public universities in Nigeria, I went through the same system, but the system is obsolete. Take, for instance, the weak curriculum that does not reflect industrial needs. The industry must train the students before they become helpful in the industry (TBF 2 NW)

In 2006, the Nigerian government authorised a public policy intervention mandating all universities in Nigeria to introduce compulsory entrepreneurship courses across all disciplines. Nonetheless, many respondents believed this step by the NUC had not achieved the desired result. Students still learn basic entrepreneurship courses at the theory level without any platform for practical entrepreneurship to develop the relevant skills required.

We needed to spotlight skills and entrepreneurship in the students, and therefore we agreed to introduce entrepreneurship courses in the universities in 2006 for a freshman in year one. Even in the second year, there is a need to teach entrepreneurship. It is well entrenched in our curriculum, but the truth is that there is a difference between the theory and practice of entrepreneurship (NUC)

Over the years, Nigerians have complained about the outdated higher education system and advocated a change to reflect the present and future knowledge that will benefit the industry, the government and society at large.

The education system in Nigeria is outdated. when you talk of ICT, you are talking about a profession that is developing every second, and it evolves every minute as such, we need an education system that will focus on the current and future knowledge and produce skilled graduates'' (TBF 1 SW)

It is observed that many students who are doing well in the industry were self-trained and self-motivated to engage in developing their skills. According to some respondents, many entrepreneurs in the ICT sector are self-taught through YouTube and other free online platforms.

### **6.5.1.7 Brain Drain**

Brain drain is the emigration of skilled human capital searching for higher wages and better working environments from developing countries to developed countries (Okoye, 2016). Brain drain has been described as one of the leading factors responsible for the loss of human capital in Nigeria. Respondents described brain drain as partly responsible for the low capacity of industrial and university research in Nigeria. They noted that industrial research in Nigeria had contributed

to the quality research output in the 1980s when industries were present and visible across the country. Since the country began to experience declines of highly skilled individuals due to emigration, industrial researchers disappeared in Nigeria.

Nigeria's growing brain drain is another factor that leads to the low competitiveness of our universities and industries. We used to have a strong industrial researcher in Nigeria, where are they now? They immigrated to developed countries. The available ones have become politicians, so the skills needed in the industry are lacking. Another thing is the environment, and if our skilled personnel have a better environment to work in, with adequate pay and incentives, there would have been an increasing number of people engaged in research activities (NITDA)

Before the 1980s, we used to have people engaged in industrial research, especially in medicine. Most of them have left in search of a better life, and I think that has contributed to the skills gap in the country where people cannot engage in industrial research (UI)

It is even alarming the rate of brain drain in academia compared to the industry. In 2006, during population census, when SAGEM, a technology company, was looking for researchers in one area of software, and they wanted to collaborate with the university to do some research. There were only two people at that time who knew that application, and they have left the country for the U.S. You see the gap this has created? When they get frustrated, they go, and they never come back. (ABU)

This position was supported by other respondents who expressed concerns about the gap it has created. An increasing number of researchers are leaving Nigeria, resulting in the decline of the research community. The human capital flight is influenced by many factors, including lack of incentives, poor working conditions, lack of infrastructure and poor remuneration for skilled labour. The findings show that human capital flight affects both universities and industries; it creates a skill gap that takes many years to fill. This hurts collaboration between universities and the industry and the innovative capacities of the organisations.

#### **6.5.1.8 Lack of National IP Policy and Enforcements of IPR**

The findings have identified the lack of IPR policy and enforcement as the major inhibitors of the UIG collaboration in Nigeria. According to the research participants, the driving force of any intellectual work and innovation is the legal protection it enjoys. Without the enforcement of the IP laws, the inventors and innovators might not enjoy the benefit of their work nor collaborate with any organisation. The participants have identified these challenges as significant roadblocks to the UIG collaboration in Nigeria.

The lack of a comprehensive IP policy in Nigeria is one of the major inhibitors to any form of intellectual collaboration between universities and industry. It is hard for either the university or industry to engage in any form of cooperation when they know that an effective enforcement mechanism does not bound such collaboration. All the IPR laws governing the IP system are outdated, so we need the National Assembly to do something about it urgently (NUC).

This is one of the areas that is challenging our university and industry collaboration in Nigeria. The country needs an effective policy tool to enforce IPR. Without IPR and enforcement, the partnership or any intellectual work cannot be protected (TBF 2 SW)

We are seriously concern about the lack of IP policy in most universities in Nigeria. We do not even have it in the country, and that's why enforcement is problematic. Without an effective IP system, even the commercialisation of research cannot be effectively done. No

company will agree to collaborate when they know that their right is not well defined, not protected or can be infringed, and nothing will happen (UNIBEN)

One of the inherent problems that inhibit UIG collaboration related to the IPR system in Nigeria is the outdated laws and regulations that do not reflect the current realities of knowledge in the digital age.

The laws protecting the IP system are all out of date, and there is no IPR system enforcement. This should worry any potential collaborator with university or government in Nigeria (TBF 1 SE)

Further to the above-identified challenges, IP Infringements is another significant challenge for IP rights and development in Nigeria. These violations are more dominant in the information and communications technology – ICT – (internet & software piracy) and film and entertainment (musical & cinematography disc piracy).

#### **6.5.1.9 Poor Work Ethics in Private and Public Organisations**

Finding from the research participants points to the fact that poor work ethics such as indiscipline, lack of courtesy, disrespect, lack of dedication, and commitment to work hinder all stakeholders' collaborative efforts. Respondents described the attitude to work by some employees, such as lack of upholding organisational slogans to ensure maximum utility of opportunities, or outright disrespect and violent attitudes project organisations as non-tolerant and unaccommodating. This opinion has been expressed by all the respondents from all stakeholder groups. For instance, according to ABU,

Work ethics in Nigeria is poor. We have experienced, dedicated and well-trained employees who are very committed, and we also have the bad ones. Sometimes our attitude in our workplace matters a lot. We are aggressive toward each other; we do not uphold our organisations' slogans and mistreat our fellow workers. I think this disrespectful attitude contributes to the inhibiting factors of the UIG collaboration we are talking about (ABU)

Another respondent echoed this opinion from the government who noted that people's attitude shapes the organisation. With a good attitude from employees, the potential of an organisation to collaborate and with other organisations improves.

The collective work ethics of an organisation and attitude, loyalty, and ethics of employees speak volumes of the organisation. Some organisations and their staff are very unfriendly and disrespectful, while others are very nice. But as a government agency, we always have standards and even motivation for staff who behave and commit well. But as humans, we have our bad attitudes, and this has been a challenge in Nigeria. Our work ethics sometimes ruin our opportunities (NITDA).

A respondent from TBF 1 SE cited an example of how a university worker disrespectfully and aggressively ended a longstanding relationship between his company and the university. He describes the university employee's attitude as a repellent to any potential collaboration capable of tarnishing the university's image.

There is a guy at the Director of Academic Planning's office who disrespects everyone. When you come to their office, he thinks you are there to beg his boss, and he begins to show some aggressive behaviours. That makes me angry (TBF 1 SE).

Good work promotes mutual trust. But when people use bad language and tend to be disrespectful and aggressive toward one another, trust and communication will break, and that will ultimately affect cooperation (TBF 1 SS)

The poor work ethics such as aggression, disrespect, and poor conduct of employees has been repeatedly mentioned by the research participants from all stakeholder groups. According to the participants, poor work ethics is a factor that is prevalent in private and public organisations, including universities. This has been identified by the participants as potentially prevent mutual trust and good flow of communication.

## **6.5.2 Social Factors**

### **6.5.2.1 Lack of Effective Communication and Attitude of Stakeholders**

Lack of communication is one of the critical problems preventing the initiation of successful University-Industry-Interaction in Nigeria. Industry respondents raised the issue that universities and government leaders are rude and have a superiority complex. They stated that contacting universities and government agencies is hard and challenging due to their attitude:

Communication is challenging to set up. If you want to see the Director-General of a government agency or Director in the Ministry or other agency, there are no direct communication channels. You call them many times; you cannot even get anyone to speak to you. You go to their office you spend hours you cannot see them, and the same applies to the universities. Therefore, there must be a change of attitude toward others, especially dealing with government or university work. If they want, they can be rude in their personal life, but when they are discharging official responsibilities, they need to respect other people'' (TBF 1 SE)

Despite the easy mode of communication driven by social media, I know some university professors who do not even have an email address or hardly check their emails in three months. How can you work with these kinds of people when handling collaboration (TBF 1 SW)?

The attitude of pride and superiority complex of universities cannot allow this smooth interaction. The university community is very rude and unaccommodating to even their immediate communities. They are professors and PhDs; they tend to see other members of society as second-class people (TBF 1 NW)

It is not that the university does not respond to communication; it is just that they have some wired behaviour; They have some superiority complex and think people with lower qualifications do not deserve their attention. We tend to have some attitude that courtesy is everything (FMCDE)

Government respondents agreed that faculty members have some attitude problems, including a lack of respect for people with lower qualifications, which is the cause of the communication gap. Although some respondents dismissed the claim that academics are arrogant, but also admitted that they often only interact with other like-minded academics. Other respondents alluded to the views that most universities and government agencies do not have dedicated contact emails or phone numbers you can call.

### **6.5.2.2 Stakeholders Preference for Foreign Goods and Services**

One of the challenges of establishing and sustaining UIG interaction in Nigeria is the public demand for foreign products and services. According to the respondents, many Nigerians think



that any goods or services produced in the domestic markets are of inferior quality. Interviewees identified this challenge as a factor that creates a barrier for interaction between universities and industry in Nigeria. Getting the universities and government to believe in the industry or getting the industry to think universities can conduct blue sky research is challenging.

In this country, we prefer anything imported with that mistaken view that whatever is imported is of higher grade or quality than the one produced locally, and it is not so. We have some things that are produced by us locally. The local product can compete with those products outside the shores of the country. So, to get Nigerians to buy these things or accept our local products and indigenous technology is not easy (NOTAP)

This challenge seems to occur across the board; on the one hand, the universities do not believe in the goods and services of the industry. On the other hand, the industry does not have the confidence to patronise the research conducted in Nigerian universities.

The industry does not believe in the quality of our research; they prefer foreign companies. They have a thirst for foreign university research. I assure you that we can handle any research here in Nigeria without any foreign involvement. But it is a perception problem that we cannot fix (ABU)

Meanwhile, the findings show that the industry also believes the universities and government agencies patronise foreign-based companies at the expense of the local companies. They think that foreign companies have more capabilities and competence:

Heads of government agencies love to patronise foreign-based technologies. We are trying to develop a technology that can perform the same function or even better than the foreign ones. Right now, government officials prefer foreign companies, and this has not changed despite the policies and laws by the government (TBF 1 SW)

This position was also corroborated by another respondent who stated that:

Everyone in Nigeria thinks about foreign-based technology, from the universities to the government down to the industries; we are all guilty of this problem. We cannot develop our domestic capabilities if we do not believe in our local goods and services (TBF 1 NE)

This perception has created public impulse for overseas products in Nigeria. It has also created an avenue for foreign companies to see Nigeria as a dumping ground for every technology. This affects people's perception that foreign technologies are cheaper and durable. The respondent from the government has advocated for sensitisation of the companies and for the public to bestow their confidence in the local companies and the national universities, stressing the importance of collaborative knowledge creation and solutions to local problems by the domestic institutions of knowledge production and the local companies. Establishing active channels of communication is key to maintaining clear inter-organisational communication. Without precise, consistent, and open channels of communication, the desired UIG interaction will be challenging to achieve. To create an atmosphere of close collaboration, stakeholders must make a concerted effort to consider another partner (s). Each collaborating partner must always be treated with the utmost respect and dignity before, during and after formal or informal communications or conversations.

## 6.6 Chapter Summary

This chapter presented findings on the four developmental stages of the Triple Helix collaboration and general inhibiting factors of UIG collaboration. The four developmental stages were applied to examine congruencies and incongruencies of the theoretical proposition in the organisational practice within each institutional sphere. Findings revealed some congruencies and incongruencies on three developmental stages, including internal transformation and role-taking, the influence of each helix upon the other and the creation of a new overlay of communication. In the fourth developmental stage, the recursive effect of the trilateral network was found to be incongruent with the organisational practices. Moreover, findings on general inhibiting factors of the UIG network presented in the last section shows different barriers obstructing the collaboration. These institutional factors comprised of the lack of funding resources/ funding, different orientation of the actors, low-quality research output, corruption and favouritism, mismatch between the graduates and the industrial needs and brain drain. Social factors comprised of lack of effective communication and stakeholder preference for foreign goods and services. In the next chapter, the author will present the discussions of major findings on the four channels of UIG assessment, four developmental stages, and the general inhibiting factors of the UIG interaction.

### 7.1 CROSS-CASE ANALYSIS AND DISCUSSIONS

The previous two chapters (Chapters 5&6) reported interview findings from the University-Industry-Government (UIG) respondents. Chapter 5 dealt with the results from an assessment of UIG collaboration based on the four interaction channels. Chapter 6 focused on the results of the four Triple Helix developmental stages of UIG collaboration. The first section of this chapter will focus on the cross-case analysis and discussion of the channels of interactions linking them with the various innovation theories. The second section of this chapter presents cross-case analysis and discussions of the four developmental stages of the Triple Helix Model, identifying the congruencies and incongruencies of the Triple Helix theory and practice in Nigeria. The last section also presents the cross-case analyses and discussions of the factors inhibiting the UIG collaboration. The sections show the diversity of stakeholder groups' responses and draw together the vital issues and insights from the previous chapters. This chapter then culminates in an evaluated conceptual framework.

The study aims to understand better the effectiveness of UIG interaction in Nigeria, particularly in the knowledge-intensive firms and STEM-related areas in the universities.

#### **Research Objectives**

- 1) To examine the critical national factors inhibiting the effectiveness of UIG interaction in Nigeria.
- 2) To critically examine the UIG literature in order to identify and discuss the key theories of innovation, channels of interaction, enablers, and inhibitors of the collaborations.
- 3) To develop a conceptual framework from a critical and analytical review of the literature
- 4) To develop and evaluate a revised conceptual framework following an in-depth analysis of the fieldwork data and make a significant contribution to existing knowledge on UIG interactions.
- 5) To develop recommendations for the institutional spheres on measures to stimulate the UIG collaboration in Nigeria.

### 7.2 Addressing the UIG Network

The stakeholders have been mapped against four themes to draw out areas of similarities, differences in the network interaction. Each UIG perspective is further analysed below.

#### 7.2.1 Inter-organisational Human Capital Mobility

Inter-organisational human capital mobility has been identified in the conceptual framework as one of the channels of UIG collaboration. Staff exchange or circulation of staff across the institutional spheres helps knowledge flow between people and spreads new ideas, new knowledge, creativity, and innovation (Ranga and Etzkowitz, 2013; Marques, 2017; Liu and Huang, 2018). The empirical results of this research have shown evidence of the flow of people between the three institutional spheres. The results found that many faculty members voluntarily transfer their services to the Ministries, Agencies, and Parastatals of Government either permanently, full time, and sabbatical or secondment basis. University staff or faculty members who transfer their services to the government maintain their ties with the university formally or in an informal capacity and serve as the bridge linking the university and government. The finding also indicates a smooth flow of human capital from industry to university and government. This occurs when universities and governments hire experienced industry practitioners who add value to the university or government. It was also observed that human capital mobility from university to industry and government occurs through the Student Industrial Work Experience (SIWES) scheme, which prepares students at Nigerian Universities, Colleges of Education, Colleges of Technology, and Polytechnics for the industrial work situations they are expected to encounter after graduation. The movement of people and the knowledge they carry with them (often termed “tacit knowledge”) is a crucial flow in national innovation systems. Whether on a formal or informal basis, personal interactions are an important channel of knowledge transfer within the industry and between the public and private sectors. (Polanyi, 1962). The theories of innovation described the significance of skilled human capital in building technological innovation of a country. For instance, Triple Helix Model labelled it as circulation of people among the three institutional spheres, which helps spread new ideas and skills (Dzisah and Etzkowitz, 200). National Innovation Capacity (Furman, Porter and Stern, 2002), and National Innovation Systems Lundvall (1992), Nelson (1993) Edquist (1997) frameworks emphasizes on the accumulation of human capital available for R&D, which produces a stream of commercially relevant innovations (Furman, Porter and Stern, 2002; Datta, Saad and Sarpong, 2019). This research confirms the existing knowledge through a transfer of service (described above) across the stakeholders. The knowledge created after staff circulation, especially in the government-owned research organisations, confirms the Mode 2 knowledge production where new knowledge is made in an inter-disciplinarity, economically and socially relevant research theme (Shinn, 2002: 603). The finding goes against the traditional Mode 1, which proclaims that problems are set out and solved in a context primarily governed by the academic community in a disciplinary context. Knowledge productions in Mode 1 do not usually involve multiple skills, people, or locations (it is characterised by homogeneity). The knowledge produced is also relatively less socially accountable and reflexive, and the quality of knowledge

produced is predominantly determined through peer review that exclusively involves the academic community.

However, despite the movement of staff from university to industry and government through the SIWES scheme, empirical outcomes indicate that government and industry derive minimal benefit from the students. This is due to the limited knowledge students bring to the industry and government. There is also concern about the growing number of students without corresponding relevant industries in which to place them. This situation has forced students to scout for a placement for themselves from the available options without considering the relevance of their field of studies. Consequently, many students end up undertaking their industrial placements in irrelevant organisations. These issues limit knowledge transfer while students lose focus and sometimes wait longer for another placement. This finding has been confirmed by previous studies conducted by Obanor and Kwasi-Effah (2013). Ikechukwu (2016) recommended that the Industrial Training Fund (ITF), a government agency responsible for coordinating the programme, should present a new agenda focusing on students' placement with relevant industries and ensure the government's policy statement regarding the establishment of SIWES is efficiently implemented. Oladimeji et al. (2017) identified three primary sources of internship placements 1) students sourcing for themselves, 2) institutions sourcing for students) and 3) institutions requesting on behalf of students. Due to the lack of openings with organisations, students often scout for industrial attachments for themselves even if it means the organisation is outside their professional course of studies. The ineffectiveness of the knowledge flow between universities and industry has contributed to a growing margin between the skills expected from graduates and current graduate's skills and capabilities. Evidence shows limited human capital mobility from universities and government to industry. This limited movement and transfer of services may be attributed to negative incentives, including an unstable business environment and job insecurity. Contrary to the widespread practice of firms attracting new Knowledge from external sources, including public researchers and university faculty members, the research findings show that Nigerian firms have limited access to external sources of human capital, either flowing from the university or government-owned research institutions. Tables 7.1, 7.2 and 7.3 show the summary of responses from University-Industry-Government participants. These summaries show the diversity of the responses, which led to the cross-case analysis presented in Table 7.4.

Table 7. 1 Summary of Responses: Government Perspective

Theme: Inter-organisational Human Capital Mobility					
UI	UNIBEN	UNILORIN	ABU	UNN	ATBU
The Staff transfer their services to the government on contract, sabbatical, and its working Well.	There are faculty members that are attracted to the oil companies to undertake some secondments and sabbaticals positions.	Our staff are changing their workplace and getting appointments in the government on sabbatical, permanent or Contract basis.	Sometimes students cook up reports, and the tutors have no time to verify those stories, and I think that is one of the reasons why the knowledge flow is not very useful	Yes, many universities friends have got secondments and, in some cases, permanent jobs in the oil companies.	One of the effective ways to transfer skills to the governments is through a transfer of service by our staff on contract, sabbatical, temporary or Permanent bases.

Table 7. 2 Summary of Responses: Government Perspective

Theme: Inter-organisational Human Capital Mobility				
TBF1 SW	TBF 1 NE	TBF 1 SE	TBF 2 SS	TBF 2 NC
The university staff or lecturers need the money, and the oil Industry pays well.	I think the purpose of this programme Is not working well. I believe due to the curriculums in the university	But the university students doing I.T. in the industry do not bring proper knowledge or skills to the industry due to the poor university quality of our university Education.	I can generally say, transfer of services as a good channel of knowledge flow both to university and government	Through SIWES, we receive students who come for industrial attachment and then go back and complete their Studies.

Table 7. 3 Summary of Responses: Government Perspective

Theme: Inter-organisational Human Capital Mobility					
NITDA	NUC	NBTI	FMST	FMCDE	NASRDA
I worked for ABU University for many years, and I decided to transfer my service to the government.	Preferably many university employees work for the government than the industry because of pensions, and gratuities that will sustain you after retirement	The Director-General of NBTI was from university; he transferred his services to the government and still holds a part-time teaching position. Yet, in the industry, it is not possible, and no one will decide to leave the government and work for any industry. Remember there is no pension or gratuity in the industry	There is a need for more sensitisation for booth university and industry to switch working environment. This should be encouraged by the gov't.	Sometimes the Federal Ministry relies on the expertise of the sabbatical staff for training, workshops and seminars for the rest of the staff.	Many university staff who come to work for the government sometimes come with some negative attitudes which are adversely affecting the whole knowledge transfer activities

The cross-case analysis in Table 7.4 shows common, different, and missing views indicating similarities, differences, and gaps from the participants. Responses among universities participants show consensus on inter-organisational human capital mobility methods occurring through secondments, sabbaticals, temporary or permanent basis, and SIWES.

Table 7. 4 Cross-Case Analysis Inter-Organisational Human Capital Mobility

Responses	University	Industry	Government
<b>Common views</b>	Sabbatical, Secondment SIWES Programme (UNILORIN)	SIWES programme, (TBF 2 SS)	Sabbatical, Secondment SIWES programmes (FMST)
<b>Different views</b>	Falsification of reports	Lack of technical Knowledge	Attitudes of academics affecting knowledge transfer
<b>Missing views</b>	Limited transfer of service to the industry.	University and government attracted to the oil companies.	No incentives working for Industry.

Different views were expressed within the university stakeholder on the effectiveness or otherwise of knowledge transfer through this channel, indicating that the SIWES scheme is faulty due to falsification of records by students. There was also a limited response as to why most university researchers prefer oil companies to other sectors of the economy. Findings also show consensus among industry respondents, pointing to the fact that an effective channel of knowledge transfer from universities to industry and government occurs through SIWES. However, there are variations in their opinion regarding lack of technical knowledge and basic skills, limiting the efficiency of the SIWES programme. Like the university respondents, the industry respondents did not emphasise why the university prefers the oil industry more than other sectors of the economy. Responses from government participants also show a consensus that sabbatical, secondment, and SIWES programmes are effective channels of flow of skills among the three institutional spheres. However, some respondents differed, noting that the knowledge and skills flow from university to government is faulty due to the negative attitudes some academics bring with them. Although highlighted briefly above and attributed to the unstable business environment, pensions and other benefits, gaps were noted in low motivation and incentives for transferring services from universities and government to industry.

### 7.1.2 Research/Equipment Facility Sharing

Sharing of research facilities is one of the channels of UIG interaction identified in the conceptual framework. Gain access to technology and knowledge and expensive research infrastructure (Ankrah and AL-Tabbaa 2015). Access to innovation-related facilities or infrastructure is one of the major channels of UIG interaction that leads to knowledge transfer activities. Stakeholders can leverage each other's capabilities and facilities in design and execution (Liew, Shahdan and Lim, 2013). Once appropriate facilities and infrastructures are available and accessible to the UIG network, it creates new opportunities for partners that would otherwise be inaccessible to them due to the cost of equipment and qualified personnel (Guimón, 2013). Research collaboration based on sharing facilities promotes the exchange of knowledge and innovation (Guimón, 2013). The utilisation of these infrastructures strengthens

the relationship between the trilateral networks of UIG. These facilities could be any physical structure, research equipment, laboratories, or incubator facilities (D'Este and Patel, 2007; Lu, Etzkowitz and Zhou, 2008; Jongwanich, Kohpaiboon and Yang, 2014; Díez-Vial and Montoro-Sánchez, 2016; Liu and Huang, 2018).

The empirical results show the presence of the trilateral network through sharing of physical space, research facilities, and equipment through the National Board for Technology Incubation (NBTI). The government mediates and stimulates collaboration by providing facilities through NBTI and Technology Incubation Centres (TICs), spread through the six geo-political zones of Nigeria. The NBTI, in most of its locations, is equipped with laboratories, workshops and other ICT facilities. The TICs have introduced an arrangement where each firm is attached to a university professor for mentoring and guidance. They have been granted access to various facilities such as office space, laboratories, and internet services at the TICs. Although not all SMEs go through the NBTI process, the results have shown that NBTI is one of the focal points where physical space promotes the linkage between universities and industry. The extant literature offers the vital roles of physical space, tangibles, and physical environment, which can interfere with people and their actions, such as social interaction, in various ways (Oksanen and Ståhle, 2013). The physical space provided by the government (incubation centres) assists in developing new entrepreneurs and enterprises and providing start-up businesses to survive and continue in business on a sustainable basis (Aladejebi and Oladimeji, 2020). The physical environment is recognised as a significant factor for knowledge creation and learning (Senoo et al., 2007; Nonaka and Takeuchi, 1995). This finding is consistent with the regional development emphasis presented by Etzkowitz and Leydesdorff (2000); Etzkowitz and Ranga, (2011), where the institutional framework of Triple Helix spaces consists of knowledge, innovation, and consensus spaces are analysed. The Triple Helix spaces provide insights into the process and mechanisms by which the institutional actors interact and co-evolve over time. These spaces offer an exciting approach to localised innovation processes and the use of regional resources. Triple Helix Model considers incubating firms as an invention of organisational innovations, new social arrangements, and new channels for interaction between UIG through creation and sharing of physical devices in speeding up innovation (Etzkowitz, 2003b). The finding is also congruent with National Innovation Framework. Lundvall (1985) emphasises network formation and interactive learning at the national level, encouraging and enabling fruitful interaction between different actors such as students, researchers, and professional practitioners. The interaction between people, enterprises, and institutions is the core of the innovation system (Lundvall, 1992). The government's institutional mechanism of university-industry linkage provides excellent incentive and opportunity for commercialisation and fosters a more vital spirit of entrepreneurship. Tables 7.5, 7.6 and 7.7 present summaries of the responses indicating the diversity of opinions from the respondents



**Theme: Facility Sharing: University Perspective**

*Table 7. 5 Summary of Responses*

<b>Theme: Facility Sharing: University Perspective</b>				
<b>UI</b>	<b>UNIBEN</b>	<b>ABU</b>	<b>UNN</b>	<b>ATBU</b>
We have received funding from the government, and very soon, we will establish incubation centres.	The only way is to make a concerted effort and fund the university to get all these incubators facilities, Science Parks and other relevant infrastructure or nothing will work the way we want	We normally use our facilities if we need anything that we do not have in our facilities, we utilise the TIC facilities.	We have created a well equipped Science Park, which enables us to collaborate with external organisations, including government and companies.	We are jointly using the facilities in the NBTI. We do fabrications with the industry using the research facilities owned by the government

*Table 7. 6 Summary of Responses*

<b>Theme: Facility Sharing: Industry Perspective</b>				
<b>TBF1 SW</b>	<b>TBF 1 NE</b>	<b>TBF 1 SE</b>	<b>TBF 2 SS</b>	<b>TBF NC</b>
Some companies go to the TICs where the government helps in linking them to universities so that they can use government facilities jointly	The university facilities are outdated, and some universities do not even have up to date libraries or laboratories.	There are facilities in the university science park, which we utilise, but we also, use government TICs.	Government is promoting joint facility utilisation and linking the companies and universities through the TICs. We are currently collaborating with some university lecturers on certain projects	Many universities researchers and companies use research facilities like computers, H.D. printer and fabrication equipment at the TICs

*Table 7. 7: Summary of Responses*

<b>Theme: Facility Sharing: Government Perspective</b>				
<b>NUC</b>	<b>NBTI</b>	<b>NOTAP</b>	<b>FMCDE</b>	<b>NASRDA</b>
The establishment of these Incubation Centres is an excellent platform that promotes this interaction.	We have established at least one Incubation Centre in each geo-political zones, and the number will increase very soon.	The government has a robust policy on the incubation of entrepreneurs. The incubation is based on shared facilities and office space and training opportunities.	The incubation centres have not lived up to expectation due to the challenges lack of enough funding.	Let us even agree there are some collaboration based on sharing facilities or equipment but are they enough to drive innovation

The cross-case analysis presented in Table 8.8 shows consensus, differences, and missing issues among each stakeholder group that the respondents have not adequately captured. Participants from universities agreed that UIG collaboration based on physical space and facility sharing exists, and the government enables it through the TICs. However, there is a disagreement between them. For instance, ABU insisted that they use their facilities and only use external facilities on exceptional occasions. The University of Nsukka also utilises its facilities located in the Science Park and not bothered going to the government-owned incubation facilities. However, little discussion on why other universities have no effort to establish their Science Parks was missing. The industry

stakeholders also agreed on the roles of the government promoting this collaboration through the TICs. Some industry respondents expressed different views about the effectiveness of the TICs, submitting that most of the equipment at the TICs are outdated, thus having little impact on the industry. However, there was little discussion on private incubations' roles in promoting collaboration by sharing facilities or research equipment or office space. There is a consensus among government respondents with regards to the roles of TICs in stimulating this collaboration. They all agreed that TICs play a significant role in providing researchers facilities and physical space and encouraging UIG collaboration. Some respondents differed on the effectiveness of these TICs and berated their performance due to lack of funding. There are vital issues that the government respondents have not adequately addressed. This includes the government's efforts in promoting university-based science parks to enable universities to collaborate more effectively and contribute through their research laboratories, libraries and other facilities located within the Science Park.

*Table 7. 8 Cross-Case Analysis Facilities Sharing*

<b>Responses</b>	<b>University</b>	<b>Industry</b>	<b>Government</b>
<b>Common views</b>	Technology Incubation Centres (TIC)	Technology Incubation Centres	Technology Incubation Centres
<b>Different views</b>	We use our facilities	Facilities in TICs outdated	Lack of funding
<b>Missing views</b>	Limited university Science Parks	Limited private incubation centres	Role of government in promoting university-based Science Parks.

### **7.2.2 Joint Curriculum Design**

Joint curriculum design has been identified in the conceptual framework as a means through which UIG collaboration occurs. Many studies on University-Industry-Government collaborations have shown the relevance of joint curriculum development in producing skilled graduates that will contribute to the industry (Lagoke, Adesola and Soname, 2020; Teo, 2019). One of the deliberate goals of education is to facilitate the attainment of knowledge and skills relevant to different contexts and the needs of stakeholders (Matkovic *et al.*). UIG collaboration in curriculum design is vital. It provides numerous benefits such as improved quality of educational programs, research collaboration, the attraction of funding, and better employment opportunities for graduates (Tessema and Abejehu, 2017). The benefits for the industry include better-trained graduates, technology transfer, and innovation in the marketplace. Hence curriculum designs or reviews require a multi-stakeholder approach involving the university and external stakeholders (Oliver and Hyun, 2011). Therefore, a constant dialogue between government, universities, and industry leaders is critical to discuss vital and divergent issues when reviewing curricula (Madden *et al.*, 2013).

The empirical results from this research show limited collaboration between the stakeholders in curriculum reviews. The curriculum review process in Nigeria occurs in two stages. First, the government plays its role by coordinating and setting the benchmark for Minimum Academic Standards (BMAS) for universities through National Universities Commission (NUC) and ensuring periodic review of the policy every five years. During the periodic review, meetings are organised by the NUC (government), every stakeholder is expected to participate and provide input. At the second stage, universities are empowered to review their curricula internally based on the standards set by the government. The results show a lack of participation by stakeholders, especially industry representatives at the government or university stages. The lack of involvement of all stakeholders is due to poor communication or availability of platforms where the stakeholders can meet, brainstorm and fashion an up-to-date curriculum based on the new frontiers of Knowledge. The results from this research corroborate evidence from Lagoke, Adesola and Soname (2020), who found limited collaboration due to the lack of, among other things, platforms, fora, or business engagements dedicated to curriculum reviews. According to Cohen, Fetters, and Fleischmann (2005), radical curriculum reform requires widespread participation among stakeholders in fashioning current Knowledge. Without collaboration between UIG stakeholders in designing the curriculum, the Knowledge and skills of graduates will be out of date. The results clearly show that the process of collective curriculum design deviates from the theories of innovation. For instance, Triple Helix literature (Leydesdorff and Etzkowitz, 1996; Lee and Kim, 2016) strongly advocates collaboration between stakeholders and interactive learning. In the Triple Helix entrepreneurial university proposition, more attention is paid to teaching and learning. The latter concept combines academic values in well-endowed curricula while interacting with the professional practice dynamics (Clark, 2004). The 'third mission' of universities on regional economic and social development is to meet the widespread need to generate knowledge-based innovation (Etzkowitz, 2003) and incorporate a process of mutual networked learning (Lansu *et al.*, 2013). As against the Mode 2 knowledge production system that encourages collaborative stakeholder process with application motive, findings show curriculum design within the universities and government follows the traditional faculty inclined process, which agrees more with the traditional Mode 1 process. Mode 2 knowledge is not set within a particular discipline, nor is it determined by the professional interests of academics alone. Instead, it is envisaged at the outset and provided in the context of usage. The curriculum design process should cross the boundaries of a single institution. Collaboration is critical to allow students access to different employment pathways in the community, industry, and other related fields of work. Education should be comprehensive, sustainable, and superb but must continuously evolve to meet the challenges of the fast-changing and unpredictable globalised world. This evolution must be systemic, consistent, and scalable; therefore, school teachers, college professors, administrators, researchers, and policy makers are expected to innovate the theory and practice of teaching and

learning, as well as all other aspects of this complex organisation to ensure quality preparation of all students to life and work (Serdyukov, 2017). In education, innovation can appear as a new pedagogic theory, methodological approach, teaching technique, instructional tool, learning process, or institutional structure that, when implemented, produces a significant change in teaching and learning, which leads to better student learning. So, innovations in education are intended to raise productivity and efficiency of learning and improve learning quality (Serdyukov, 2017). This consistent dynamic change is comfortably embedded in the National Systems of Innovation (Lundvall and Johnson, 1994). Ellahi, Khan and Shah, (2019) recommends that universities should collaboratively prepare their students with the latest knowledge and skills to face future challenges. Universities should develop a vital channel to enhance their approach and education methods to handle the latest technologies such as Data Analytics, Artificial Intelligence, Augmented Reality, and Cloud Computing. For instance, Japan has exemplified collaboration in the curriculum review process with the emergence of online gaming. When a deep understanding of online game development procedures was needed to keep up with the advancements in technology, there was no; there was no consistent education program designed specifically for gaming in Japanese higher education institutions. A curriculum framework was created and implemented by the government in collaboration with the International Game Developers Association (IGDA) (Mikami *et al.*, 2010). This shows a concerted effort at preparing students for new Knowledge and potential commercialisation, wealth creation and employment generation. This reveals a difference in approach between Nigeria and Japan on the production and application of knowledge to generate employment value. Tables 7.9, 7.10 and 7.11 show a summary of responses from the participants.

Table 7. 9 Summary of Responses Universities Perspective

<b>Theme: Joint curriculum design: University Perspective</b>					
<b>UI</b>	<b>UNIBEN</b>	<b>UNILORIN</b>	<b>ABU</b>	<b>UNN</b>	<b>ATBU</b>
What happens is that the professional bodies will come to the university and check what we teach, and that is not even a thorough check, and that is it.	The collaboration is weak, and the industry is not invited for the internal university curriculum reviews. NUC should create a platform for the university and industry to collaborate and design the curriculums.	It is normal to collaborate with the government since all universities are under the government. what is important is to carry the industry along, and we have not seen this playing out very well	Generally, the UIG collaboration on curriculum review is weak in this country, and this is due to the lack of proper consultation. The government needs to do more in bringing the industry representation on board	Yes, we do collaborate: every university is different, as far as my university is concerned, we do not just work with industry, but also, other professional bodies.	It does not look like every stakeholder is invited to these stakeholder meetings. So, in my opinion, this is one area that needs attention quickly to marry and gown and town at the curriculum level.

Table 7. 10 Summary of Responses Industry Perspective

Theme: Joint curriculum design: Industry Perspective					
TBF1 SW	TBF 1 NE	TBF 1 SE	TBF 2 SS	TBF 2 NW	TBF NC
We have made several attempts to be part of the curriculum design so that we can make a significant input into what the universities courses, but NUC does not give us that opportunity	I have never been invited to any curriculum reviews or any curriculum development by the government or the university.	I think there is a lack of genuine commitment from both the universities, government and the industries.	The university does not invite us for any curriculum design, and they do it through their Senate, I think. This is very bad for the education system in this country.	Yes, I believe they collaborate, but I also think that we have too complicated Private- sector representation with overlapping duties	I have never been invited for curriculum meetings, some people say the government invites our professional bodies, but I am not sure

Table 7. 11 Summary of Responses Government Perspective

Theme: Joint curriculum design: Government Perspective					
NITDA	NUC	NBTI	FMST	FMCDE	NASRDA
I have noticed this communication gap, and I have discussed with NUC on many occasions.	I have worked for 20 years here at NUC, in all these 20 years of my work, often when you call the stakeholder meetings, no matter how much notice you give the industry, they are hardly represented.	There is a glaring communication gap between these stakeholders. This is a major concern to the government.	In developed countries, the industry has its agenda, and government and universities integrate into what the industry wants into the curriculum	No there is no enough synergy between the university- industry and government. I do not think they collaborate in any way to develop curriculum	It is a matter of misunderstanding in my view. The government needs to communicate with the industry and carry them along

The cross-case analysis in Table 7.12 presented some consensus, differences and gaps in the views expressed by University-Industry-Government participants. The common views among university participants indicate non-existent collaborations between the three institutional spheres. In contrast, different views show diverse opinions; for instance, ABU opined that it is not the collaboration between the stakeholders on the curriculum design but its impacts on students' skills and knowledge. Furthermore, university respondents provided limited roles of the professional bodies influencing the joint curriculum designs in Nigeria. Responses from industry are consistent with the universities, where most respondents agreed that partnership on joint curriculum designs is non-existent due to lack of proper communication and consultation. Other respondents differed and opined that industry collaborates with the government during curriculum designs. However, industry respondents were silent on their genuine commitment to work with the government and universities to solve the constant communication gap. The responses from government participants show consensus on the lack of collaboration regarding curriculum designs. They agreed that lack of communication

contributes to the limited partnership between the three institutional spheres. However, some respondent differed, noting that industry representative shows no commitment to the collaboration. Moreover, gaps were noticed from the government respondents on the roles of professional bodies in influencing firms to collaborate with universities or the government during curriculum design.

Table 7. 12 Cross-case Analysis Joint Curriculum Design

Responses	University	Industry	Government
<b>Common views</b>	Industry not invited	No collaboration due to communication gap	Communication gap
<b>Different views</b>	Yes, we do collaborate.	Yes, we collaborate	No commitment
<b>Missing views</b>	Roles of the professional bodies	Genuine commitment	Limited roles of professional bodies

#### 7.1.4 Consultancy and contract research

As identified in the conceptual framework, studies have highlighted contracts and consultancy as UIG collaboration and knowledge transfer (D’Este and Patel, 2007; Perkmann and Walsh, 2007; Muscio, Quaglione and Vallanti, 2015). Consulting (informal) is when faculty members utilise their academic knowledge and expertise to help external organisations, especially companies (D’Este and Patel, 2007). In contrast, contract research is a formal collaboration that involves legally binding agreements between the stakeholders of the UIG network (Ankrah and Omar, 2015). Formal and informal partnerships within the UIG network have been proven to be effective channels of knowledge exchange and knowledge spill-over (Grimpe and Hussinger, 2013). In most formal university knowledge transfer mechanisms, specific target knowledge is generated and transferred or a stated research outcome (Macho-Stadler et al., 2007, Muscio et al., 2013). Sometimes too formal university knowledge generation and transfer contracts are driven by intellectual property (IP) regulations (Rogers et al., 2001, Steffensen et al., 1999). Research studies available on both formal and informal modes of university knowledge transfers have described the two different, and while some papers categorise consultancies and conferences as formal (Barnes et al., 2006, Grimpe and Hussinger, 2013, Perkmann et al., 2013).

The evidence from this research highlights a collaboration between UIG institutional spheres based on contract and consultancy arrangements. The evidence shows that contracts and consultancy within the UIG network involve research on developing software and training staff on the software application leading to effective knowledge transfer. Software developed by the

industry is deployed to the government and universities to solve their challenges. These technologies are utilised in the areas such as auditing of university or government expenses, automation of payment systems, creation of a database for critical government and university systems, installation of some critical ICT infrastructure, web design and maintenance. After developing and deploying these technologies, firms consult for the government and universities on handling the software and hardware where necessary and collaborate further to create other solutions. This channel has created a knowledge flow within the UIG network. Moreover, the government realises the growing need to educate the industry and universities on patenting of inventions and commercialisation of research outputs and has established a dedicated office at NOTAP to consult for the industry. NOTAP created an office to consult and raise awareness within universities and industry sectors to understand the importance of patenting inventions and commercialising research outputs.

Additionally, the government also consult with both universities and industry through National Centre for Technology Management (NACETEM), providing advice for dynamic technology-driven, knowledge-based development. The evidence from this research shows that these channels are built based on informal interactions through social contacts, conferences, workshops, and other informal associations. These relationships provide opportunities for the stakeholders to socialise and transfer useful knowledge that will help build their organisational capacities and knowledge stock, and later build a robust social capital and integrate people for mutually beneficial interactions (Yokakul and Zawdie, 2009). Sometimes there is no clear difference between formal and informal mechanisms. Some personal agreements may call for contractual relationships in exceptional circumstances and become legally binding on both researchers and firms. In this case, the mechanism then becomes a formal mode and covers both parties' duties and responsibilities, including remunerations for academics. This finding confirms existing knowledge and is consistent with the extant literature (Schartinger *et al.*, 2002; Perkmann and Walsh, 2007; Datta and Saad, 2011a). For instance, a study conducted by Zahra and George (2002) considered informal interaction as a product of social integration, which contributes to a free flow of knowledge and information. Informal instruments of university knowledge transfer remain the origin of virtually all forms of university interactions and strive better when there are thorough human interactions, thus making knowledge flow from its source to recipients. This statement is supported by the network system theory (Brenner *et al.*, 2011, Burt, 2001, Nelson, 1989) and social capital literature (Chenhall *et al.*, 2010, Cohen and Fields, 2000, Gonzalez-Brambila, 2014), which have both explained how informal mode of knowledge transfer work. The systems of innovation literature emphasise geographical proximity, cultural background, friendship, common educational background etc. because these factors favour mutual trust, understanding, and collaboration (Lundvall, 1992; Von Hippel, 1988). However, industry respondents claimed that the universities' knowledge is obsolete and does not have commercial value. This claim relates to theoretical knowledge conforming to Mode 1 production. Therefore, some industry practitioners prefer to consult and gain knowledge from peers rather than from the universities. This finding contradicts

the conventional wisdom and theoretical propositions of the Triple Helix Model, where universities, as institutions of knowledge production, serve as the engines of economic growth through commercialisation of Knowledge (Abbas *et al.*, 2018; Etzkowitz and Leydesdorff, 2000). Tables 7.13, 7.14, and 7.15 show the summary of responses across the three institutional spheres.

Table 7. 13 Summary of Responses: University Perspective

Theme: Contract and Consultancy: University Perspective					
UI	UNIBEN	UNILORIN	ABU	UNN	ATBU
If it is a larger company, we sometimes sign a contract, and if it is a smaller company, we can deal with them at an individual level.	When we discover that the companies are capable of handling the technical problems, we contract it out for them to handle	Different companies have different capacities, but the majority of companies have limited absorption capacity, and we hardly engage in contract or consult for these types of companies.	Trust me, we have the ability to do what the industry expects from us, and that will shock them.	We also train some companies, especially since we created the Science park.	Contract and consultancies are still growing, we hope to have the capacity to make them more robust in the future, but as it is now, it is not very strong.

Table 7. 14 Summary of Responses: Industry perspective

Theme: Contract and Consultancy: Industry Perspective				
TBF1 SW	TBF 1 SE	TBF 2 SS	TB2NW	TBF 1 NC
We collaborate on a contract basis for developing software and training. We have worked for the Federal Industrial Research Organisation (FIRO), and I still consult for them. So, I can say this interaction is strong (TBF 1 SW)	The I.T. business has lots of regulations by the government, so the government consult for the industry on procedures of commercialisation. We also consult for the NBTI zonal office here in the South-East.	I can remember, we trained the University of Benin some coding and web design three years ago, and the relationship was cordial. If we sign any contract, we try to deliver based on the exact terms and conditions to avoid legal issues.	The research from our universities are not commercially valuable, so they are still left behind.	No university in this country knows what I have learnt in the field of technology over the last few years. I know their capabilities: they taught me old stuff which has not been in use in the current technological world.

Table 7. 15 Summary of Responses: Government perspective

Theme: Contract and Consultancy: Government Perspective					
NITDA	NUC	NBTI	FMST	FMCDE	NOTAP
During the registration of the IT companies, we offer consultancy services to the companies to raise their awareness	Contract and consultancy collaboration is weak, even if it is happening, I believe it should be more pronounced between university and industry.	When the incubation programme is finished, we attach each entrepreneur to the university and sometimes help them negotiate their needs before they engage in any contract or consultancy services.	The companies have also trained our staff in handling the software and are consulting for them.	We organise workshops and seminars frequently in the office, and we invite the industry	The universities and companies consult for the government on training staff. The only challenge we have is mostly the issue of trust and continuity. Building trust will make the collaborations a continuous one, but establishing trust is a huge challenge.



Table 7.16 depicts the cross-case analysis showing consensus, variations, and missing responses from the participants. Similar responses have been expressed on the positive strength of contract and consultancy as a means of UIG collaboration by the university respondents. These responses show that contracts and consultancy occur primarily through training and developing software. However, different views emerged from ATBU, indicating that contract and consultancy have not been strong, but growing slowly. It is noted that university respondents have not had an in-depth discussion on the absorptive capacities of companies. Responses from the industry also show consensus on software development and training as a dominant means of contract and consultancy between the institutional spheres. However, some respondents differed on the universities' capacity to handle industrial research due to the low-quality research output emanating from the universities. The responses from industry participants were silent on the possible breach of contract leading to legal issues between the stakeholders. The majority of the government responses show the availability of contract and consultancy through training of government personnel by industry, consulting on software application—the consulting partnership between government and industry is also through research commercialisation. However, some government respondents differed, noting that collaboration through contract and consultancy is weak. The government respondents did not emphasise the role of trust in sustaining this partnership.

*Table 7. 16 Cross-case analysis Contract and Consultancy*

<b>Responses</b>	<b>University</b>	<b>Industry</b>	<b>Government</b>
<b>Common views</b>	Provide training	Training /software development	Training/ software development
<b>Different views</b>	Contract and consultancy are growing	Low-quality research outputs	Weak collaboration
<b>Missing views</b>	The abortive capacity of companies	Legal issues	Trust issues.

### **7.3 Discussions on the Four Developmental Stages of Triple Helix**

This section identifies the congruencies and incongruencies of the Triple Helix development based on the organisational practices of the stakeholders. Examining organisational practices will identify issues that are taken for granted, which might facilitate or impede the Triple Helix practice or affect a proper transition into the Triple Helix model of innovation.

#### **7.3.1 Internal Transformation and Role Taking: - University Perspective**

Since the advent of Knowledge as the most important source of economic growth and competitiveness, universities have been charged with playing a significant role in society (Foray and Lundvall, 1998). The Triple Helix theory assumes that each institutional sphere

amends its internal structures, policies, cultures, and organisational practices to shoulder new tasks (Etzkowitz, 2003). Internal transformation within universities means the ongoing efforts by universities to integrate entrepreneurship, technology transfer or commercialisation of research initiatives and make a direct contribution to regional and national development (Leydesdorff, 1997). The internal transformation within the universities will be discussed from two different perspectives. One is the change in teaching and research functions within the Nigerian universities and the general reforms to bring the universities into the limelight in the nation's development process.

The results of this research show universities' transformation initiatives at various stages. The reforms introduced by the government reflected in the National Policy on Education (2004) have redesigned the university system for better quality and administrative efficiency. These policy reforms are intended to bring the university system into the global limelight by increasing higher education institutions (HEI), strengthening the governance structure and quality assurance (Saint, Hartnett and Strassner, 2003). The policy also prescribed autonomy for all federal universities. Before autonomy was granted, there was massive government control over the administration and general functions of the universities. For instance, student admission, staff employment and promotion, the appointment of principal officers, and structures of capital expenditure were all executed by the government (Olayinka, Adedeji and Ojo, 2017).

With 170 universities, 128 polytechnics, and 177 colleges of education, the knowledge infrastructure in Nigeria constitute the largest higher education system in Africa (NUC 2019). It is also instructive to note that of the 170 universities in Nigeria, comprising 43 Federal, 48 States and 79 Privates, 66.1% of the students are in Federal Universities while 27% are in the 48 State-owned meagre 6.9% are in the 79 Private universities. Thus, even though more private universities have been established over the last few years (2011 to 2019), their absorption capacity is still low. The growth in higher education has created wider access to university education, indicating a fundamental transformation expected to contribute to employment generation and wealth creation (Ranga and Etzkowitz, 2013). The literature on the increase in student enrolment is diverse, with conflicting arguments. For instance, Trow (2007) shows a significant improvement in HEI to absorb the growing demand.

On the other hand, Pelletier (2006) and Saad, Guermat and Brodie (2015) posit that expanding higher education often leads to a poorer quality of education and a quest for a diploma than proper skills. However, Saad, Zawdie and Malairaja, (2008) noted a positive relationship between HE enrolment and national innovation performance favouring developing countries. The growth in HEI in Nigeria is similar to the Malaysian experience (Malairaja and Zawdie, 2008). For instance, in 1962, there was only one university, but by 2011, there were about 18 public universities, 27 private universities and university colleges and 559 private colleges (Saad, Zawdie and Malairaja, 2008).

In 2018, Malaysia had more than 590 higher education institutions due to the increasing demand for access to higher education.

Similarly, different results indicate the transformation in research and teaching functions. For instance, compulsory entrepreneurship education applies to all federal universities to develop students' critical thinking abilities, idea generation competencies and a commitment to achieving entrepreneurial goals at graduation (Maxwell *et al.*, 2018). This gradual and consistent transformation confirms existing knowledge, is congruent with the theory, and indicates development towards forming a Triple Helix model.

On the other hand, this research indicates incongruency with the theory because many faculty members and university researchers maintained their old tradition of teaching and research without much individual effort to partake in practical commercialisation or spinoff activities. The faculty members believe that the purpose of the university is to teach and conduct research. Therefore, digressing from teaching and research the core institutional norm of the university will undermine the ultimate objective of universities and plunge the university into identity crises. This finding is incongruent with the Triple Helix model and conflicts with the theory's propositions that identify the faculty members as dynamic producers of knowledge transitioning to a knowledge-based economy (Etzkowitz, 2003; Leydesdorff and Zawdie, 2010). This belief is an indication that universities in Nigeria are still engrossed with the first academic revolution where universities only teach and conduct research with no cultural change that will aid the knowledge transfer and commercialisation activities (Ranga and Etzkowitz, 2013). Moreover, evidence suggests that despite the government's effort to transform the universities and bring them into the global limelight, ongoing transformations are not enough to enable the universities to lead in the transition to a knowledge-based economy or innovation-led economy.

One of the critical challenges identified by the Triple Helix model is the conflict between the Triple Helix actors and the dynamism of the model, which emphasises constant changes in the way knowledge is being created (Ranga and Etzkowitz, 2013). The finding confirms this conflict, showing that not all faculty members are happy about slanting the university toward the entrepreneurial route. There is a conflict between the beliefs of some faculty members and the emerging emphasis on universities transforming into entrepreneurial institutions. The empirical findings on the university faculty members' perspectives, attitudes, and culture negate the widespread phenomenon of the third university mission (Zawdie, 2010). The third university mission emphasises that Knowledge is categorised by its significance and application within an interdisciplinary and multidisciplinary setting and its outreach to the immediate society (Gibbons *et al.*, 1994). Studies have shown that role of the university is not restricted to teaching and research but contains a third mission to engage with society and address the increasing social and economic challenges (David, 2002; Giuri *et al.*, 2019). This finding is directly opposite to what Etzkowitz

(2002) found in MIT, where he observed MIT scientists' attitudes to entrepreneurial science developed from hostility and disagreement to agreement and compliance. The empirical result of this research on universities internal structural transformation shows an evolving shift of universities toward entrepreneurial universities. The literature indicates that universities take on industry roles through university-based spin-out, focusing on the commercialisation of research output and IPR. Still, the results of this research show limited successful spin-out from universities. Only two universities (the University of Nsukka and ATBU) mentioned the roles of their spin-out in the commercialisation of research output. Most of the universities do not have successful spin-out, limiting their ability to take on industry roles. Therefore, it can be concluded that the institutional practices of universities are partially in conformity with the Triple Helix development. Table 7.17 shows the summary of responses from the universities.

*Table 7. 17 Summary of Responses*

<b>Theme: Internal Transformation and Role Taking: University Perspective</b>					
<b>UI</b>	<b>UNIBEN</b>	<b>UNILORIN</b>	<b>ABU</b>	<b>UNN</b>	<b>ATBU</b>
These initiatives were to make an internal effort to include entrepreneurship spirit into our mandates and encourage ourselves to be part of the government's plan for private sector-led economic growth.	There are challenges of perception from our faculty members, changing that perception on academic entrepreneurship and commercialisation of research is a big problem that we must deal with	Such reforms include autonomy, internal auditing, the introduction of entrepreneurship in the curriculum and establishment of various Centres of Entrepreneurship.	So, I can generally say that there is some level of transformation, and we are making progress on changing our research priorities, and hopefully, we shall be there. But these transformations are not enough to bring about the change that we desperately needed.	The introduction of the curriculum on entrepreneurship is also an indication of a change in the direction of the university.	As part of the effort for transformation, we have recently established a Centre for Entrepreneurship and Industrial Training unit. We commercialise our research output through the spinoff called AKIM.

### **7.3.2 Internal Transformation and role-taking: -Industry Perspective**

Micro, small, and medium enterprises are globally recognised as engines of socio-economic transformation, and they have become well established in both developing and developed economies. According to SMEDAN (2017), Nigeria's MSMEs contribute 47% to Nigeria's GDP and employ 84% of Nigeria's workforce. They offer opportunities to drive jobs and wealth creation as well as income redistribution in society. Results on the internal transformation of industry show regional variation in terms of growth and innovative capabilities. The improvement in innovative capacities was noticed mainly in the firms located within the few private technology innovation hubs across the six geo-political zones. The hubs located in the Southern states, especially the South-West, show more successes and transformation than those in the Northern parts of the country. The success of the technology hubs located in the South-Western states has been attributed to the concentrations of firms, demand for technology from the population and beyond, investment opportunities, available infrastructure supported by the state governments and relative peace enjoyed by the southern states. For instance, to support the innovation ecosystem, the Lagos state

government established an Employment Trust Fund (LSETF) in 2016 to provide financial support to residents of Lagos State and support them with wealth creation and tackling unemployment. The state government earmarked 70 million USD for direct investment in Micro, Small and Medium Enterprises (MSMEs) or support people to acquire skills to get better jobs and become entrepreneurs. Such incentives have not been replicated in other states of the federation. However, the innovation hubs located in the Northern part of the country have reported a lack of investment opportunities, infrastructure challenges and a growing problem of lack of awareness of their capabilities from the public. This growth and transformation in the innovative capacities of the firms in the South-West are congruent with the theory (Etzkowitz, 2003; Ranga and Etzkowitz, 2013).

Regarding the industry taking on the university's role, results show some industry's outstanding performance through some innovation hubs. These hubs provide advanced training to groups, individuals and organisations and incubating start-ups. For instance, the Co-Creation Innovation hub (Cc-hub) is one of the outstanding technology incubation hubs launched in 2011. Cc hub has built a community of over 14,000 enthusiasts and incubated a portfolio of over 120 early-stage ventures, including spin-out of firms like LifeBank, Riby, BudgIT, WeCyclers, and iHub. This trend in the South-Western region is similar to Berlin's Silicon Allee or London's Silicon Roundabout, or the Silicon Valley cluster and Route 128. These are regional cluster strategies where industrial capacity and competitiveness is enhanced through clustering of related technology-based firms with the support of the government (Castells, 1989; Krugman, 1991; Porter, 1990). A notable destination in the Nigerian tech cluster is the Yabacon Valley; the area is thriving, home to hundreds of banking institutions and tech start-ups. The explosion of these start-ups has led to many venture capitalists, angel investors, and increased media attention. This development was supported by the UK-led West African Science and Innovation Network currently stationed in Lagos. This practice is consistent with the theory of the Regional Innovation System (Lau and Lo, 2015). Moreover, the role played by these Innovation Hubs is consistent with the theoretical proposition of the developmental stage of the Triple Helix model (Etzkowitz, 2003). Table 7.18 shows the summary of the responses from the industry participants.

Table 7. 18 Summary of Responses

<b>Theme: Internal Transformation and Role Taking: Industry Perspective</b>				
TBF1 SW	TBF 1 NE	TBF 1 SE	TBF 2 SS	TBF 1 N.C.
These companies that incubate firms, train people in a very appropriate and gainful way.	The security challenge here in the North and lack of investment opportunities coupled with the low level of awareness by our people are the factors responsible for the low industrial output.	We are into many business activities ranging from software production and incubating new firms to providing them with training.	There is noticeable progress in places like Port Harcourt, and Lagos due to the market opportunities.	The biggest challenge for us here is that we do not have the infrastructure, so our operating costs are higher than gains, infrastructures are very poor, and we do not have supporting research institutions.

### 7.3.3 Internal Transformation and Role-Taking:

The government's transformation here means the government's efforts in promoting the UIG network through reforms targeted at promoting innovation and R&D affecting both universities and industry. The role of the public sector (government) in fostering innovation has been acknowledged since the early works on systems of innovation (Lundvall, 1992a; Nelson and Rosenberg, 1993; Giesecke, 2000). The government's intervention in stimulating the innovation ecosystem is based on guidelines, establishing institutions, spotting glitches, and implementing to resolve difficulties (Edquist, 2011).

The Triple Helix theory professes that government becomes the enabler by providing technology infrastructure, legal infrastructure relevant policies, incentives, and initiatives to aid technology development and correct market failures (Link and Scott, 2010). The government, comprising the aggregation of public-sector agents, acts as an entrepreneur in the provision of technology infrastructure when its involvement in the overall technological change process is innovative and characterised by entrepreneurial risk (Link and Scott, 2010). The results show efforts by the government focused on improving innovation, creating institutional frameworks for funding, and establishing boards overseeing the coordination of the innovation activities. These efforts focus on various policies and funding mechanisms to encourage R&D, commercialisation of research, technology development and entrepreneurship. The first step taken by the government was to review the STI policy through the Federal Ministry of Science and Technology (FMST). As discussed in chapter two, the Nigerian STI policy from 1986 to 2011 has gone through various reviews. The latest review was in 2011, where the concept of innovation was integrated into the STI policy, changing it from Science and Technology Policy to Science Technology and Innovation Policy in 2011. The new STI Policy acknowledged the weak implementation, insufficient funding and weak interaction between the University-Industry-Government and introduced a renewed commitment to improving the situation (STI 2011). According to

Oyewale, Adebowale and Siyanbola (2017), the previous policies were confronted with inadequate policy preparation processes; implementation of the policy is commonly beleaguered with the absence of STI physical infrastructures, capital goods producers, and policy-implementing institutions or agencies and policy somersaults. The new policy has been considered a milestone in the development of the innovation ecosystem in Nigeria. Consequently, the National Innovation System framework was adopted, stressing economic development initiatives, employment generation, and wealth creation through the proliferation and growth of SMEs in the country (FMST 2012).

It is acknowledged that most STIs in developed countries go through various stages of development, and Nigeria is no exception (Steinmueller 2018). Studies carried out by Schot and Steinmueller (2018) identified the vital stages of STI transformations in historical context, dating back to the post-World war era. They noted that the first stage of the STI review was Post-World War II. The government institutionalised their support for R&D. The second transformation was during the 1980s when governments emphasised competitiveness, which shaped the National Innovation Systems. The third transformation integrates contemporary social and environmental challenges, including Sustainable Development Goals calling for a change in production methods. Consistent with Schot and Steinmueller (2018) submissions, the Nigerian STI Policy has gone through a series of changes reflecting the dynamism of science, technology, and innovation. This transformation culminated in the National Council on National Science Research (Baskaran, 2017), similar to other developed and developing countries like the U.S. and Brazil.

For instance, in Brazil, the government funds innovation through the National Council for Scientific and Technological Development. The Council is responsible for promoting innovation in science and technology and the application of Knowledge in economic development. The Council provides funds for research projects, grants for purchasing equipment, and sponsors programs to produce scientific knowledge and establish research networks (Valle and Sakuray, 2014). The Nigerian government provides funding for research through its various agencies and specially created the Tertiary Education Trust Fund (TEDFUND) as an intervention body complimenting the budgetary allocation given to the HEI and the various research organisations in the country. Since this fund was established, there has been an improvement in funding and other relevant resources in the HEI. The transformation from the government is congruent with Triple Helix theory that emphasises the role of government in financing and incentivising R&D. The literature shows that government takes on the roles of the industry through the government-owned incubation centres and public venture capital initiatives (Etzkowitz, 2008). This research shows that government takes industry roles through the incubation centres promoting joint knowledge creation and

commercialisation of activities. However, public venture capital initiatives are not very robust in Nigeria. Table 7.19 shows the summary of responses from the government participants.

Table 7. 19 *Summary of Responses*

<b>Internal Transformation and Role Taking: Government Perspective</b>				
<b>NITDA</b>	<b>NBTI</b>	<b>FMST</b>	<b>SMEDAN</b>	<b>NOTAP</b>
I can't remember all, but the few ones I can remember including National Innovation and Research Council, the National Council on Competitiveness created by the government to encourage universities to engage in research with industry	The essence of the incubation programmes is to help encourage innovation to stimulate entrepreneurship and make Nigeria an innovation-driven economy. That is why we established these incubation centres.	The introduction of innovation into the 2011 STI policy and the establishment of the National Research and Innovation Council (NRIC) indicates a milestone in achieving innovation.	Despite this progress, we are yet to see any positive impact from the establishment of these institutional supports	The government has established the National Competitiveness Council recently. This is in addition to the help from TETFUND to our universities.

Table 8.20 presents a cross-case analysis showing the consensus, difference, and gaps in the participants' responses. Similar views were expressed among the university respondents regarding transformation within the universities by introducing Centres for Entrepreneurship and Innovation and entrepreneurship education. However, different views were expressed, highlighting that the transformations were not enough to bring about innovation and progress. Moreover, gaps were identified from the responses to the roles of university-based spin-offs in innovation and regional economic growth. There is also consensus among the industry participants, showing the transformation through private innovation hubs and individual firms being able to train and incubate companies and corporate enterprises. However, there are different responses to the performance of companies based on regional locations indicating that the transformation of some firms in the South is more visible than those in the North. There is also a limited response on the role of firms in funding research and development. Government respondents agreed on the transformation by the government since the inclusion of innovation in the STI Policy and the establishment of the National Innovation and Research Council and National Council on Competitiveness in Nigeria. They differed on the effectiveness and positive impact of these Councils on innovation in Nigeria. Lastly, there are gaps those participants from the government have not emphasised. These gaps include the lack of structured public venture capitalists in the government.

Table 7. 20 *Cross-case Analysis of Internal Transformation and Role Taking*

<b>Responses</b>	<b>University</b>	<b>Industry</b>	<b>Government</b>
<b>Common views</b>	Establishment of Centres for Entrepreneurship and Innovation	Incubation of firms/ training	Establishment of National Innovation and Research Council, STI Policy 2011
<b>Different views</b>	Transformation not properly utilised	Uneven transformation and growth	No positive impact has been recorded
<b>Missing views</b>	Role of a university-based spinoff.	Funding research	Public Venture capital initiatives



### 7.3.4 Influence of One Helix Upon Another (Interdependency)

#### 7.3.4.1 Influence of Government on the University

The second developmental stage of the Triple Helix Model is the interdependency of each helix on others in building Hybrid Triple Helix institutional spheres. The Triple Helix theory has identified the influence of government on the universities in many aspects by promoting entrepreneurial dynamics using Science Parks, Intellectual Property and Technology Transfer Office (IPTTO), or university-based business incubators (Ranga and Etzkowitz, 2013).

This research shows that the government has supported innovation and knowledge transfer activities in universities in various ways. Prominent among the initiatives include the establishment of IPTTO through NOTAP. The IPTTO was established to promote the UIG network and facilitate joint knowledge creation, application and patenting of invention emanating from the universities. The IPTTO will facilitate the exploitation of the Intellectual Property system in Tertiary Institutions; it will allow the universities / R&D institutions to use the IP system as a source of technical information and generate wealth and income. Since the establishment of IPTTOs in the various universities, there has been an improvement in the culture of patenting, which was absent for decades. For instance, data from NOTAP shows no single Nigerian- registered patent was recorded for over 30 years. However, about 20 patents have been filed within the first six months of creating IPTTOs in the various universities. As depicted in Figure 8.1 below, the IPTTO has recorded 32 applications in 2010, 55 in 2011, 75 in 2012, 59 in 2013, 34 in 2013, 32 in 2015, 60 in 2016 and 36 in 2017. The number of Nigerian-registered patents has increased significantly since the creation of the IPTTOs. This gradual improvement in patent applications has also contributed positively to the culture of patent awareness in the research community.



This finding is consistent with the Triple Helix Model and confirms existing knowledge on the roles of IPTTOs in promoting innovation and technology transfer through intermediation (Tunca and Kanat, 2019). Despite the availability of the IPTTOs, and improvement in patenting culture, the results have revealed that universities hardly convert research output into a monetary value. The inability of research output to attract a financial value was attributed to the poor commercial content of the research conducted within the universities, lack of strong national IP policy, and poor R&D funding (Ukwuoma, Amade and Moghalu, 2013), which are considered as barriers to UIG collaboration as discussed in section 7.3.

Moreover, despite the critical role of Science Parks in promoting innovation and technology development, the results of this research show limited evidence of universities or government promoting innovation through Science Parks. The lack of Science Parks in Nigeria was attributed to the lack of a comprehensive understanding of the essence of Science Park by university management or political leaders. The adoption of the Science Park initiative will hugely benefit innovation and technology transfer in Nigeria. For instance, with the recent introduction of a Science Park by the University of Nsukka, collaboration has spiked, especially in the automobile industry. Since then, a local automobile company INNOSON Motors has signed an MOU with the UNN Science Park for tractor manufacturing plans known as Lion IVM 20 HP Agricultural tractors. Hitherto, the tractor manufacturing plants were outsourced to a Brazilian company domiciled in Brazil. But with the establishment of the UNN Science Park, the capacity for indigenous production is enhanced. The same initiative could be extended to other universities in Nigeria. Table 7.21 shows a summary of responses from the university participants.

Table 7. 21 Summary of Responses

<b>Sub-Theme: Influence of Government on the University</b>				
<b>UI</b>	<b>UNIBEN</b>	<b>ABU</b>	<b>UNN</b>	<b>ABTU</b>
The major influence of these policies, especially the IPTTOs is that the universities now have a point of contact on issues relating to the commercialisation of research output.	There has been a slow, but growing awareness on entrepreneurship (Though in theory) among lecturers and even students.	The introduction of IPTTO and a curriculum on entrepreneurship on the universities are considered very vital steps toward collaboration and technology transfer for us	The approach from our university is different in the sense that the IPTTOs play a limited role. The University Science Park is doing the major work of the IPTTOs	Since the creation of the IPTTOs, we have an institutional structure on the ground, we are working on raising awareness for staff to embrace commercialisation and improve their culture and knowledge of the patent.

### 7.3.4.2 Influence of Government on the Industry

The Triple Helix theory professes that government promote the industry through policy initiatives and institutional frameworks to promote industrial capacity and encourage

knowledge transfer activities (Ranga and Etzkowitz, 2013). The results of this research show that the Nigerian government has established various tools targeted at supporting industry and influencing their capacity to engage in innovation and knowledge transfer activities. These initiatives include establishing the Small and Medium Enterprises Development Commission (SMEDAN), as contained in the National Policy on Small and Medium Enterprises Development 2004, to monitor and coordinate SMEs and link them to internal and external sources of finance (SMEDAN, 2017). In recent times, the government, through SMEDAN, has introduced various initiatives that have helped improve the productions of goods and services within the industry. To assist the MSMEs, SMEDAN has established the National Enterprise Development (NEDEP) Programme to, directly and indirectly, generate an estimated 5.0 million jobs between 2013 and 2015. This programme focused on Skills Acquisition, Entrepreneurship Training/Business Development Service (BDS) and access to finance. The entrepreneurship training/business development service component is being implemented under the One Local Government One Product (OLOP) platform. The access to finance component is being handled by the Bank of Industry (BOI) and skills acquisition by the Industrial Training Fund (ITF) (SMEDAN, 2020). The government, through NITDA, has introduced the Technology Innovation Support Scheme to provide an opportunity for the building the capacity of both Hub Managers and Technology start-ups and ensure the creation of entrepreneurs and jobs within the ecosystem. The programme involves equipping Nigerian youths with the technological and entrepreneurial skills required to establish innovative companies or secure decent work in existing enterprises. The Nigerian government has created the Office for ICT Innovation and Entrepreneurship (OIIE) under NITDA to nurture, cultivate, and expand ICT innovation and entrepreneurship within Nigeria in line with National ICT Policy and NITDA Act 2007. The establishment of OIIE as a specialised organisation will address the challenges inhibiting the growth of entrepreneurs and create enabling environments to foster innovation and entrepreneurship in the country. It is expected that through these initiatives and programs of OIIE, there will be an increased contribution of ICT to the GDP and wealth creation. The Nigerian government established The Office for Nigerian Content Development in ICT (ONC) as a subsidiary of the National Information Technology Development Agency (NITDA). This office was created to stimulate the development of the ICT industry with a primary focus on developing local skills, technology transfer, use of local human resources and local manufacturing.

Moreover, through the Central Bank of Nigeria (CBN), the government has eased accessing loans to the firms by establishing the National Collateral Registry, where firms use mobile and movable possessions or personal assets as collateral. This development helps the financial abilities of businesses so that they can use their assets such as cars, power generating sets or other types of machinery as collateral to access funds. These projects and programs enhance the entrepreneurship

capabilities and enable the firms' environment and nurture entrepreneurship and innovation. The funding opportunities introduced by the government include YouWin Connect under the Federal Ministry of Finance, Youth Entrepreneurship Support (YES) and Graduate Entrepreneurship Fund (GEF), all through the Bank of Industry (BOI). The introduction of these initiatives in Nigeria follows the examples of the US and China. For instance, in the US, both the Small Business Innovative Research (SBIR) and Small Business Technology Transfer (STTR) programs are responsible for funding small start-ups. The difference between the SBIR and SMEDAN in Nigeria is that SBIR provides funds directly to entrepreneurs while SMEDAN intervenes and link entrepreneurs with either private funding agencies or government grants. However, despite the government transformation and introduction of various mechanisms, funding remains a challenge for the growth of SMEs. This finding is consistent with the report of previous joint research conducted by SMEDAN and the National Bureau of Statistics (2017). They found that (89.6 per cent) of the firms lack access to finance as the most critical impediment. This was followed by inconsistent policies of government (58.3 per cent), weak infrastructure (57.2 per cent) and lack of entrepreneurship/vocational training (53.3 per cent). Table 8.21 shows the summary of responses from the industry, while Table 8.22 shows the cross-case analysis of universities and industry.

The cross-case analysis shows some consensus and different views between the universities and industry participants. The agreement among the universities is on the various policies promoting technology transfer and commercialisation. For instance, the university respondents mentioned the influence of IPTTOs in promoting the awareness and culture of patents and introducing curricula promoting entrepreneurship education in the universities. However, there are some different views, especially from UNN, where the respondent believes that the IPTTOs have a limited role in commercialisation processes in the University of Nsukka. Instead, he claimed that university-based Science Park plays a key role in promoting technology transfer. Some industry participants differed, pointing out the non-proper communication on some of the activities offered by the government to the firms. On the other hand, the industry also expressed similar responses regarding SMEDAN, OIIE, and NITDA in promoting the industrial capacity through funding opportunities, promoting innovation eco-systems, upskilling the industry, and the role of NOTAP in saving the cost of technology transfer agreements. However, respondents from universities and industries have not captured or emphasised whether the intervention of these institutions have led to a technological breakthrough capable of attracting revenue to the universities or industry.

Table 7. 22 Summary of Responses

Sub-Theme: Influence of Government on the Industry				
TBF 2 SW	TBF 1 NE	TBF 2 SE	TBF 1 SS	TBF 1 NC
There was minimal information or culture of patent, not just in the industry alone, but also, in universities. So, I think the intervention of NOTAP has helped.	SMEDAN has provided many companies with funding and training opportunities. Even though it is not enough, and there are still the companies are facing financial challenges.	Through the activities of SMEDAN and OIIE, the government is doing a lot on the innovation ecosystem. Many funding opportunities have been introduced, even though accessing them is a big hustle	Government intervention through NOTAP is saving the cost of Technology Transfer Agreements (TTA).	There are many issues of non-proper communication by the government. For firms that live far away from Abuja, the information hardly reaches them.

Table 7. 23 Cross-case Analysis: University-Industry

Responses	University	Industry
<b>Common views</b>	Roles of IPTTOs and Introduction of entrepreneurship	Establishment of SMEDAN, and the funding opportunities
<b>Different views</b>	limited roles	Non-proper communication
<b>Missing views</b>	Technological breakthrough	Technological breakthrough

### 7.3.5 Creation of a New Overlay of Networks and Organisations (Intermediaries)

According to Etzkowitz (2003), creating a new overlay of interaction involves expanding the network beyond bilateral linkage and pushing for the emergence of a new Hybrid network through external bodies such as regional clusters or other governmental or non-governmental organisations. The innovation intermediaries play different roles in stimulating innovation and technology transfer (Nakwa, Zawdie and Intarakumnerd, 2012). The Triple Helix theory identified the functions of each institutional sphere in creating these new intermediaries. Ranga and Etzkowitz (2013) identified a new overlay of communication through cluster development initiatives at the regional level among the three helixes as a conventional practice of the Triple Helix development. In this regard, universities are expected to play a leading role in providing education, research, and technology transfer to firms located in the cluster.

Nevertheless, the results show that, despite the presence of different clusters in the country, the roles of the universities in the emergence or development of the regional clusters are limited. Nigeria currently has several active clusters, spread across the six geo-political regions of the federation. Each cluster focuses on a different area, including health care, engineering, science, ICT, and craft technology. These include, for example, the Nnewi Automobile clusters in the South-East, an ICT cluster in Lagos (South-West), and a leather cluster in the North-West. This finding

is similar to the African Institute of Technology Inc research in which they revealed weak partnerships between universities, companies, government labs, and researchers in most clusters in Nigeria (African Institute of Technology Inc, 2015). This may be due to the orientation of the universities that focused only on teaching and research without rigorous technology transfer and commercialisation activities. The limited intervention of HEI calls for a review to tilt their orientation toward entrepreneurial routes. An entrepreneurial university with multiple teaching, research, economic and social development missions is superseding the research university as the academic paradigm (Etzkowitz, 2014). The entrepreneurial university paradigm also contributes to cluster development and regional competitiveness. Therefore, universities must change their orientation towards the entrepreneurial or ambidexterity model (Ferreira and Steenkamp, 2015).

Results from the industry indicate the emergence of many external groups and intermediaries, creating new channels of communication within the innovation network through training, policy initiation, and funding opportunities (Etzkowitz, 2003; Nakwa, Zawdie and Intarakumnerd, 2012). For instance, the Young Innovators of Nigeria (YIN) was created in 2014 as an interest group of young technology entrepreneurs and practitioners who promote technology-based knowledge businesses and influence the developments of the Nigerian technology innovation ecosystem. This platform is an avenue for boosting the growth of local content in ICT and innovation across Nigeria. The group has created numerous podiums for joint ventures, new ideas, and brainstorming to train young people to apply technology. The multiple impacts made by this body include the training of young secondary school students on coding and computing and sharing of information among the members in the various technical experts and professional organisations like the Computer Society of Nigeria and the Computer Professional Registration Council, among many others.

Additionally, the result shows the impact made by philanthropic and non-governmental organisations like the Tony Elumelu Foundation (TEF) and the Nigerian Economic Summit Group (NESG). In the last five years, the Tony Elumelu Foundation has spent over N2 billion supporting start-ups and other institutions through seed funding and technical support. This foundation is the largest African philanthropic initiative devoted to entrepreneurship and innovation in Africa. The organisation dedicated over \$100 million to identify and empower 10,000 African entrepreneurs, create a million jobs, and add \$10 billion in revenues to Africa's economy (TEF 2015). The results further show that the Nigerian Economic Summit Group has been at the forefront of organising Triple Helix workshops and seminars advocating for support from all the institutional spheres to help Nigeria drive toward knowledge and innovation-driven economy collaboratively. This group aims to raise competitive digital industries in achieving industrialisation in Nigeria. This group fit into the Triple Helix intermediary's role, coordinating and supervising the UIG network and promoting innovation (Nakwa, Zawdie and Intarakumnerd, 2012). According to Porter (1998), the government provides secure, deliberate, and systematic support for cluster development. This support could integrate cluster development

into the overall national development plans or through funding and infrastructure development. The research results show that the Nigerian government does not have an articulated cluster policy in Nigeria but has put some supporting structures to improve the cluster strategy. These supporting structures are part of the National Information Communication and Development Agency (NITDA), the Federal Ministry of Industry Trade and Investment (FMITI), and SMEDAN. These structures include the 23 Industrial Development Centres and Technology Innovation Hubs managed by NITDA. The IDCs were established to provide extension services to SMEs in such areas as project appraisal for a loan application, training of entrepreneurs, managerial assistance, product development, and other extension services. Although the government abandoned the IDCs due to management and funding issues, various attempts to revamp them proved fruitless. Other initiatives include establishing the Technology innovation Hubs where Technology, Business, Innovation and Entrepreneurship are nurtured by building pools of evolving talent and IT professionals. Through the Hub, NITDA provides the right enabling environment by putting a high-quality infrastructure and support services.

Some studies have integrated external innovation networks in the Triple Helix configuration and referred to it as a Quadruple Helix Network (Danilda, Lindberg and Torstensson 2009). The Quadruple Helix has been used to analyse the impact of civil society and non-profit organisations as social elite groups of well-educated, well-informed consumers that participate and help to shape the innovation systems by being active, demanding, and imaginative (Carayannis and Campbell, 2009; Carayannis and Campbell, 2010). The finding confirms existing knowledge on the roles of different actors and intermediaries in the innovation ecosystem through the NESG, YIN, and TEF, among others. Tables 7.24, 7.25 and 8.26 show the summary of responses.

*Table 7. 24 Summary of Responses*

<b>Theme: Creation of a New Overlay of Networks and Organisations: University</b>				
<b>UI</b>	<b>UNIBEN</b>	<b>UNILORIN</b>	<b>ABU</b>	<b>UNN</b>
Association of Nigeria (MAN),	Universities are not fully equipped to	We do not invest in Science Parks,	Ideally, our contribution to the	The university has contributed a lot
Council for the Regulation of Engineering (COREN) are trying to encourage collaboration through brainstorming. But it is still at its infancy stage.	make any visible contribution through the Science Parks, clusters or incubations. That is partly due to the failure of the education system, and a lack of foresight from the universities	which are platforms that will make a visible contribution to the emergence of clusters. So, we do not play a major role in the incubation of high-tech industries, and it is about time we have this paradigm shift.	economic development or prompting UIG collaboration will be stronger if we had a platform like science parks and well-functioning university-based incubation centres.	toward the formation and eventual success of the Nnewi cluster in terms of training of human capital and many other kinds of research in the field of science and technology.

Table 7. 25 Summary of Responses

Theme: Creation of a New Overlay of Networks and Organisations: Industry					
TBF 1 SW	TBF 1 NE	TBF 1 SE	TBF 1 SS	TB2NW	TBF 1 NC
Organisations like the NESG and the Tony Elumelu Foundation is doing their best. These bodies organise meetings and workshops to discuss the importance of collaboration.	NESG has recently held a meeting in Lagos, where they invited the participants from university-Industry-Government and brainstormed on how they can promote the collaboration.	I believe that these organisations need to be more open to all companies when it comes to favours, they have preferred companies to push, and not all companies will be treated equally.	We are not being carried along; they do not invite us to their meetings or give us an opportunity to be part of the collaboration. These organisations, especially the NESG tend to be more elitist initially when it started	Young Innovators of Nigeria (YIN) is one organisation that has also created some avenues for us to come together through some training, workshops, and annual exhibitions nationally and internationally.	YIN is one of these organisations; they promote exhibitions of innovation by companies and create formal and informal links between firms and universities.

Table 7. 26 Summary of Responses

Theme: Creation of a New Overlay of Networks and Organisations: Government					
NITDA	NACETEM	FMITI	FMST	SMEDAN	NOTAP
We do not have a clear policy on clusters, but we try to support those clusters through the various innovation hubs we have established	There should be complementary platforms from local governments and states. The States and local government councils should be active in attracting talents and innovation activities.	We have some supporting structures for the cluster's development through the Incubation Centres and Innovation hubs established by NITDA. But the government has limited support for the clusters, that is why they are not visible.	The recent effort by the government in rejuvenating the cluster strategy is made through Ministries of Communication Digital Economy, Ministry of Science and Technology and Ministry of Investment, Trade	What we see in Nigeria is that development initiative comes only from the Federal government instead of all stakeholders, including the private sector.	This project is another strategy for helping the cluster in Nigeria. The project is yielding some results, but there should be a clear cluster policy in this country to identify what each level of government can do about it to contribute to its

Table 7. 27 Cross-case Analysis

Responses	University	Industry	Government
<b>Common views</b>	Limited contributions	Emergence/ Interventions from NESG, TEF and YIN	Technology Innovation Hubs.
<b>Different views</b>	University has contributed a lot through Science- Park	Intermediaries/ Organisations more elitist	Limited support by the government
<b>Missing views</b>	Lack of foresight from the universities	Roles of the states and local councils	Roles of states and local councils

The cross-case analysis in Table 7.27 above shows consensus among the university respondents who unanimously agreed on the limited roles of the universities in cluster development. They attributed this limited contribution to a lack of support and the nature of the universities in Nigeria. On the other hand, the University of Nsukka differed and noted that the university has contributed toward the emergence and development of the Nnewi Cluster in South-Eastern Nigeria. The



universities have not discussed the critical roles of university leadership in the limited roles of universities in the emergence of clusters. The industry responses also show consensus on the roles of the Nigerian Economic Summit Group NESG, the Tony Elumelu Foundation and Young Innovators of Nigeria (YIN). However, one respondent held a different view, noting that these organisations operate in an elitist approach and not involving all companies in their activities. Industry responses were silent and less emphatic on the pivotal roles of states and local government councils in the emergence of clusters. The responses from the government show some consensus on the emergence of intermediary structures through Technology Innovation Hubs in supporting cluster initiatives, while others differed and stated that the innovation hubs offer limited support. There are gaps noted in the responses from industry and government. These gaps were noted in the lack of insight provided by industry and government respondents on the critical roles of the States and Local government councils.

### **7.3.6 The Fourth Developmental Stage:**

This stage of Triple Helix network development refers to the advanced stage of UIG interaction. The emphasis is given to building an overlapping and relatively interdependent relationship between the three institutional spheres (Sarpong *et al.*, 2015). Under the Hybrid configuration, each institutional sphere keeps its unique features while taking the role of the others (Etzkowitz and Leydesdorff, 2000; Etzkowitz, 2003).

The results of this study show that despite steps being taken by the government and the transformative efforts by the institutional spheres, a considerable gap still exists between the institutions. These gaps constitute significant impediments (discussed in detail in section 8.3) to the emergence of the Hybrid Model. The results from the universities show that Nigeria has not yet achieved the Hybrid Model due to the lack of investment in education, decayed infrastructure, and incompetent political leadership. The university participants attributed this to the inability of the government to invest in education and the lack of policy implementations. The industry results are consistent with the universities in that they believe that the government does not invest sufficiently in education compared to developed countries. Therefore, UIG interaction within the Hybrid model is challenging. Although the government results show the efforts at various levels of government institutions, they admit that the government needs to do more and be ready to provide the right leadership. Leadership commitment or its absence plays a critical role in the success or otherwise of UIG collaboration (Goddard and Kempton, 2011). According to Dankbaar (2019), transparent behaviour and empowered leadership are essential organisational requirements for successful collaboration. The finding is incongruent with the theory that expects the UIG network to create socio-economic development and jobs (Saad and Zawdie, 2011; Sarpong *et al.*, 2017).

Tables 7.28, 7.29 and 7.30 present the summary of responses from the research participants. The cross-case analysis in Table 7.30 shows consensus, differences, and gaps in the responses

from the participants. The consensus from the university respondents can be seen in their opinion that the lack of sufficient funding to universities hinders the transition to Hybrid Triple Helix practices. However, some university respondents believed that universities could make progress if Nigeria gets the leadership right. Similarly, the consensus among the industry and government participants also shows leadership problems and lack of infrastructure attributed to the inability of governments to provide enough funding. But government respondents expressed more optimism with the recent progress in science and ICT, noting that Nigeria is on the right track to Hybrid Triple Helix innovation.

Nevertheless, there are gaps in the responses from all institutional spheres. The Triple Helix encourages dual roles for professors to holding positions in government alongside part-time positions as faculty members in the universities. They use their positions to attract research funding and grant to the universities. Although this study confirms in section 8.1 that university staff serve as a bridge linking the university and government, respondents did not emphasise the dual roles of the professors in attracting funding outside the university and making the process of Hybrid Triple practice attainable. The theory also supports practitioners in teaching in universities on a part-time basis, combining industrial practice and teaching. However, the industry respondents provided no comments regarding this dual role limiting the opportunity to generate extensive analysis. In the Hybrid Triple Helix interaction, the role of leadership is critical; however, the data from government respondents did not generate adequate information on the essential role of the leaders, creating a missing link in the analysis

*Table 7. 28 Summary of Responses*

<b>Theme: The Recursive Effect of Trilateral Networks: University Perspective</b>				
<b>UI</b>	<b>UNIBEN</b>	<b>UNILORIN</b>	<b>ABU</b>	<b>UNN</b>
This network cannot be achieved without adequate budgetary allocation, adequate facilities within the universities and motivation for the researchers.	If you look at the university policies, goals and visions, they look beautiful on paper, but when you think about how we go about implementing them, that is when you understand everything is messed up	I think I can blame the government for that, a country's ability to grow depends on the investment in its knowledge infrastructure look at how the universities have been funded? That is a pity.	The universities cannot function properly when they are not funded, the facilities in the universities are dilapidated, and everything about the incentive of staff is in a mess.	We are making some progress. The major issue is the leadership if policies of government toward improving the universities and industries are implemented without any delays and funding provided, the system of this partnership will work.

Table 7. 29 Summary of Responses

Theme: The Recursive Effect of Trilateral Networks: Industry Perspective					
TBF 1 SW	TBF 1 NE	TBF 1 SE	TBF 1 SS	TB2NW	TBF 1 NC
First, there are challenges of leadership, and secondly, we are not utilising our talents rightly. We have tried many development plans, but all the development plans failed because of bad leadership	The situation cannot be as perfect as we want unless we change our institutional configurations. government should implement the right policies and make the collaboration productive for all, but we are not yet there	The leadership in Nigeria knows that no country can industrialise, develop and apply its Science and Technology without the required infrastructure, focused leadership, and knowledge and skills	I believe we are making some progress; we just need a better economic policy and a better knowledge infrastructure in the universities and other research institutions.	With the recent progress in the ICT, both private and public sectors which is driving the level of incubation programmes, there is hope that we will get there.	The perfect situation of UIG interaction has not been achieved because of the institutional weakness in the country.

Table 7. 30 Summary of Responses

Theme: The Recursive Effect of Trilateral Networks: Government Perspective					
NITDA	NACETEM	FMITI	FMST	SMEDAN	NOTAP
I know that there are many challenges with the economic, social and political settings, but we are making the right decisions and interventions.	Government has not adequately fulfilled its promises, and the universities have been underfunded to the extent that they cannot even perform their primary duties efficiently.	We have seen for the first time an improvement in the business environment and the establishment of a National Research and Innovation Council that implements the STI and provide adequate funding.	We are making progress, but we are not yet there compared to the developed countries. Gradually, we are beginning to see changes from what we have been used to.	I remain positive that in the end, we will have a perfect situation of UIG interaction.	The commercial content of our research is abysmal then tell me how we can achieve the perfect UIG practice in Nigeria?

Table 7. 31 Cross-case Analysis

Responses	University	Industry	Government
<b>Common views</b>	lack of funding	Leadership problems Infrastructural decay	We are in the right direction
<b>Different views</b>	Collaboration is emerging	Need for the right leadership	progress has been made
<b>Missing</b>	Dual roles for professors	Dual roles for the industry	leadership

#### 7.4 Discussion of the General Factors Inhibiting the Network

University-Industry-Government (UIG) collaboration has been widely perceived to magnify organisational capacity, enhancing a nation's growth prospects and competitiveness (Ankrah *et al.*, 2013; Ankrah and Omar, 2015). Despite the numerous benefits of this cooperation, many

factors have been identified that inhibit these interactions (Abbasnejad *et al.*, 2011). Extant literature on the barriers to collaboration is fragmented and overlapping, but many studies have categorised the barriers into institutional, orientation, relationships, or output barriers (Bruneel, d'Este and Salter, 2010; Rybnicek and Königsgruber, 2019). This section discusses the empirical factors hindering UIG collaboration in Nigeria.

#### **7.4.1 Institutional Factors**

##### **7.4.1.1 Lack of Resources/Funding**

The success or failure of UIG collaboration depends on the availability of resources at the disposal of each collaborating partner (Rybnicek and Königsgruber, 2019). This research shows that one of the factors limiting UIG interaction is the lack of funding for universities and the limited access to funding for firms. The lack of funding for universities is reflected in the annual budgetary allocation to the education sector. For instance, data from the Nigerian Budget Office shows funding allocation to the Federal Ministry of Education has been increasing over the years. However, the increment is still not enough to fund R&D activities of the universities and other HEI, limiting their capacities to collaborate on any impactful research. According to the data from the Budget Office, the total allocation to the Federal universities in 2017 was N235.1bn (\$ 603,382,917), up from the 2016 figure of N216bn (\$556, 730, and 928). The 2018 allocation was N254.49bn (\$654,674,332), including Universal Basic Education. Globally, the Gross Domestic Expenditure on Research and Development (GERD), as a percentage of GDP, is a commonly used funding level indicator (Coccia, 2008).

Comparing levels assigned to research and development within Africa, South Africa is at 0.76 %, Egypt at 0.4 %, and Nigeria's lowest at 0.2 % (OECD, 2019a). This allocation goes against the National Policy on Science and Technology 2011, stipulating that the Federal Government funds science and technology development programmes up to 5 % of its annual budget. The individual Nigerian States contribute by way of sponsored research projects; this has not yet been achieved. According to the mandates of the National Research and Innovation Fund (NRIF), a minimum of 1% funding should be invested into innovation, and at least 5% should be sourced from government allocations, Public and Private Partnership, International R&D funds, and Venture Capital for implementation and achievement of the 2012 STI policy. However, these strides were never achieved. Previous studies by Nwachukwu (2014) attributed the funding challenges to the inconsistency, inefficient management, wastages, and leakages from the education system managers. Many directors in the government-owned research organisations also stated that the responsibility of government agencies is not just to regulate but also to collaborate in research capacities. They noted that the regulation and collaboration in research capacities had been a challenge due to the limited funding by the government. The funding challenge has left many government institutions unable to sponsor Research and Development (R

& R&D) or collaborate in developing technologies in the country. Many research laboratories are dilapidated, critical research infrastructures and buildings have been abandoned for many years due to lack of adequate funding. Training and capacity building for researchers, engineers and scientists have been ignored for many years impacted by financial constraints. Furthermore, underfunding government institutions has a political perspective, having been identified by the government as critical for achieving their political objectives. For instance, successive governments in Nigeria come into power with specific political agendas, considered as essential to making their policies and promises to the people. Examples of such promises include, for instance, a 7-point agenda in 2003-2007 and a transformation agenda in 2011 -2015. These agendas were intended to be achieved through some government agencies. Consequently, any government agency that does not fall under the identified programme receives minimal attention from the government.

Additionally, the results also show that despite SME's contribution of 47% to Nigeria's GDP and employing 84% of Nigeria's workforce, SMEs still have difficulty accessing credit facilities (Akinyemi and Adejumo, 2017). Consequently, they are constrained to approach commercial banks to access loans that come with substantial interest rates. The results confirm existing literature on the barriers to UIG collaboration within Nigeria (Bruneel, d'Este and Salter, 2010). The literature acknowledges the significant role of R&D financing as input to the innovation process (Cirera and Maloney, 2017). These results corroborate Shittu, Owodunni and Olugasa, (2017), who found lack of funding as a significant barrier to UIG collaboration in Nigeria. R&D is thought to facilitate advances at the technological frontier and catch-up by building absorptive capacity (Cohen and Levinthal 1990). The literature suggests that the quality of and improvements in knowledge and research delivered are fundamentally related to funding (Greenaway and Haynes 2003). Failure to invest in R&D contradicts NSI and NIC frameworks, and both theories strongly advocate investment in education and training as one of the critical determinants of the innovative capacity of a nation (Furman et al., 2002; Saad et al., 2015).

#### **7.4.1.2 Bureaucracy**

Existing evidence identifies bureaucracy as a factor constituting a significant barrier to UIG collaboration (Link, 2003, Siegel, 2003). Bureaucracy comprises rigid organisational practices, rules and regulations guiding government institutions. According to Rybnicek (2019), adherence to these laid down rules and procedures might inhibit potential cooperation between organisations with different missions and guiding principles (Mori, 2017). The results of this research found that bureaucracy inhibits UIG collaboration in Nigeria. Bureaucracy impacts the internal and external organisational practices affecting programmes and projects within the universities and government institutions. One of the bureaucratic bottlenecks identified by universities and government participants relates to the delays in the decision-making process and endless paperwork and approvals. Also, the introduction of the Single Treasury Account

by the Nigerian government to unify all payment systems through the Central Bank of Nigeria (CBN), to control government expenses and flow into the Federation account without glitches has impacted on processes and procedures involving payments between the stakeholders. This process caused delays in releasing funds due to the various levels of verification required by CBN before disbursement of funds. These bureaucracies also influence research and innovation activities for both government-owned research institutions and universities. This finding corroborates previous research. (Schofield, 2013; Rybnicek and Königsgruber, 2019). Mori (2017) identified the limitations of bureaucracy, its effect on individuals, and how it damages organisational effectiveness constraining management choices. According to Chand (2015), bureaucracy has many drawbacks, such as stifling creativity, compromising organisational goals and hindering new practices in organisations. Therefore, bureaucracy is not only a barrier to UIG collaboration, but it also impedes the dynamism of knowledge-intensive firms where the application of intangible assets is essential than the accumulation of physical capital. Stefan, Sveningsson and Alvesson, (2001) identifies the incompatibility of bureaucracy with knowledge-intensive firms. They mentioned that, unlike bureaucratic organisations, knowledge-intensive firms are engaged in tasks that are too complex and challenging to be converted into standardised work practices and procedures. Styhre and Lind (2010), commenting on bureaucracy and post-bureaucratic literature, recommended adopting a softer ambidextrous model of bureaucracy by some entrepreneurial universities by incorporating elements of bureaucracy and flexibility. Using the term soft bureaucracies, the university structure enacts a hybrid organisation form that includes the conventional functional and hierarchical organisation and less strict and compartmentalised elements.

#### **7.4.1.3 Different Orientation of the Stakeholders**

The literature on University-Industry-Government collaboration has identified differences in culture and orientation of the stakeholders as a barrier to cooperation (Bruneel, d'Este and Salter, 2010; Ramli and Senin, 2015; Rybnicek and Königsgruber, 2019). On the one hand, the university is driven by creating new knowledge, educating society, and supplying human capital to the workforce, while the industry is driven by profit maximation (Ramli and Senin, 2015). This difference brings about mutual suspicion and blatant disrespect between the stakeholders. One of the clear instances causing friction between the three institutional spheres relates to payments due to the industry from universities and government. The results show that when industry engage in a paid consultancy for both government and university. Most of the time, the government, and universities delay payments to the sectors. Whenever there is a delay in releasing funds to companies, the firms apply pressure with calls and frequent visitations to universities or government to upsets the managers in the universities or government organisations.

Consequently, withholding such payments due to companies affect their businesses, which leads companies into operational troubles. The results show a clear case of different cultures and apparent variances in orientation between the private and public institutions. Companies act more on short term goals and time frames, while in academia, the time horizon is not essential, and the goals might not be defined (Seppo and Reino, 2012). Dealtry *et al.* (2005) note that different organisational cultures, languages, and values can bring many interaction problems and intolerance toward the other party. Cyert and Goodman (1997) found that partners have different organisational cultures, languages and values that pose problems for any collaborative work. They also note that companies usually do not understand how work is allocated in universities or how university budgets are handled.

On the other hand, university partners do not understand the real market forces, time demands, and the incentive structure of the firms. This finding confirms existing knowledge of differences in culture and orientation of the institutional spheres to negatively affect the UIG collaboration and knowledge transfer (Bruneel, d'Este and Salter, 2010; Schofield, 2013). This finding reflects Mgonja (2017) systematic review of literature on barriers to UIG collaboration in different countries, which found that cultural barriers present a significant challenge within the African context. In a similar study, Bruneel, d'Este and Salter (2010) examined barriers between UK universities and companies and found that orientation-related barriers significantly inhibited UIG collaboration.

#### **7.4.1.4 Low-Quality Research Output and Mismatch Between the Curriculum and Industrial Needs**

Universities play a significant role in the development of science in most countries worldwide (Etzkowitz *et al.*, 2000; Datta and Souleh, 2018; Datta and Adesola, 2018). Their role is producing, transmitting, and disseminating new knowledge, providing human capital and skills to society (Ani, 2012). Many universities have developed a third mission that encourages commercialisation of research outputs by fostering links with knowledge users and society through patenting and licencing (Gulbrandsen and Slipersaeter, 2007; Etzkowitz and Leydesdorff, 2000). This research shows that qualities of the research output produced within the universities and research organisations are low. They are kept dormant on the shelves of the universities and government-owned research institutions. These research outputs have not been converted into tangible value because they lack commercial content or are weak in their industrial applications. Many attempts have been made by industry to devise a means to access those research outputs and assess their industrial applications, but they are not accessible to the industry. That has significantly affected the commercialisation of the research process.

Further results found a mismatch between the current curricula being taught at the universities and industrial needs in terms of skills expected from graduates. This mismatch has been attributed to the historical colonial context of the universities, despite the numerous educational

reforms introduced by the successive governments. Section 8 of the National Policy on Education states that university education should make an optimum contribution to national development by ensuring that technology-based professional courses in the universities deliver exposure to the relevant future working environment. It is believed that teachers and students in professional fields have relevant industrial and professional experience. According to the report produced by the United Nations Industrial Development Organisation (UNIDO) in 2017, there is currently an enormous skills gap and difficulties in filling vacancies in the Nigerian labour market. The report concludes that posts involving soft skills such as planning and organising, customer handling, or teamwork are hard-to-fill vacancies.

Additionally, a lack of strategic management, planning and organising skills, problem-solving and customer handling skills were reported to affect managers' occupations. Basic and advanced IT skills were more frequently described as lacking among applicants for professional positions, while technical skills were lacking among professionals, technicians, and plant operators. Figure 8.2 below depicts the skills gaps.

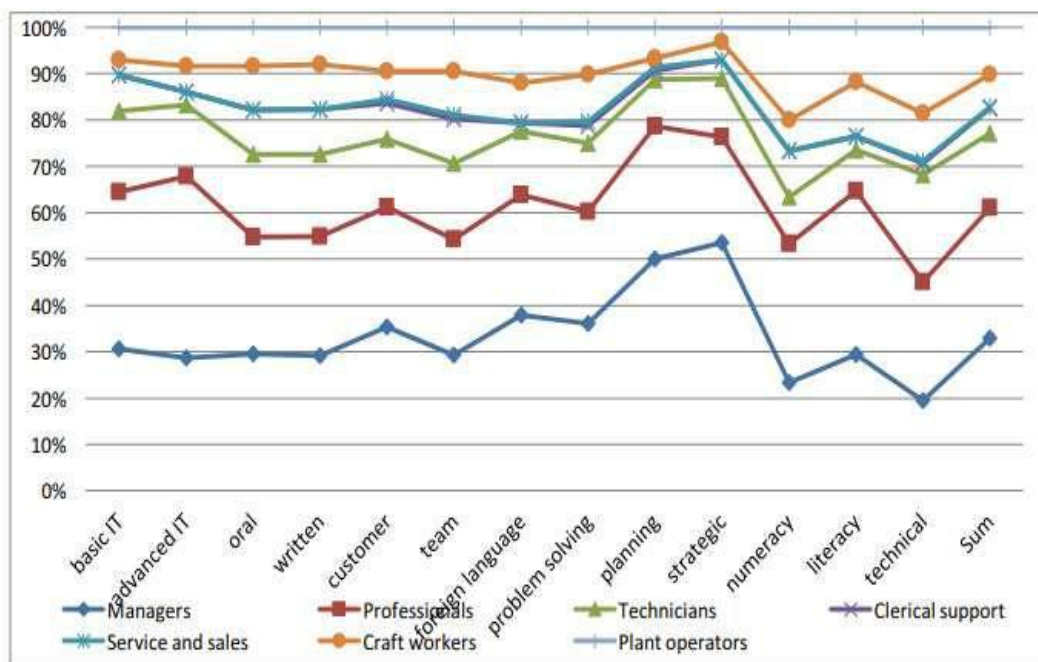


Figure 7. 2 Skills Gap; Source: UNIDO 2017

This explains some of the reasons Nigerian universities score very low in the Global University Rankings. According to the 2018 World University Rankings by Times Higher Education, only one university in Nigeria was considered eligible; the University of Ibadan ranked around 801 to 1000. Eight universities from South Africa featured the best performing-University of Cape Town graded 171st. Egypt had nine listed, Thailand 10, Turkey 22, and Brazil 32. Moreover, Mba and Ikwechukwu (2019) made a comparative analysis of the economic impact of Nigerian universities with South Africa, Brazil, Turkey, Egypt, and Thailand, based on total scholarly output for all subjects in each nation; the global patents that cite scholarly output; and the number of scholarly outputs from academic/corporate collaborations for all universities. The authors found that even



though Nigeria has the highest concentration of HEI and population compared to these countries, its performance is sub-standard. Nigeria produces 44% of the scholarly output of South Africa and 32 % of Egypt. With regards to the number of scholarly outputs undertaken with corporate /commercial organisations, Nigeria produces just 24% of Egypt’s total, and 10 % of South Africa’s, even though the nation’s economy is larger than these two countries – 60 % larger than Egypt’s and 7% larger than South Africa’s. These two countries also have fewer universities than Nigeria: Egypt has 43; South Africa 26

Table 7. 32 *Research Output; Source: Mba and Ikwechukwu 2019*

Country	Scholarly Output	Citations	Patent-Cited Scholarly Output	Academic-Corporate Collaboration	GDP
	Overall	Overall	Overall	Overall	(\$ billion)
Brazil	849,643	2,056,643	12493	12848	2055
Turkey	536,057	1,096,570	7307	4267	851
South Africa	244,576	788,990	3792	4108	349
Egypt	181,364	538,608	3169	1817	235
Thailand	159,204	416,453	3418	2382	455
Nigeria	80,390	142,656	504	437	375

Measuring the impact of Nigerian universities based on the number of research papers cited in global patents, Mba and Ikwechukwu (2019) found that Nigerian universities fare poorly. For instance, Nigerian research papers were cited at 16% and 13% compared to Egypt and South Africa, and just six per cent and four per cent of Turkey and Brazil. When taken collectively, Nigerian universities perform worst in all areas.

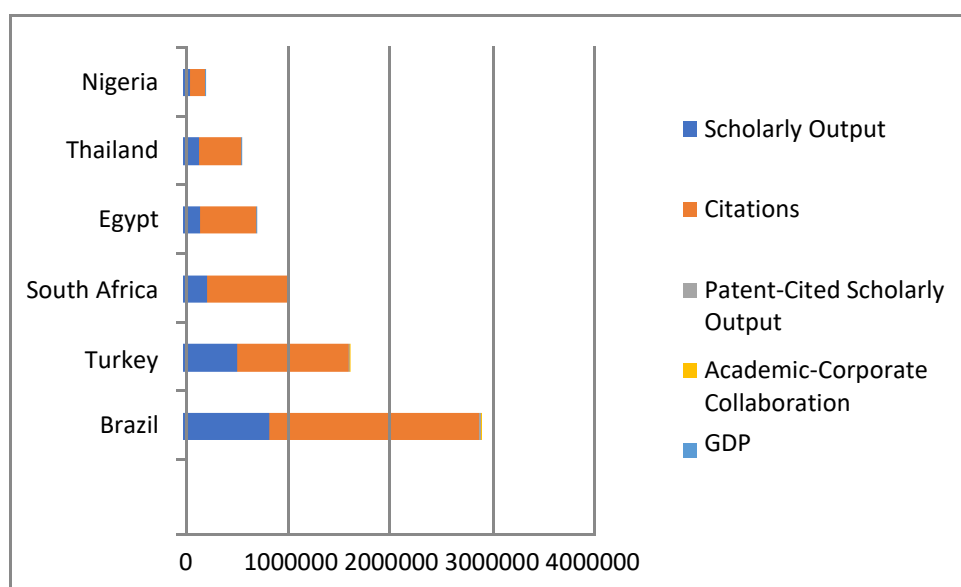


Figure 7. 3 *Research Output; Source: Mba and Ikwechukwu 2019*

The finding corroborates Adelabu and Akinwumi (2008), who found that research output from Nigerian universities is declining due to challenges such as funding, human and physical resources, and poor student's output. The finding also confirms Ahmed, Umar, and Paul (2015), who attributed the low-quality research in the Nigerian universities to a lack of infrastructural facilities, poor staffing, and inadequate funding. The results also contradict the major theories of innovation, which have distinct perspectives on the role and purpose of academia in the innovation ecosystem at the national and regional levels (Datta and Saad, 2011). NIS framework prescribes the role of higher education and training people and doing research that enhances the creation of new ideas in the economy (Edquist, 2005). NIC framework also emphasises the status of skilled labour in carrying out research and development and strongly advocates investment in education and training (Saad et al., 2015). However, the finding suggests that the low quality of research output in Nigeria is partly due to a lack of investment in education which negatively affect the production of skilled people capable of engaging in R&D. Triple Helix Model also emphasises the critical roles of universities by developing an entrepreneurial ethos and 'third mission,' i.e., its engagement with industry and the wider community which takes precedence over its traditional missions of teaching and research (Etzkowitz and Leydesdorff, 1995). Universities would thus be expected to be at the forefront of innovative activities, undertaking industry-oriented research and development and actively commercialising their research output (Etzkowitz and Leydesdorff, 1995; Etzkowitz and Leydesdorff, 2000).

#### **7.4.1.5 Corruption and Favouritism**

Corruption is perpetual in society and occurs in all cultures. It has many various forms and numerous consequences, both on the economy and the society at large. Among the most frequent sources of corruption are the political and economic environment, professional ethics, and morality and, of course. Corruption thus inhibits economic growth and affects business operations, employment, and investments (Shore, 2018). It affects the socio-economic development of many countries (Ojeka et al., 2019). Corruption arises from the illegal and dishonest behaviour of the state and appointed bureaucrats manifesting in the management of public funds through disingenuous activities aimed at manipulating the government about the cost and quality of public goods (Corrado and Rossetti, 2018). Corruption is not just in the government but in universities. According to Shore (2018), corruption is also endemic in higher education around the globe. Some aspects of corruption in education have been addressed in recent works by Noah and Eckstein (2001) Eckstein, (2003) Segal,(2004). The presence of corruption in higher education throughout the world is a growing concern for the industry as it influences its effectiveness and efficiency (Osipian, 2008). The negative impact of higher education corruption on economic development and social cohesion is also disturbing (Osipian, 2008). This research found that corruption in the public sector and the HEI constitute a

significant barrier to UIG collaboration in Nigeria. These corrupt propensities manifest in unethical practices in the procurement process of the government and universities. This unethical and dishonourable practice has been described as favouritism and who you know syndrome by the research participants. The practice refers to people in a higher position of authority conniving with companies with political connections or companies within the same industry to rig bids to get contracts from the university or government. Evidence from this research shows that in many contracts involving monetary transactions, decision-makers either from the university or government devices can distort the process for financial kickbacks. Favouritism becomes a tool for exploitation during the eligibility selection process or contracts tendering. The cumbersome nature of the eligibility criteria for contracts from the university or government makes it hard for companies that do not have a connection to be awarded contracts. No matter how competent and credible a company is, the corrupt process automatically eliminates those companies that do not have political connections. Further evidence attests those bureaucrats hide under a proxy company to gain self-awarded contracts that a third party executes on their behalf.

Some studies have confirmed how corruption affects innovation and collaboration. The results of the corrupt process correspond to the definition of the World Bank (2004). In its procurement guidelines, World Bank describes “corrupt practice” as “The offering, giving, receiving, or soliciting, directly or indirectly, of anything of value to influence the action of a public official in the procurement process or contract execution. This finding confirms existing knowledge in the aspect of barriers to UIG collaboration in the context of Nigeria (Allu and Ebohon, 2018). Nadeem et al. (2021) note that the innovation level depends heavily on its strong institutional settings, quality of education, and peaceful environment. Contrastingly, weak institutional capacity, corruption, inadequacy in education and terrorism can affect the pace of innovation. Pohlmann, Bitsch and Klinkhammer (2016), investigating corruption practices in SIEMENS Telecom company, noted that managers use corruption (e.g., bribes) in emerging markets BRIC (Brazil, Russia, India, China) to obtain contracts by inducing the management or procurement officers. Gebhardt (2017), in his studies of the Chinese coal mining industry, also found that politically induced corrupt behaviour blocks innovation. Corrupt activities and transactions have adverse effects on the public, businesses, public service, and entrepreneurship development. Diamond (1994) described the negative impact of corruption in the procurement process on young people as distorting their minds and encouraging them to engage in rent-seeking instead of engaging in a scientific and professional activity to solve societal problems. Tanzi and Davoodi (1998) state that the social and economic effect of corruption in the procurement process is costly, inefficient, and out of proportion promoting illegal means of self-enrichment for corrupt officials at the expense of legitimate work. Other studies have also confirmed that corruption puts pressure on human capital empowerment, affects the capacities

of companies to grow and perform better, - hinders employment opportunities, and affects social infrastructure and foreign direct investment (Corrado and Rossetti, 2018).

#### **7.4.1.6 Brain Drain.**

Brain drains, otherwise known as the flight of human capital, is a phenomenon that has been of concern to academics and development practitioners for decades (Sako, 2002). The emigration of skilled human resources for education, trade, and other opportunities for a better standard of living, good salaries and access to advanced technology has attracted growing concern with the impact on health systems in the originating country (Sako, 2002; Mocetti and Porello, 2010). The evidence from this research shows that brain drain has a significant impact on the science system in Nigeria, where many qualified researchers from universities and industries leave the country searching for better opportunities abroad. The results revealed that the phenomenon of human capital flight creates a skill gap and contribute to the decline in the human capital base in Nigeria. The university respondents noted that on many occasions, the university had lost some of the smartest and reputable researchers due to frustration, lack of incentive and low remuneration. The exit of university researchers has been described as a severe blow to the research community and has created a long-term gap to fill. Results from the industry are consistent with university results revealing that the harsh business environment in the country is responsible for the exit of many entrepreneurs in Nigeria who are desperate to explore other countries and seek opportunities for success.

This result is in sharp contrast to the theoretical proposition of National Innovation Capacity (NIC), which is the synthesis of three theories; - New Growth Theory (Romer, 1990), National Innovation System (Freeman, 1995; Lundvall, 1992b; Nelson and Rosenberg, 1993) and cluster-based theory (Porter, 1998). NIC strongly emphasises that the innovative capacity depends mainly on the stock of its human capital, financial resources and R&D capacity, technological sophistication and IPR protection. Existing knowledge shows that the availability of skilled human resources can facilitate the production of a substantial amount of technical knowledge and thus enhance innovation performance (Saad, Guermat and Brodie, 2015). When skilled people look for better opportunities abroad and leave the country, and especially when many skilled people are not employable due to the mismatch between university curricula and the industrial need, there is a serious gap that will affect UIG collaboration (Saad, Guermat and Brodie, 2015; Okoye, 2016; Mocetti and Porello, 2010). Dzisah and Etzkowitz (2008) have confirmed the effect of brain drain on the human capital stock citing the Indian Institute of Technology (IIT) examples during the post-colonial era to provide technical training with the help of sponsors from home and abroad. Many scientists who went to India to train undergraduate students later gathered in IIT and formed into a diaspora of intellectual capital that could be drawn upon as a development resource by countries of origin, either attracting some people back or using the networks of those who remained to support the advancement of the science-based industry. Similar to the findings of

this research on the effect of brain drain, Datta and Saad (2011) note that due to the need for industrialisation and self-sufficiency in the 1960s, the Indian government needed some homegrown skilled engineers and scientists.

The government invested in the higher education sector by setting up some prominent institutions like the IIT. The investment in the HEI created some intended and unintended consequences. The intended consequences were the production of many skilled engineers. However, the unintended consequences were that a significant number of the skilled human capital emigrated from 1970 to 1990 to developed countries such as the UK and the US, generating potential brain drain partly responsible for creating a skill shortage and negatively affecting the economy in India. However, Datta and Saad (2011) conclude that the brain drain concerns among Indians were later transformed positively into brain circulation by maintaining social ties and establishing new business opportunities between the new countries that the skilled workers emigrated to and India. However, this research could not confirm this brain circulation phenomenon in the Nigerian context because of a lack of evidence. One of the significant concerns regarding the emigration of the highly educated labour force from developing to developed countries is the potential loss of the investment directly associated with training (Capuano and Marfouk, 2013). In this regard, countries need their skilled workforce to stay so that their professional expertise can benefit the population. Their emigration strongly affects the innovation system and weakens institutional collaboration, knowledge production, dissemination, and utilisation. The result sharply contrasts with the theories of innovation such as NIS, NIC and Triple Helix that unanimously emphasise the accumulation of human capital and skills in promoting national and regional innovation. This finding could contribute to the extension of the literature specifically on the barriers to UIG cooperation and will be recommended as a further area of research.

#### **7.4.1.7 Lack of National IP Policy and Enforcement**

One of the national factors identified in the conceptual framework as an inhibitor to UIG interaction is the lack of national IP policy and weak or lack of enforcement of the IP policy. The Convention Establishing the World Intellectual Property Organization (WIPO), concluded in Stockholm on July 14, 1967 (Article 2 (viii)) provides that intellectual property shall include rights relating to - literary, artistic and scientific works - performances of performing artists, phonograms and broadcasts, - inventions in all fields of human endeavour, - scientific discoveries, - industrial designs, - trademarks, service marks and commercial names and designations, - protection against unfair competition, and all other rights resulting from intellectual activity in the industrial, scientific, literary or artistic fields (WIPO 2004). The intellectual property (IP) owned by a university, or a country shows their intellectual and innovative capabilities to compete in the global environment. However, many universities and countries are behind in contributing to the outcome of IP (Jamil, Ismail and Mahmood, 2016). UIG collaboration can be improved by adopting favourable policies beneficial for both parties

(Plewa *et al.*, 2013). Universities leverage the strong IPR to generate revenue, and industries gain the knowledge, innovative ideas, skills, and technologies used by digging into the links with universities (Tijssen, 2012). This research shows that UIG collaboration is inhibited primarily due to Nigeria's lack of national IP policy. The existing laws governing the IPR regimes are obsolete and are not in tandem with the current global trend. According to Titilope (2020), the protection of IPRs strongly depends on extant laws that are reviewed regularly to address emerging and current issues in the operating environment. Research participants from all stakeholder groups agreed that the lack of IP protection is largely due to the lack of national IP policy that should drive all institutions to benefit from their intellectual work. They also noted that even when there are potential projects mostly relating to software production between universities and industries, the projects get abandoned, or stakeholders show a lack of commitment due to the fear of IP issues. The results show that besides the lack of national policy driving the utilisation of inventions and innovations, there is also a huge problem with the enforcement of IPR in Nigeria. The results show that the problems with enforcing the IPR in Nigeria include corruption by the regulatory officials, inadequate sanction for offenders, lack of skilled personnel, lack of awareness of intellectual property right by the populace, and outdated intellectual property laws. This finding is consistent with Nwabachili, Nwabachili and Agu, (2015), who found that in West Africa, people have resorted to infringing other people's works to reap where they did not sow, thereby depriving the owners of such work of their labour, time and expense. Titilope (2020) notes that the intellectual property rights of creators and investors in Nigeria are not adequately protected due to illegal activities such as piracy, counterfeiting and imitation. For instance, he reports that the Nigerian Copyright Commission reported that a loss of more than US\$82M per annum. The Nigerian film industry loses an approximate amount to the tune of N4.2M yearly due to illegal digital duplication, online piracy, and unlawful rental of video works within the country. The lack of National IP policy and weak enforcement has affected how universities, industries, and other research organisations accelerate the transformation of inventions into industrial processes and products and strengthen collaborative ties between universities and industry. This research is not consistent with the theories of innovation that stresses the critical role of the government in strengthening the UIG interaction through different policy instruments. Triple Helix Model, NIC and NIS are unanimous and strongly emphasise that the government creates the appropriate S&T policies, creates an innovation infrastructure, design appropriate 'rules of the game', and facilitates learning between academia and industry (de Almeida Borges *et al.*, 2020). However, the finding shows the government has not adequately played its role in ensuring that IPR policies are created, implemented, and enforced. According to the NIC framework, the ability of a country to produce commercially relevant innovations largely depends on the availability of human capital and financial resources available for R&D activity, level of technology sophistication, and intellectual property protection (Datta, Saad and

Sarpong, 2019). The findings are also incongruent with the NIC framework. The Nigerian government has contributed to inhibiting UIG interaction by paying less attention to key issues such as IPR policy enactment and enforcement. This finding could also contribute to knowledge in providing a proper understanding of the lack of IP enforcement as a barrier to the UIG collaboration.

#### **7.4.1.8 Poor Work Ethics in Private and Public Organisations**

As identified in the conceptual framework, another unique national factor inhibiting the UIG interaction in Nigeria is the poor work ethics of employees in both the private and public sectors. The concept of work ethic dates to the early 20th-century scholar, Max Weber (Weber, 1904-1905), who has been frequently credited with contributing to the success of capitalism in western society with what became known as the Protestant Work Ethic (PWE) (Van Ness *et al.*, 2010). Weber underscored the importance of work dedication and wondered why some people place a greater significance on work and seem more diligent than others. Malcomson *et al.* (2006) described work ethic as a value system stressing the moral values of work, self-discipline, and individual responsibility to accomplish economic well-being justifying through divine providence actions that emphasise achievement, rapid growth, and acquisition of capital, and the importance of self-reliance. The research participants mentioned that one factor contributing to the frequent friction between UIG stakeholders is poor work ethics. The poor work ethics frequently manifest the way stakeholders treat each other with disrespect, lack of dedication to work, aggression toward each other, and lack of organisational commitment by staff. The research participants described these attitudes as prevalent and repellent to any collaboration and joint knowledge creation. The Director of Research and Commercialisation at NOTAP noted that his trend of mutual disrespect and aggression toward each other had been the culture of many Nigerians in private and public sectors. They bring this terrible attitude to their organisations and discredit organisational reputation and image capable of affecting any potential collaboration. This attitude affects not only a collaborative effort between UIG but also inter-governmental collaboration. According to Omisore and Adeleke (2015), poor work ethics, bad attitudes, and values can be influenced by the organisation through interventions like training, motivation, coaching, etc. Adeyinka (2014) identified certain categories of unethical practices, especially in public service, such as passing around unregistered or counterfeit software, hawking wares and bodies that are predominant among female workers. Organisations are expected to adhere to their professionals' behaviours and exhibit high professionalism by adhering to their professional ethics when discharging their duties.

#### **7.4.2 Social Factors**

##### **7.4.2.1 Stakeholder Preference for Foreign Goods and services**

Despite the government interest to be self-sufficient, the importation of goods and services has continued to dominate many economies in developing countries, including Nigeria (Udegbe, 2017). The importation of goods and services from foreign countries harms indigenous industrial capacities (Udegbe, 2017). The present study found that one of the biggest challenges that hinder UIG collaboration in Nigeria is the public demand or preference for imported goods and services, even though some of these can be produced locally. Demand for foreign goods and services, including technology-based services, contributes to the barriers of UIG collaboration, as shown in this research. The results revealed that government and university officials do not have much confidence in the capacity of domestic firms. They prefer to engage with foreign companies even when it is evident that domestic firms could compete with foreign companies on executing the same task. This wrong perception about the incapacity of indigenous firms became widespread not just within universities or government but with the public in Nigeria. The justification from Nigerians has always been that Nigerian companies do not produce high-quality goods or services.

On the other hand, the industry results show disbelief and mistrust in the research capabilities of domestic universities. Industry prefers to collaborate or engage with foreign firms for R&D and technology development, or their peers involved in the same type of business. Furthermore, the results also show that government leaders in various decision-making positions tend to contract foreign companies at the expense of domestic companies. This propensity of government employees to engage the services of foreign companies even when the same expertise exists in Nigeria has caused concern in the government. Successive governments have introduced various policies and Executive Orders to address this issue and promote indigenous capacities. For instance, the Public Procurement Act of 2007 states that all Ministries, Department and Agencies of government should promote local firms in awarding contracts to provide goods and services. The National Information Technology Development Agency (NITDA) in 2013 released guidelines on Nigerian content development in information and communication technology. According to the guidelines, ICT companies in Nigeria keep 50% of local content either directly or by outsourcing to local businesses to encourage Nigerian representation and participation.

Moreover, the Nigerian government recently signed an Executive Order (5) to encourage all government institutions to be biased towards domestic companies in awarding contracts in the procurement of science, technology, and engineering materials. This challenge has created distrust among the stakeholders in terms of the capacity to deliver on contractual responsibilities. This challenge has been identified as a barrier to UIG collaboration within the Nigerian context. This factor is very significant to many developing countries, especially those in Sub-Saharan Africa who depend on developed countries for their technological consumables. The existing literature does not capture this theme as a significant barrier to the UIG collaboration. Therefore, this result contributes to the extension of the literature by identifying stakeholder preference as a barrier to UIG interaction in Nigeria. This finding could also be recommended for further research.



#### **7.4.2.2 Lack of Effective Communication and Attitude of the Stakeholders**

Despite the enormous benefits of interaction between University-Industry-Government, the literature has identified a lack of effective communication as a potential barrier to collaboration (Hong, Heikkinen and Blomqvist, 2010; Englund and Felice, 2010; D'Este and Patel, 2007). This research shows that many government bureaucrats and faculty members are difficult to communicate with despite the various communication platforms facilitated by social media. Difficulties communicating with the university was attributed to academic arrogance, rude attitudes, and superiority complex. Many participants expressed frustration and anger with the lack of a dedicated desk for receiving emails or responding to telephone calls in the many public institutions, including universities, in Nigeria. The challenge has made communication very difficult. The results further suggest that despite the telephone lines, emails, and other means of communication featured in the various website of the universities and government institutions, establishing contact is difficult. This result confirms existing knowledge Rybnicek and Königsgruber (2019) identifies the communication gap as a significant setback in the UIG collaboration. Chin et al. (2011) note that UIG collaboration may not lead to effective knowledge transfer without effective communication between partners. Kopczynska and Ferreira (2017) note that communication is a precondition of partnership and critical success factors.

#### **7.5 The Evaluated Conceptual Framework**

The conceptual framework, depicted in Chapter 3, was developed based on a critical and analytical literature review. It provided the researcher with the blueprint of an overall assessment of the UIG collaboration using innovation theories. The primary objective of this research was to develop and evaluate a revised conceptual framework, following an in-depth analysis of the fieldwork data. Having presented the findings and cross-case analysis and discussed the assessment of the interaction based on the conceptual framework, this section presents the evaluated conceptual framework. It highlights the differences between Figure 7.4 and 7.5



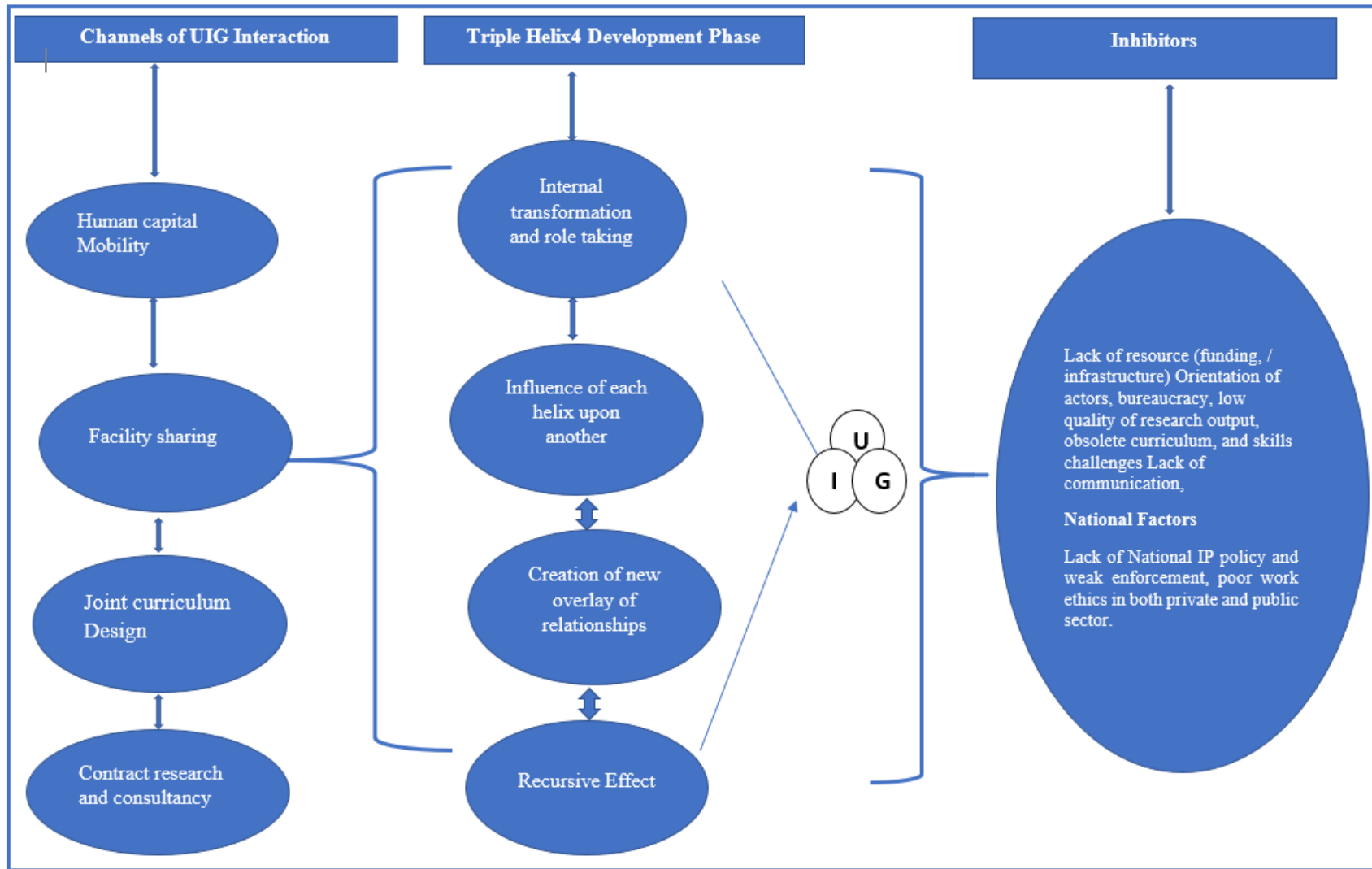


Figure 7. 4 Conceptual Framework

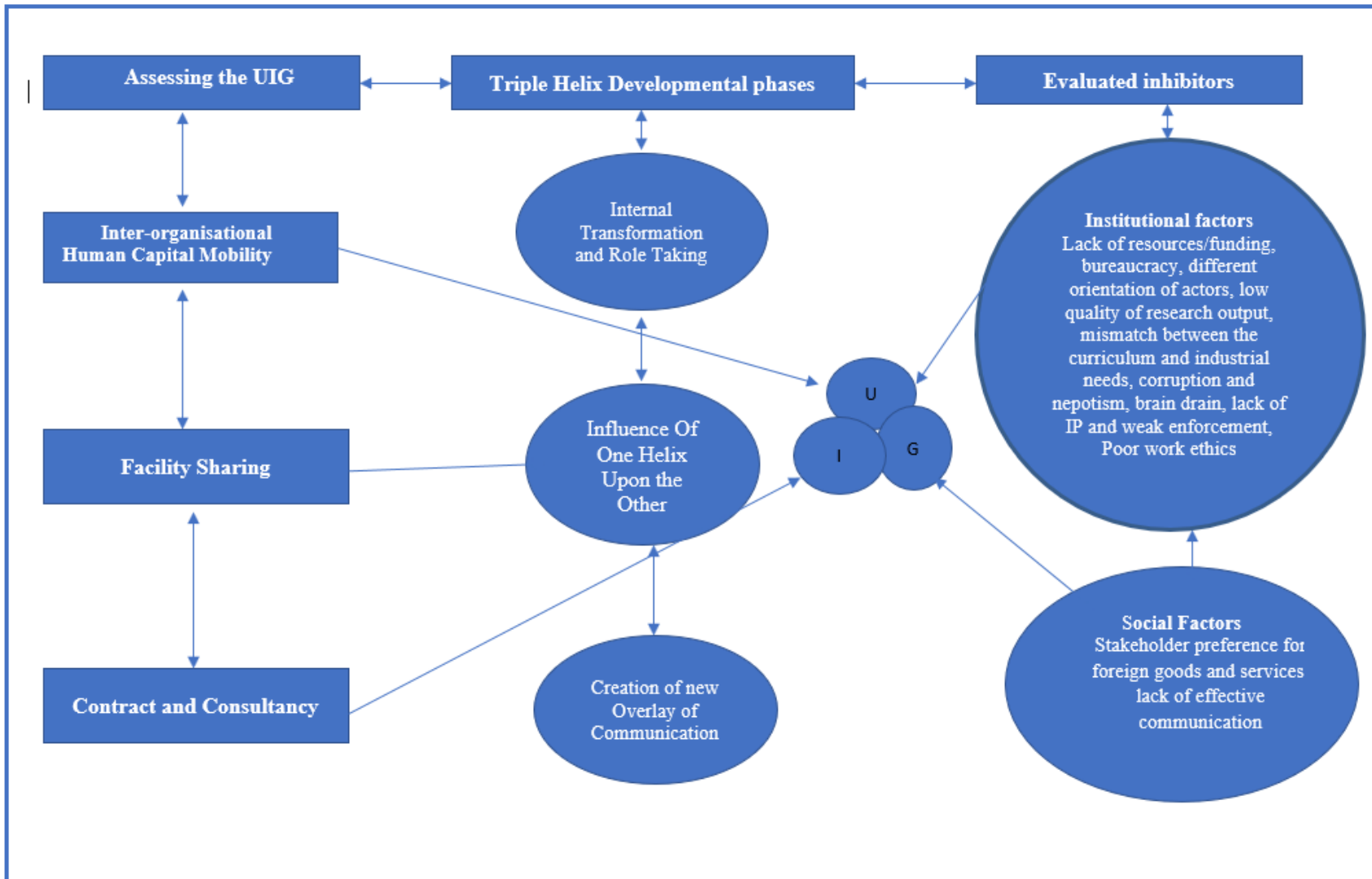


Figure 7. 5: Evaluated Conceptual Framework

### **7.5.1 Inter-organisational Human Capital Mobility**

Figure 7.4 depicts the four channels of UIG assessment, four developmental phases and the general inhibitors of the collaboration. Figure 7.5 indicates the post-analysis evaluated conceptual framework showing the channels found to be active developmental stages congruent with the theory. The evaluated conceptual framework shows that inter-organisational human capital mobility is one of the strongest and active channels of UIG interaction between the three institutional spheres. This channel of knowledge flow occurs through transfer of service based on sabbatical, temporary or permanent routes. The result also shows that faculty members who transferred their services to the government maintain their ties with the university and serve as one of the most robust bridges facilitating the smooth relationship between the university and government partnerships. The empirical findings confirm that human capital mobility from University-Industry occurs through Student Industrial Work Experience (SIWES). The results are consistent with the theories of innovation. NSI, NIC and THM strongly stress the importance of skilled human capital in developing technological innovation. Triple Helix Model regards this circulation among the three institutional spheres as instruments that spread new ideas and skills (Dzisah and Etzkowitz, 200). Etzkowitz (2008, pg. 2) described it as *the ‘blood through the arteries that dynamise various levels of the circulatory systems’*. National Innovation Capacity (Furman, Porter and Stern, 2002), and National Innovation Systems Lundvall (1992), Nelson (1993) Edquist (1997) frameworks also prominently consider the accumulation of human capital relevant in raising R&D in producing technological innovation (Furman, Porter and Stern, 2002; Datta, Saad and Sarpong, 2019). The collaborative knowledge creation after staff circulation confirms the Mode 2 knowledge production where new knowledge is created in an inter-disciplinarity, economically and socially relevant research theme (Shinn, 2002: 603).

### **7.5.2 Research/Equipment Facility Sharing**

The evaluated conceptual framework Figure 7.5 indicates the sharing of facilities between the institutional spheres facilitated by the government through the National Board for Technology Incubation (NBTI). The findings indicate that this channel brings actors together to collaborate and collectively share resources and physical facilities such as laboratories, computers, and other vital research facilities. This collaboration has facilitated knowledge transfer and utilisation. Sharing research facilities enables knowledge flow and innovation (D’Este and Patel, 2007; Guimón, 2013).

### **7.5.3 Contract and consultancy**

As depicted in Figure 7.4, the conceptual framework described contract and consultancy as a significant channel of UIG interactions. The empirical findings have confirmed active contract and consultancy engagement between the actors, facilitated by personal relationships and informal activities. These personal relationships lead to establishing social capital, which is critical for innovation (Datta and Saad, 2011b). This finding is consistent with the NSI and Triple Helix theory. Formal and informal interactions contribute to knowledge assimilation and the free flow of information among the UIG stakeholders (Datta and Saad, 2011b).

### **7.5.4 Four Developmental phases**

The conceptual framework Figure 7.4 identified the four developmental stages of Triple Helix development and examined the congruencies and incongruencies of the developmental aspects in practice (Etzkowitz, 2003). The evaluated conceptual framework, Figure 7.5, confirmed three domains of emerging Triple Helix development. The propositions on the three developmental stages were found to be congruent with the organisational practices within the UIG; nevertheless, considerable challenges and incongruencies were also identified. The last developmental stage: The recursive effect of the networks on the spiral was not reflected in the evaluated conceptual framework due to the lack of empirical evidence.

As indicated in section 7.21, the results identified some major internal transformations in the universities regarding the first developmental stage. These are reflected in administrative structures, teaching and research functions. The first structural transformation in the university includes cancellation of the initial Vice-Chancellors privilege of choosing 10% of student intake each year, broadening or reconstituting the University Governing Council and exemption of university staff from public service salaries. The second transformation involves the growth in the number of universities, including private and state universities in the country, creating broader access to education (Etzkowitz, 2003; Moeliodihardjo *et al.*, 2012). Additionally, teaching and research functions have also been transformed by establishing various Centres for Entrepreneurship and Innovations in the universities and introducing the curriculum on entrepreneurship. This finding is consistent with the internal transformation of the university as professed by the Triple Helix theory (Etzkowitz, 2003; Saad and Zawdie, 2011). However, the finding identified discrepancies with the change in perception of university faculty members who think that changing university orientation will lead the university into an identity crisis. This finding is incongruent with the theory.

Regarding taking others' roles while maintaining institutional identity, the university is expected to take on industry roles by creating spin-offs and commercialising research outputs. This effort appeared to be weak due to the inability of the universities to develop a spin-off, lack of university-

based incubation centres and other necessary facilities. Despite the internal transformations, universities need to make further efforts to catch up with universities in developed countries. Accomplishing the right configuration between the missions of teaching, research, and economic development is crucial in building an entrepreneurial university (Etzkowitz *et al.*, 2000). Nevertheless, not all countries have the same culture, institutional configuration, and education system to support this realignment. Since there is a difference between the educational systems of developed and developing countries, the ability of a university to engage effectively in entrepreneurial activities is constrained by its context and resource-based capability and capabilities (Datta and Souleh, 2018).

Regarding the internal transformation of industry, the theory presupposes that industry takes on the role of universities by providing training for individuals and corporate organisations and acting as the university simultaneously; it maintains its identity (Etzkowitz, 2008). The empirical finding also confirms an internal transformation within the industry through the technology innovation hubs that emerged recently in the country. The successes and transformation of the industry follow a regional pattern. The South-Western region has more firms with successful spin-out, greater availability of investment opportunities, and a larger concentration of firms than other regions of the federation. The firms located in the South have exhibited the capacity to take the role of the university by training individuals and corporate bodies through incubation courses run in companies like Co-Creation hubs.

On the other hand, the transformation in tech-based business in the Northern part of the country is not visible due to lingering security challenges, lack of infrastructure, and investment opportunities. The general improvement in the technology-based industry is considered congruent with the theory. Regarding the government transformation, the empirical finding is congruent with the theory. The government has made several efforts to improve the innovation ecosystem aimed at helping both the universities and industries. One of the efforts at strengthening the ecosystem was the STI policy reforms, the National Council on Research and Innovation, and the National Council on Competitiveness in Nigeria. Moreover, efforts relating to R&D in the HEI include the establishment of more universities for increased access to education, the establishment of TETFUND for funding research, the establishment of various centres of incubation in the six regions of the federation and the establishment of Technology Transfer Offices in the various universities and research centres.

Regarding the second developmental phase, the influence of one helix upon the other (interdependency) is constructed in the conceptual framework to mean the introduction of policy by the government leading to change in universities and industry. The evaluated conceptual framework shows government policies that have led to change in the universities and industry. For instance, regarding the universities, government influences featured in the

establishment of IPTTOs, improving the culture of patenting in universities and creating curricula on entrepreneurship in the HEIs to stimulate entrepreneurship and commercialisation of knowledge. Regarding the influence of government in the industry, the evaluated conceptual framework shows the creation of SMEDAN, CBN's policy on ease of collaterals and various incentive tools, which has improved the capacity of the industry to engage with the universities. Creation of Technology Innovation Support Scheme offers capacity building for start-ups and ensures entrepreneurs and jobs within the ecosystem. Establishment of office for ICT Innovation and Entrepreneurship (OIIE) dedicated to addressing the challenges of constraining entrepreneurs' development. Moreover, the government has also established incentive openings such as You Win, Youth Entrepreneurship Scheme (YES), and others through the Bank of Industry.

Finally, regarding the third developmental phase, the conceptual framework professes various communication channels established within the institutional spheres facilitated by innovation networks. These networks comprise bodies, organisations or NGOs who have a significant stake in the innovation system. Various organisations have recognised the essence of the innovation network. They are playing a vital role in stimulating this UIG interaction and technology development in the country. These organisations are doing so by training young people in the technology field, raising human capital stock, supporting entrepreneurs through capital and start-up assistance, or implementing policy intervention to improve the business environment. These organisations serve as innovation system intermediaries contributing to the regional economic development through various activities such as cluster development initiatives. The conceptual framework also professes that universities in this configuration play the leading role through regional innovation clusters and science parks (Etzkowitz, 2003; Saad and Zawdie, 2011). The theory posits a vital role for universities in the emergence of knowledge-based clusters. However, the findings show limited evidence of the universities' contributions to regional clusters or Science Parks development. This finding is incongruent with the theory, which places the leading responsibilities for innovation and economic growth with universities.

As described in chapter one, the essence of conducting this study is to better understand the effectiveness of the UIG in Nigeria through a conceptual framework using the existing theoretical lenses of NIS, NIC THM. It is clear from the results of this study that despite many congruencies of the findings with the theories of innovation, in practice, considerable factors (identified as inhibitors in section 7.3). For instance, Triple Helix describes the Hybrid model of the UIG collaboration in which University-Industry-Government take each other's role, having an intersection and overlapping relationship. However, the results show that the interaction is dominated and driven by the government, favouring a Statist Model of Triple Helix, where the government directs and leads the other institutional spheres (Saad, Datta and Razak, 2017). This



result conflicts with the theoretical proposition that universities lead in the Hybrid Triple Helix interaction (Etzkowitz and Leydesdorff, 1995; Etzkowitz and Leydesdorff, 2000). These results are against the propositions of Etzkowitz and Dzisha (2007) and Saad and Zawdie (2008), who argue that the Triple Helix collaboration is a prelude that leads to socio-economic development as knowledge-based and not resource-based; endogenous and not exogenous; university-led rather than state-led; and based on Triple Helix interaction rather than on single or double institutional effort. This finding also contradicts the NSI that stipulates that innovation largely depends on the quality of the national education system, industrial relations, funding sub-system and quality of technical and scientific organisations, government policies and industrial relations (Datta, Saad and Sarpong, 2019). This research identified the weak higher education that has continued to provide obsolete theoretical knowledge conforming to the colonial system of the 1980s and unstable and insufficient funding sub-system. Additionally, the NIC framework is seen as a country's potential to produce commercially relevant innovations, and this, in turn, is dependent on a variety of factors, including human capital and financial resources available for R&D activity, level of technology sophistication, intellectual property protection and related and supporting industries (Datta, Saad and Sarpong, 2019). However, the findings show a lack of national IP policy and weak enforcement of IPR for inventors and innovators. As mentioned before, financial support for R&D is grossly inadequate to support any meaningful research. Therefore, this thesis contends that the existing theories of innovation, i.e., NIS, THM, NIC being developed in industrialised countries, have some limitations in describing the institutional linkages in Nigeria.

## **7.6 Chapter Summary**

The study assessed UIG collaboration based on the four channels of interaction, four developmental stages of the Triple Helix, and the general factors inhibiting UIG collaboration. The assessment indicates three active and one weak channel of collaboration. The three active channels include inter-organisational human capital mobility, facility sharing and contract and consultancy. The three channels were presented in the espoused conceptual framework Figure 7.4 and confirmed by the evaluated framework Figure 7.5, indicating that UIG collaborates and share knowledge and information. However, there was limited evidence for joint curriculum, and this factor was not reflected in the evaluated conceptual framework. The chapter also presented a discussion on the four developmental stages of the Triple Helix network. The espoused conceptual framework, Figure 8.5, showed the four developmental stages of the Triple Helix network. The results have confirmed three developmental stages to be congruent with the organisational practices in the UIG. They have been confirmed and by the evaluated conceptual framework depicted in Figure 8.6. The developmental stages include internal transformation and role-taking, the influence of each helix

upon the other, and the creation of a new overlay of communication among the helixes. Nevertheless, the fourth developmental stage did not appear in the evaluated framework, Figure 8.6, due to limited evidence.

Moreover, the espoused conceptual framework, Figure 7.4, has revealed numerous inhibitors affecting smooth collaboration between University-Industry-Government. The evaluated conceptual framework Figure 7.5 has empirically confirmed the barriers to UIG collaboration: lack of resources/funding, bureaucracy, different orientations of the actors, low-quality research output, mismatch of the curriculum between university and industry, and corruption and nepotism. The institutional factor that emanated from the empirical findings to be added to the evaluated conceptual framework is brain drain, lack of IP policy, weak enforcement, and poor work ethics. This important observation regarding institutional barriers could contribute to knowledge and extend the understanding and application of the theory and practice within the developing countries perspective, especially Nigeria. The inhibitors reflected in the espoused conceptual framework under social factors identified and confirmed by the empirical evidence include lack of communication and attitude of the stakeholders. The researcher's contribution to the extension of the literature is the stakeholder preference for imported goods and services. This factor may contribute to the extension of the literature on the inhibitors of the UIG collaboration from the Nigerian perspective and help unpack the mystery behind the constant demand for imported goods and services at the expense of domestic products and may help inform more robust policy formulation.

## 8 CHAPTER-EIGHT

### 8.1 CONCLUSIONS AND FUTURE RESEARCH

The previous chapter discussed the findings on University-Industry-Government (UIG) interaction based on the four channels of interactions, development processes, espoused theory, and conceptual framework, and finally, UIG cooperation inhibitors. This final chapter presents conclusions from the research, evaluates how the research objectives have been met, the contribution to knowledge, the implications of the research for stakeholders and areas for future research. The limitations of the study are also discussed with concluding remarks.

### 8.2 Summary of Key Findings and Objectives

**Objective 1** To examine the critical national factors inhibiting the effectiveness of UIG interaction in Nigeria. This critical examination of the literature shows that Nigeria suffers from a lack of national IP policy and weak enforcement of IP laws. Attempts have been made over the years to introduce IP policy in Nigeria but to no avail. Some of the legal instrument governing the IP rights in Nigeria includes Copy Right Act (as amended) Cap.C28 Laws of the Federation, Patent and Designs Act Cap.12 Laws of the Federation of Nigeria 2004. Trademark Act, Cap.T13 Laws of the Federation of Nigeria. Nigeria has ratified some specific international regimes and treaties, such as the Convention for the Protection of Industrial Property (Ratified in 1963), the Berne Convention 1986, The Rome Convention (performers, Producers and Phonograms and Broadcasting Organisations ratified in 1993, etc. But these laws and policies have been considered obsolete.

In addition, protecting and enforcing IP rights is challenging in Nigeria due to inadequate penalties for infringements and a total lack of coordination among the various government agencies responsible for protecting IP rights. A wide range of policy documents from the National Office for Technology Acquisition and Promotion (NOTAP) and World Intellectual Property Organisations (WIPO) have been reviewed to achieve this objective.

**Objective 2** To critically examine the UIG literature in order to identify and discuss the key channels of interaction, enablers, and inhibitors of the collaborations.

This objective was met through a review of extant literature, providing a clearer understanding of the UIG interactions, innovation theories, various channels of interactions, enablers, and inhibitors of the collaboration.

**Objective 3** To develop a conceptual framework from a critical and analytical review of the literature. This objective was met by developing an espoused conceptual framework based on the extant literature and national factors. The conceptual framework guided the data collection, management and analysis based on four crucial channels of UIG interaction (Ankrah and Omar,

2015), four developmental stages of Triple Helix development (Etzkowitz, 2003) and factors that inhibit the collaboration (Bruneel, d'Este and Salter, 2010; Razak and White, 2015). Identifying the four channels of interaction has helped in recognising strong and weaker channels of interaction. The stronger channels of interaction are inter-organisational human capital mobility, facility sharing and contract and consultancy. Joint curricula designs appeared to be the weakest link between the three institutional spheres.

Inter-organisational human capital mobility appears to be one of the stronger channels of knowledge flow within the UIG network. The circulation of people within the UIG network occurs through the transfer of services by stakeholders employed on sabbatical, permanent, or temporary contracts. The university staff who transfer their services to the government maintain their paid or unpaid roles depending on the nature of their transfer. The university personnel who transfer their services to the government serve as bridges linking the universities and government. Workers from industry also seek employment from the government, transferring tacit and explicit knowledge and enhancing knowledge flow between universities and government. Additionally, there is also a channel of human capital mobility from universities to the industry through the Student Industrial Work Scheme SIWES, which is affected by many administrative and operational challenges. However, there is no evidence of government or university employee transferring their services to the industry due to the unstable and risky nature of the industry.

The second channel, facility sharing among the three institutional spheres, shows strong interaction facilitated by the government through NBTI and its Technology Incubation Centres in six geo-political zones of the country. However, results on joint curriculum design show weak collaboration due to a lack of effective communication and consultation between stakeholders. This has contributed to the skills gap and mismatch between university graduates and industrial needs, which is one of the significant challenges inhibiting collaboration. Finally, results on contract and consultancy show strong collaboration built on informal relations facilitated by social contacts, conferences, workshops, and other means of social relations. The actors use personal links in networking and consulting for each other. These relationships provide an opportunity for participants to socialise and transfer tacit knowledge that will help build their organisational capacities and innovation.

Similarly, the four developmental stages show some congruencies and incongruencies between the espoused conceptual framework and the developmental stages. In the first developmental stage, internal transformation and role-taking, congruencies and incongruencies were identified from each institutional sphere. The evidence from the universities shows internal transformations in structural and administrative roles. The transformations are government-driven, and university initiated and implemented. These transformations include reforms in the administrative structure of universities that introduced greater autonomy for the universities, a review of the Vice Chancellor's privilege

of selecting 10% of admissions intake and restructuring the salary scale for university staff. Other transformations include increasing the number of higher education institutions and introducing private and state universities, which helps create wider public access to education. The transformation in teaching and research functions includes introducing various Centres for Entrepreneurship and Innovations in the universities. This gradual transformation confirms existing knowledge and is congruent with the theory.

However, the perception and attitudes of the university's staff and faculty members are still focused on teaching and research without much regard to engaging in spin-off activities, making it difficult for universities to take on industry roles. This result is incongruent with the theory that posits a key role for universities to lead in knowledge-based economic development. The industry also exhibited some level of transformation through the private innovation hubs, but this transformation reveals regional variations. The innovation hubs located in the Southern region have shown more transformative tendencies enabled by the availability of investment opportunities, infrastructure, a larger concentration of firms, and the relative peace enjoyed in the area. On the other hand, firms located in the Northern part of the country have limited investment opportunities, and they are faced with an infrastructure deficit and security problems.

Additionally, government transformation has allowed the government to promote this interaction through various policy interventions. Such interventions include recognising "innovation" in the 2011 STI policy, which was missing previously, establishing the National Council on National Science Research, and establishing the Tertiary Education Trust Fund (TETFUND) as an intervention body for funding research. The government also established the National Council on Competitiveness to monitor the innovation ecosystem and ease the business environment. These initiatives were all meant to stimulate innovation and promote a cordial relationship between the institutional spheres. The government also established various investment promotion platforms through the CBN and BOI to encourage investment in the companies and inspire easy access to funds. On the second developmental stage, the influence of one helix upon another (interdependency), findings show some progress in both universities and government policies concerning knowledge transfer and commercialisation activities. The influence of government on universities was enabled by introducing platforms such as IPTTOs and introducing curriculum on entrepreneurship, aimed at encouraging universities to engage in entrepreneurship and commercialisation of innovations. On the influence of government on the industry, the results reveal various efforts of the government to promote the innovative capacities of companies to produce goods and services and stimulate their ability to engage in research and collaboration. The targeted initiative includes establishing SMEDAN, creating OIIE, and other incentive packages to ease access to funding without the need for unrealistic

collateral. Other incentives include funding opportunities such as You Win, Youth Entrepreneurship Scheme (YES) and several others through the Bank of Industry.

Regarding the third developmental stage, creating a new overlay of communication, the theory acknowledges how the institutional spheres create external links or platforms serving as an overlay of communication between actors. These external platforms, also known as the innovation network, intermediates, include organisations like Science Parks, clusters, NGOs, and other platforms with a stake in the innovation network. The universities at this stage are expected to contribute to regional development through cluster initiatives. However, the findings show that universities have a limited role in cluster development. This finding contradicts the Triple Helix theory that sees universities leading the institutional sphere to transition to a knowledge-based economy. The results from the industry revealed many external bodies that serve as an engine for promoting Triple Helix collaboration. Such organisations include the Tony Elumelu Foundation, the Nigerian Economic Summit Group and Young Innovators of Nigeria, who vigorously encourage innovation, entrepreneurship, and collaborative knowledge creation. The fourth developmental stage is the recursive effect, where the emphasis is placed on the overlap and intersectionality of relationships in the production of goods and services. Findings show that this stage has not been achieved due to the limitations experienced in each institutional sphere that severely limited their abilities to collaborate and innovate.

**Objective 4:** To develop and evaluate a revised conceptual framework following an in-depth analysis of the fieldwork data and make a significant contribution to existing knowledge on UIG interactions. The researcher evaluated the espoused conceptual framework and identified strong and weak channels of interaction. The evaluated conceptual framework shows inter-organisational human capital mobility, contract and consultancy, and facility sharing as stronger interaction channels, while joint curriculum design appeared to be the weakest channel of interaction. The evaluated conceptual framework also identified the organisational practices congruent with the theory and those incongruent with it. This has allowed the researcher to identify the disparities between theory and practice from the four developmental stages of interaction and inhibitors to collaboration. This provides an avenue for the researcher to advance some recommendations to all institutional spheres to further strengthen their cooperation and collaborative knowledge creation, utilisation, and dissemination.

**Objective 5:** To develop recommendations for the institutional spheres on measures to stimulate UIG collaboration. The fifth objective is to make possible policy recommendations to the institutional spheres to enable UIG collaboration and eventual transition to an innovation-driven economy. This study makes significant contributions to knowledge, details of which are discussed below in Section 8.2

### **8.3 Contributions to Knowledge**

This research sets out to examine UIG interaction as a driver for innovation in Nigeria.

Therefore, this thesis has contributed to knowledge in the following ways:

#### **8.3.1 Theoretical Contributions**

The theories of innovation highlight the interactions between UIG as a means of socio-economic, regional, and national development. The literature identifies factors inhibiting UIG co-operation between diverse and fragmented groups, including institutional, orientation, relationship, and environmental factors (Bruneel, d'Este and Salter, 2010; Rybnicek and Königsgruber, 2019). Firstly, this research contributes to the extension of the UIG literature by evaluating and re-constructing the model to represent the context of current practices in University-Industry-Government relationships in Nigeria. The modified conceptual framework revealed that despite the improvement in the UIG interaction in Nigeria, applying these theories is problematic.

Secondly, the author has confirmed the UIG barriers and identified others that were not covered by the extant literature. The study identified stakeholder preference for imported goods and services over domestic products, brain drain, and lack of IPR policy and weak enforcement as additional barriers to UIG collaboration in Nigeria. Stakeholders' 's' preference for imported products and services is a consequence of the public perception that goods and services produced by domestic firms are inferior in quality and cannot compete in comparison with foreign products. The consumer preference for imported products or services has promoted a lack of confidence between organisations in each other's capabilities to discharge their contractual responsibilities. This lack of belief and confidence in capacities of the domestic stakeholder cut across the three institutional spheres, and it constitutes a significant barrier to the collaborative knowledge creation, dissemination, and utilisation. This understanding will further extend the literature on the barriers to collaboration within the context of Nigeria.

Thirdly, the UIG literature is silent about brain drain as a barrier to UIG collaboration. This research, however, has found that in Nigeria, brain drain is a factor that leads to a shortage of human capital. Many university researchers and industry practitioners have left the country due to either frustration, lack of incentives or the harsh business environment in Nigeria. This has created a loss of experienced potential researchers and entrepreneurs who can contribute to the economy. This exodus of skilled workers also contributes to a decline in the social institutions of a nation. This contribution will broaden our understanding of critical impediments to the UIG collaboration and add to the literature on UIG interactions. Another contribution to the literature on the inhibitors of the UIG collaboration is the lack of a robust national IP policy and poor or weak enforcement in Nigeria. No country can effectively manage IPR without a robust national IP that drives intellectual property protection. The law governing the IP regimes

are obsolete and out of date to drive intellectual protection in the 21<sup>st</sup> century. Besides the laws being obsolete, IPR enforcement has been a severe challenge in Nigeria. These factors have contributed to a lack of confidence in the IPR system and ultimately inhibit UIG collaboration in Nigeria.

### **8.3.2 Empirical Contributions**

Firstly, the study has contributed to our understanding of UIG interaction in Nigeria, especially science and technology. The empirical study has shown some good practices based on three channels of interaction: facility sharing, inter-organisational human capital mobility, contract, and consultancy. Understanding the strength of these factors may encourage innovation and further stimulate collaboration between the three institutional spheres. The study has also revealed the weak link based on curriculum design, contributing to the skills gap and labour mismatch between universities and industry.

Secondly, the study has revealed some considerable transformations and developments towards Triple Helix innovation from each institutional sphere by evaluating organisational practices. These good practices are shown in internal transformation and role-taking, the influence of each helix on the others (interdependency), and the creation of a new overlay of communication. However, the empirical findings also revealed that the development and transformations from each institutional sphere do not lead to Hybrid Triple Helix, thereby stifling innovation and negatively affecting the science system to feed the technology sub-system. The findings also revealed factors contributing to the blockage of smooth Hybrid interaction, including social and institutional factors. Novel among these factors is brain drain and stakeholder preference for imported goods and services, lack of IP policy and poor enforcement.

## **8.4 Recommendations**

Based on the analysis of the qualitative interviews conducted, documents analysed, informal discussions and field notes used, this section presents policy recommendations for the institutional spheres. The recommendations are presented in two categories, the first recommendation is for each institutional sphere, and the second category applies to all institutional spheres.

### **8.4.1 Recommendations for Universities**

#### **1) Transition to Fully-fledged Entrepreneurial University**

Nigerian universities should imbibe the entrepreneurial ethos by embracing ambidexterity and redirect their strategic vision and culture to allow staff and students to engage in active knowledge transfer and commercialisation. Evidence from this research has discovered that most public



universities in Nigeria are still tilted towards more traditional teaching and research issuing certificates rather than engaging in technology transfer and commercialisation either at an individual (staff) or institutional (university) level. This research recommends a cultural change to combat resistance from faculty members. This should be done by introducing policies to encourage the universities to change their attitudes towards ambidexterity supporting universities to combine teaching, research, and commercialisation with positive action. This transition can be done by introducing a new mission that encourages capitalisation of knowledge by linking users of knowledge to economic actors allowing research output from the university to translate directly into capital and attract regional and national economic development and job creation. However, this is not meant to suggest that universities should abandon research and teaching in subjects such as humanities and arts, which are not amenable to commercial use in science and business faculties teaching and research. Additionally, promoting commercial use of research and teaching does not also imply abandoning critical examination of commercial practices that are harmful to society and ecology (e.g., tobacco, armament business and fossil fuel industry)

## **2) Diversify Sources of Income**

Federal universities are funded primarily by the federal government, but they receive less than what they require to function well as institutions of knowledge production. The national budget allocated to the universities is usually less than 10%, which is lower than the African average and UNESCO's minimum recommendation of 15%. For instance, considering the percentage of funds allocated to the Nigerian education system, in the 2019 budget, the educational system is severely underfunded. Lack of funding negatively impacts teaching, research, and the availability of infrastructures such as research laboratories, up-to-date research materials, and other essential technical resources. To stay sustainable in the future, universities must diversify their funding sources by taking advantage of the IPTTOs and commercialising their research outputs. The commercialisation of research outputs will push the university to engage in more applied research and improve its collaboration with the industry to attract more funding. Therefore, it is strongly recommended that universities not depend on the government but expand their sources of revenue and become financially independent.

### **8.4.2 Recommendation for the Industry**

#### **1) Access to Funding**

Considering the critical roles of SMEs, easy access to funding to nurture and develop SMEs cannot be overemphasised. Access to finance without stringent requirements for collateral is a vital factor that creates a favourable bedrock for the survival, growth, and competitiveness of entrepreneurial development. Therefore, availability and access to adequate and sustainable financing for SMEs are vital. Entrepreneurs need to access a diverse range of low-cost capital

to enable them to produce and remain competitive. This funding should be accessible to all SMEs without the need for any political connection and favouritism.

## **2) Improving the Quality-of-Service Delivery**

Firms should step up the quality of their projects and service delivery to meet international standards. It is expected that engaging in up-to-date training and building trust with indigenous knowledge producers will improve and enhance capability and technical know-how among stakeholders.

### **8.4.3 Recommendations for the Government**

#### **1) Stabilisation of the Macro-Economic Environment**

Institutions entrusted with shaping macroeconomic policies need to develop SMEs, as they are key to realising the government's macroeconomic objectives. A stable macro-economic environment is conducive to long-term economic development. Accordingly, policies relating to SMEs should be directed at creating an enabling environment for SMEs to thrive. These macroeconomic policies must address inflation, tax, financial sector reform, exchange rates, and incentives. The government should also introduce a regulatory framework supporting competition without unnecessary barriers to market entry. Such a regulatory framework should also deal with the unethical practices often resorted to by organisations involved in competitive battles. Efforts should also be made to promote the behaviour of supporting each other.

#### **2) Investment in Physical Infrastructure**

The results of this research revealed that the availability or otherwise of infrastructure enables or disables UIG collaboration. Respondents from all institutional spheres have acknowledged that Nigeria currently suffers from the decay of critical infrastructures such as roads, electricity, and transportation system, among others. University respondents also lamented the absence or decline of essential infrastructures such as laboratories, libraries, and internet facilities. Therefore, due to the decay of national infrastructures, industries spend up to 20% of their cost of production to provide facilities. Thus, the cost of production is high, which does not encourage industries to spend additional resources to either research new products or support the commercialisation of R&D. Therefore, the government should spend more on providing infrastructure and creating an atmosphere conducive to research business and commercialisation of research outputs.

Nigeria faces a severe challenge in the power sector's operational efficiency. Cost recovery has been among the worst in Africa, supplying about half of what is required, with subsequent social costs of about 3.7 per cent of GDP. Nigeria's road networks are in poor condition due to a lack of maintenance and abandonment by the government. Addressing Nigeria's infrastructure challenges will require sustained expenditure and commitment from the government and other stakeholders. Furthermore, the government should invest in R&D, as it produces technology used to enhance

productivity, spur economic growth, and address societal concerns such as health and the environment.

### **3) Creation of a robust National Intellectual Property Rights Policy**

The study also reveals that Nigeria does not have a national Intellectual Property Right Policy. This policy is essential for providing a framework within which IP is developed, managed, and effectively harnessed for the overall benefit of institutions, inventors, authors, and the public. Nigeria is currently one of the countries that consume foreign technologies. The current law governing the IP system in Nigeria is obsolete and was inherited from the British colonial masters. With increasing technological advancement, the current legislation on the IP system has run out of relevance. As a country with many institutions of knowledge production, Nigeria should, as a matter of urgency, establish an IP policy drive and facilitate the optimal utilisation of intellectual assets. Enacting national IP policy will increase the potentials for commercialisation of research outputs emanating from the Universities-Industry-Government and create an additional funding source for the university. The government and the national assembly should consider the National IP Policy as a milestone in developing an innovation-led economy in Nigeria.

### **4) Minimise Brain Drain**

Many countries intensify their efforts to attract and retain international students, researchers, experts' entrepreneurs, etc., to increase their human capital development and increase the risk of brain drain in the sending countries. Evidence from the research shows that in developing countries such as Nigeria, brain drain changes the skill structure of the labour force, cause labour shortages, and adversely affects the higher education system and the industry. This research also shows that the phenomenon of human capital flight creates a skills gap and contributes to the decline in the human capital base in Nigeria. Although, brain drain is difficult to stop and will take years to solve the reasons that lead to the brain drain. Therefore, reforms to increase the competition are also needed, as a level playing field. The Nigerian government must improve its financial systems, restructure regulatory requirements, create a conducive atmosphere for innovation, and address the personal and professional factors of the emigrants. The government should also improve the quality of the university systems, entrepreneurial ecosystem. Government should also Support business culture and competencies. Nevertheless, providing these factors will not automatically solve the brain drain phenomenon but will improve brain circulation. Examples range from creating physical infrastructures such as business incubators to the transfer of soft skills as seen in the mentoring programmes or developing project management skills of young graduates. Government or organisations at all levels should reward talents. Financial incentives may boost the appeal of a region to talent among professionals, entrepreneurs, researchers, and scientists.

## **5) Promotion of Domestic Goods and Services**

Evidence from this research shows that stakeholders patronage imported goods or services at the expense of domestic products. The government, through its numerous Executive Orders, monetary and fiscal policies, have tried to coerce consumption of locally made goods or services by placing bans on certain imports and enforcing strict foreign exchange policies. But this has failed to deter stakeholders as they still prefer to engage in foreign goods or services. Government and university administrators do not have much confidence in the capability of national firms; they choose to engage with foreign companies. This wrong perception about the incapacity of indigenous firms became widespread not just within universities or government but with the public in Nigeria. The stakeholders believe that Nigerian firms do not produce high-quality goods or services. The undesirable attitude of the stakeholders towards locally-made products has contributed to the factors inhibiting UIG collaboration in Nigeria. Therefore, the government should create a platform for building trust in Nigerian products, manufacturers, suppliers, and service agents. Organisations should be designed to educate consumers of their rights, fight for them when there's a violation and protect them from possible violations. This would ensure that manufacturers are conscious of the consequences of substandard outputs when producing. It would serve as a strong motivation for local reputable producers and service providers to observe extremely high commercial standards. It would also eliminate nonchalant capitalists who do not care so much for reputation and operate only in the short term and organisations producing below standard outputs due to competitive pressure to up their games. Nigerian manufacturers should improve the quality of their goods and services by using high-quality raw materials, modern production techniques, and technologies to meet the standard of foreign-made goods and services. Also, quality control agencies such as the National Agency for Food and Drug Administration and Control (NAFDAC) and the Standard Organization of Nigeria (SON) should double their efforts at guaranteeing that goods produced in Nigeria conform with the prescribed and acceptable standards. As a matter of urgency, the regulating agencies should insist on best practices and at the same time emphasise zero tolerance for low quality with emphasis on quality and durable products.

### **8.4.4 Recommendations for all Institutional Spheres**

#### **1) Modernisation of the Curriculum**

Due to the increasing application of knowledge in the production of goods and services, the labour market demand for skilled graduates has intensified. The finding has revealed low employability of graduates due to the disconnection between the present university curriculum and industry needs. The industry expects certain critical skills from graduates, such as communication skills,

interpersonal skills, and personal development. Unfortunately, most Nigerian graduates lack these skills, and due to that, the industry spends a considerable amount of money on training graduates before they can contribute to the industry. This skills mismatch has been attributed to a lack of co-operation between UIG on curriculum designs and obsolete curricula in the universities. Therefore, there should be an effort from all the stakeholders, including professional bodies, to ensure curriculums are updated and designed collaboratively. The study found some of the factors preventing this are lack of consultation and a communication gap. Bridging the communication and consultation gap will ensure collaborative modernisation of curricula to ensure that the education system supplies relevant skills to the industry and prepares the students for the 21st century. An industry-oriented curriculum promotes better job opportunities for students and increases high salary earnings. By employing novel and effective pedagogy in training, students can recognise the relevant concepts and improve their analytical skills and creativity.

## **2) Attitudinal Change of the Stakeholders**

The research results have shown that one of the obstacles to UIG collaboration is faculty members' attitudes and some government decision-makers on initiating and sustaining partnerships. The results show that there are some elements of unusual narcissism and elitism amongst professors and university administrators within the academic atmosphere. This attitude creates some uncomfortable moments where industry experts feel demeaned and disrespected. This contributes to the challenges being faced by the industry when initiating any collaboration. Government employees often have the same aggressive and unfriendly manners. This attitude creates a lack of communication, trust and understanding among the stakeholders. Moving forward, a change of attitude is needed to achieve a friendlier, more accommodating culture of cooperation, tolerance, and patience between stakeholders.

## **8.5 Limitations of the Research**

This study used qualitative methods to examine the trilateral interaction of University-Industry-Government within the knowledge-intensive sector in Nigeria. Nigeria has first, second, third and fourth generation universities. The government of the first republic established the first-generation universities in 1962. The military regime established second-generation universities in 1975. The third-generation universities include those found by Federal governments during the second republic (1979–1983) and those found under the next military regime (1984–1999). The fourth-generation universities are the universities that were created by states and private/ religious institutions from 1999 to 2020. This research concentrated only on first- and second-generation universities for several reasons, including geographical, budgetary and security constraints. The research could have integrated the third, and fourth-generation universities, some of which were specially established to focus on Science, Engineering and Technology, such as Biotechnology,

and Genetic Engineering, among other fields. Integrating these specialised universities of technology could have produced a different result. Therefore, the findings of this research are not generalisable to all universities in Nigeria. Another limitation of the study is the use of a purely qualitative method rather than mixed methods. Although a compelling argument was presented in Chapter Four as to why the qualitative approach is most suitable in this context, a mixed-method would have improved the quality of the data and provided a more robust outcome.

## **8.6 Areas for Future Research**

Firstly, this research employs qualitative methods to examine University-Industry-Government interactions as potential drivers for innovation in Nigeria. It is recommended that future research should use a mixed methodology to explore the UIG interaction. This will add breadth to multidisciplinary rigour from a diverse analytical tool by integrating quantitative and qualitative datasets. Secondly, as mentioned earlier, the research focuses only on the first and second-generation Federal universities, which have been categorised as research and teaching based universities. The scope of the research was limited due to geographical, budgetary and security constraints. Therefore, there is a need for future studies to investigate universities focused on science, technology and engineering categorised as fourth-generation universities in Nigeria. Studying fourth-generation universities will further illuminate the understanding of the dynamics of interaction and innovation from the perspective of technology-intensive universities in Nigeria.

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## 9.1 Unconditional Ethics Approval

Dr Sola Adesola  
Director of Studies  
Department of Business and Management  
Faculty of Business  
Oxford Brookes University  
Wheatley Campus  
3 August 2016

Dear Dr Adesola

**UREC Registration No: 161032**

**University-Industry-Government Interaction: Drivers for Innovation in Nigeria**

Thank you for your email of 4 August 2016 outlining your response to the points raised in my previous letter about the PhD study of your research student Usman Alkali and attaching the revised documents. I am pleased to inform you that, on this basis, I have given Chair's Approval for the study to begin.

The UREC approval period for this study is two years from the date of this letter, so 8 August 2018. If you need the approval to be extended, please do contact me nearer the time of expiry. Should the recruitment, methodology or data storage change from your original plans, or should any study participants experience adverse physical, psychological, social, legal, or economic effects from the research, please inform me with full details as soon as possible.

Yours sincerely

Dr Sarah Quinton  
Chair of the University Research Ethics Committee  
cc Pritam Singh, Second Supervisor  
Usman Alkali, Research Student Jill  
Organ, Research Degrees Team  
Louise Wood, UREC Administrator

## 10 Appendix 2

### 10.1 Letter of invitation

06 June 2017

#### INVITATION LETTER

Dear sir/ madam, my name is Usman Alkali; I am Doctoral Student in the Business School at Oxford Brookes University. To fulfil the requirements of the Degree of Doctor of Philosophy, I am conducting a study titled ‘ **University-Industry-Government interaction: drivers for innovation in Nigeria,** and I would like to invite you to participate. The research is being supervised by Dr Sola Adesala, Director of Studies and Prof Pritam Singh. The aim of the research is to understand the interaction as potential drivers for innovation and the general factors militating against the collaboration. You are being invited to participate in the research because you have been identified by the researcher (via purposive sampling) as a key individual who has specific knowledge and expertise either because of the position you occupy or the role you play in your University/ Institution. You should not feel obliged to take part in the research or disclose any information. However, it would be extremely helpful to the research if you felt you were able to participate. If you do give consent to participate, you will be asked to sign an Interview Consent Form. The interview stage of the research study will comprise a one-to-one semi-structured interview with the researcher, which will be digitally audio recorded with your permission. Audi recording the interview gives the researcher an opportunity to transcribe, analyse and reflect on the responses you give during the interview. Your interview will last approximately forty-five minutes to one hour, during which you will be asked a series of semi-structured questions. The interview will take place during your normal working hours in your office. As you have been identified as someone who plays a key role in the University-Industry-Government interaction, the anonymity of the response you give in the interview will be guaranteed and be treated in strict confidence. To reiterate, it will be extremely helpful to the research if you felt you were able to participate. You will find details of the research study in the attached participant information sheet. Please carefully read this carefully. If you would like to discuss its content or would like further information before you decide, please do not hesitate to contact me.

Best regards.

Usman Alkali PhD researcher

Business and Management

15023878@brookes.ac.uk +44740469594

## 11 Appendix 3

### 11.1 INFORMATION SHEET FOR SEMI-STRUCTURED INTERVIEW

**Name, position and contact address of Researcher:** Usman Alkali, Principal Investigator, Department of Business and Management, Faculty of Business, Oxford Brookes University, OX33 1HX.

Tel: 08039788768; e-mail: 15023878@brookes.ac.uk

#### **Chapter 2 Study title**

University-Industry-Government (UIG) interaction: drivers for innovation in Nigeria

#### **Chapter 3 Invitation paragraph**

You are being invited to take part in a research study. Before you decide whether or not to take part, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully.

#### **Chapter 4 Purpose of the study**

The purpose of my research is to investigate the university-industry interaction as a driver for innovation in Nigeria. It is dependent on oil as its primary source of revenue. The oil sector contributes to about 90% of its foreign exchange earnings. Apparently, in recent times, the volatility of the oil price has negatively impacted the sustainability of oil as a major source of its foreign exchange earnings. There is a need for a paradigm shift from the dependence on natural resources to a system where knowledge creation, use and diffusion become the means of wealth creation and employment generation. World Bank has identified four key pillars for economies transiting from a natural resource-based to a knowledge-based economy. They include 1) Information and communication infrastructure, 2) Knowledge and skills, 3) National Innovation system and lastly, the Business environment. Among other things, the research aims to review previous works on innovation systems, knowledge-based economies, and Triple Helix literature.

In order to carry out my research, I intend to carry out a semi-structured interview with you and some other stakeholders in the universities and the industry and government organisations. The semi-structured interview will be held with some selected Directors of Research and innovation of departments in 6 of the selected universities and the decision-makers in some industries. This interview will help gain an in-depth view of the stakeholders on the current state of the interaction and the potential barriers. It may also provide the researcher with an in-depth understanding of what policies are needed to be put in place for proper university-industry-government interaction. All information provided will be strictly confidential and used only for the purpose of my PhD; such information will not be passed to any individual/organisation.

#### **Chapter 5 Why have I been invited to participate?**

You have been chosen to take part in this interview because of your position in the university, industry, or government within my research area. I strongly believe that your experience in this University/industry-Government collaboration will be valuable to my research. The information you will provide along with that of others to be interviewed, will help in my data analysis. A total number of 30-35 participants stated above will be asked to participate in this interview. This will help me to



gain in-depth knowledge from you and other academicians/ decision-makers in the University/industry on your views about the interactions.

#### **Chapter 6 Do I have to take part?**

Participation is voluntary; therefore, it is up to you to or not to take part in the interview. If you made up your mind to participate in the interview, I would need to get your details so that I can arrange with you the best time and date for the interview. A consent form will be made available for you to read and sign prior to the day of the meeting. The purpose of the consent form is to get your approval for participating in the meeting. Also, if you decide to take part, you are free to withdraw at any time and without providing any reason for your withdrawal.

#### **Chapter 7 What will happen to me if I take part?**

The semi-structured interview will be a carefully planned series of questions that are designed to obtain your perceptions and experience on the university-Industry interaction. Each interview is expected to last for 30 minutes. Your discussion will form part of the basis of my data, and apart from your time, there is no inherent risk involved in your participating in the interview. If you agree to participate, I will need your permission to record the interview with an audio device. The reason for recording it is to enable me to capture your views so that I can listen to it after the interview in order to transcribe your discussion. Any information you provide will be used for the purpose of the research only and will not be passed to any individual or organisation.

#### **Chapter 8**

#### **Chapter 9 What are the possible benefits of taking part?**

One of the benefits of your participation in the research is that you will be able to have a copy of the summary of the research outcome upon the completion of my research work. Your opinions will go a long way in shaping the strategies used by your university to cooperate with the industries. It may also lay a good foundation for better cooperation between your university and the industries which will ultimately boost the capabilities and creativity of both the university and the industry.

#### **Chapter 10**

#### **Chapter 11 Will what I say in this study be kept confidential?**

I want to assure you that the information collected will be kept strictly confidential (subject to legal limitations). The information you will provide during the interview will be used for the purpose of my research alone and will not be shared with any individual/institution. Information collected from the interviews will be transcribed, coded, and interpreted by the researcher, and this data will form part of practical evidence for my PhD thesis. Also, your identity will be protected from being referred to by pseudonym in any publication arising from the research. The data collected will be stored in secured devices and locations that are encrypted and password protected. Please note that data generated in the course of the research must be kept securely in paper or electronic form for a period of ten years after the completion of my research project.

#### **Chapter 12 What should I do if I want to take part?**

To participate in the research, I will leave the consent form with you so that you can reflect on any concern and questions you might have as regards your participation. Should you decide to take part in the interview, kindly sign the consent form which I will come to pick up prior to the interview? A convenient date and time will be arranged with you for the interview.

#### **Chapter 13 What will happen to the results of the research study?**

Information collected from the interviews will be transcribed, coded, and interpreted by the researcher and this will form part of my practical evidence for my PhD dissertation. After the completion of the research work, you will be able to receive a summary of the research findings. Also, the researcher intends to use part of this data as part of practical evidence in conference papers and journal articles.

**Chapter 14 Who is organising and funding the research?**

I am conducting this research as a student of the Department of Business and Management, Faculty of Business, Oxford Brookes University, Oxford. The cost of the research is fully borne by the researcher.

**Chapter 15 Who has reviewed the study?**

This research has been approved by the University Research Ethics Committee, Oxford Brookes University.

**Chapter 16 Contact for Further Information**

For further information, you can contact me on Tel: 08039788768 e-mail: [15023878@brookes.ac.uk](mailto:15023878@brookes.ac.uk) and should you have any concern about the way in which the study has been conducted, kindly contact the Chair of the University Research Ethics Committee on [ethics@brookes.ac.uk](mailto:ethics@brookes.ac.uk).

**Chapter 17 Thank you**

Thank you for taking time to read the information sheet.

## 12 Appendix 4

### 12.1 CONSENT FORM

**Full title of Project:**

University-Industry-Government (UIG) interaction: drivers for innovation in Nigeria

**Name, position and contact address of Researcher:** Usman Alkali, Principal Investigator, Department of Business and Management, Faculty of Business, Oxford Brookes University, OX33 1HX.Oxford Tel: +447404695464 ,+2348039788768; e-mail: 15023878@brookes.ac.uk

**Please initial box**

1. I confirm that I have read and understand the information sheet for the above study and have had the opportunity to ask questions.
2. I understand that my participation is voluntary and that I am free to withdraw at any time, without giving reason.
3. I understand that the interview will be audio recorded.
4. I agree to take part in the above study.

**Please initial box**

- |  |                          |                          |
|--|--------------------------|--------------------------|
|  | Yes                      | No                       |
| 5. I agree to the use of anonymised quotes in publications   | <input type="checkbox"/> | <input type="checkbox"/> |
| 6. I agree that the data gathered in this study may be stored (after it has been anonymised) in a specialist data centre and may be used for future research | <input type="checkbox"/> | <input type="checkbox"/> |

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Name of Participant	Date	Signature
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Name of Researcher	Date	Signature
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### 13.1 Semi-Structured Interview Protocol (Universities)

#### **Semi-Structured Interview with universities**

Thank you for giving me the opportunity to interview you. My name is Usman Alkali, a PhD student at Oxford Brookes University, Oxford, United Kingdom. I am conducting a study on the ***“University-Industry-Government (UIG) interaction: drivers for innovation in Nigeria”***. The Interview will last for an hour, and please note that every answer in this Interview is valuable. All information provided in this Interview will be treated confidentially and will be used for this research.

- 1) General information – name, organisation, and position.
- 2) Please briefly describe the interaction between your university industries and government institutions in Nigeria
- 3) Can you identify some of the channels of the collaboration?
- 4) What are the channels of inter-organisational human capital mobility from the university to industry and government?
- 5) In what ways does the university share research facilities/equipment with the industry?
- 6) Does the university solicit input from the industry and government in designing the curriculums?
- 7) How will you describe the contract and consultancy between University-Industry-Government?
- 8) Can you please tell me the effort internal effort made by the university to transform itself toward commercialisation and knowledge transfer activities?
- 9) Can you please tell me if there is any government initiative or policy that has influenced your university’s activities toward commercialisation and knowledge transfer activities?
- 10) Can you please tell me if there is any internal organisation, groups or platform created by the university to promote this collaboration?
- 11) Is the current UIG practice in Nigeria is perfect?
- 12) What do you think are the practical inhibiting factors of the UIG collaboration in Nigeria?
- 13) What is your general assessment of the innovation in Nigeria considering the UIG collaboration?

## 14.1 Semi Structured interview Protocol (Industry)

### **Semi-Structured Interview with industry**

Thank you for giving me the opportunity to interview you. My name is Usman Alkali, a PhD student at Oxford Brookes University, Oxford, United Kingdom. I am conducting a study on the *“University-Industry-Government (UIG) interaction: drivers for innovation in Nigeria”*. The Interview will last for an hour, and please note that every answer in this Interview is valuable. All information provided in this Interview will be treated confidentially and will be used for this research.

- 1) General information – name, organisation, and position.
- 2) Please briefly describe the interaction between your company, universities, and government institutions in Nigeria
- 3) Can you identify some of the channels of the collaboration?
- 4) In what ways does inter-organisational human capital mobility from university to industry and government occur?
- 5) In what ways does the industry share research facilities/equipment with the universities of government institutions?
- 6) Does the university solicit input from industry in designing curriculums?
- 7) How will you describe contract and consultancy between University-Industry-Government?
- 8) Can you please tell me the effort internal effort made by the industry to transform itself toward commercialisation and knowledge transfer activities?
- 9) Can you please tell me if there is any government initiative or policy that has influenced the industry’s activities toward commercialisation and knowledge transfer activities?
- 10) Can you please tell me if there are any organisations, groups or platform or NGOs created to promote this collaboration?
- 11) Is the current UIG practice in Nigeria is perfect?
- 12) What do you think are the practical inhibiting factors of the UIG collaboration in Nigeria?
- 13) What is your general assessment of the innovation in Nigeria considering the UIG collaboration?

## 15 Appendix 7

### 15.1 Semi-Structured interview Protocol (Government)

#### **Semi-Structured Interview with industry**

Thank you for giving me the opportunity to interview you. My name is Usman Alkali, a PhD student at Oxford Brookes University, Oxford, United Kingdom. I am conducting a study on the “*University-Industry-Government (UIG) interaction: drivers for innovation in Nigeria*”. The Interview will last for an hour, and please note that every answer in this Interview is valuable. All information provided in this Interview will be treated confidentially and will be used for this research.

- 1) General information – name, organisation, and position.
- 2) Please briefly describe the interaction between your company, universities, and government institutions in Nigeria
- 3) Can you identify some of the channels of the collaboration?
- 4) In what ways does inter-organisational human capital mobility from university to industry and government occur?
- 5) In what ways does the industry share research facilities/equipment with the universities of government institutions?
- 6) Does the university solicit input from industry in designing curriculums?
- 7) How will you describe contract and consultancy between University-Industry-Government?
- 8) Can you please tell me the effort internal effort made by the industry to transform itself toward commercialisation and knowledge transfer activities?
- 9) Can you please tell me if there is any government initiative or policy that has influenced the industry’s activities toward commercialisation and knowledge transfer activities?
- 10) Can you please tell me if there are any organisations, groups or platforms or NGOs created to promote this collaboration?
- 11) Is the current UIG practice in Nigeria is perfect?
- 12) What do you think are the practical inhibiting factors of the UIG collaboration in Nigeria?
- 13) What is your general assessment of the innovation in Nigeria considering the UIG collaboration?