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The Role of Innovation in the Economic Development of Nigeria

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Abstract
Innovation is very imperative for the economic development of any nation. This article assessed the various sectors of the Nigerian economy that need innovation; the defects in the legal framework for the protection of innovators in Nigeria; investigated factors challenging technological innovation in the country. Data were collected from statutes and case laws, textbooks and the internet. It was discovered that the level of innovation and technology in Nigeria is low and the Nigerian patent law is weak. Factors posing challenges to innovation in Nigeria includes institutional framework; human capital; research/innovation infrastructure; and sophisticated business community. This article recommended that the Government should evolve policies that would address the challenges in technological innovations. The patent law needs amendment. Modern research facilities should be established and human capital developed. In conclusion, the Nigerian economy can compete globally if the above challenges are resolved.

1. Introduction

The classification of Africa as a third world, or an underdeveloped continent, despite its rich, human and material resources highlights the fact that there is a fundamental problem with the harnessing and utilization of the human and material resources in the continent.[i] The Global Innovation Index (GII) 2014 surveyed 143 economies around the world, using 81 indicators to gauge both their innovation capabilities and measurable results. Mauritius, which tops the African countries in the ranking, came at the 40th position, followed by South Africa at 53rd and Tunisia at the 78th position. Nigeria was placed at the 110th position. The foregoing GII ranking has shown that in a global and dynamic world, the economies that can remain flexible, adaptive, and innovative will reap the benefits of world trade. This is because the global competitiveness of any economy depends on its science, technology and innovation (STI) capabilities.[ii]In all ramifications of economic development, technology-dependent economies surpass economies dependent on their natural resources.

However, there remain challenges to the diffusion of technology in Nigeria. First, the law does not encourage technological innovation. Its capability to protect prospective innovators remains in doubt. Furthermore, Nigeria lacks human capital to man effectively its sectors. Moreover, research facilities in the country are either inadequate or outdated. There are no effective policies to serve as incentives to arouse local innovators and to attract foreign investors. Nigerian technological environment is discouraging. Modern infrastructures are also required to encourage foreign direct investment (FDI).

2.1. Innovation, Intellectual Property Rights (IPRs) and Economic Development

A patent is a special right to the inventor that has been granted by the government through legislation for trading new products.[iii]A patent is granted under the law to protect an invention that is new or essentially better in some way than what was made before.[iv] It follows therefore that a patent may also be granted in respect of an improved version of an original invention. It is immaterial that the improved version was not made by the original inventor. According to U. Uguru, a patent is a document, issued, upon application, by a government office (or a regional office acting for several countries) which describes an invention and creates a legal situation in which the patented invention can normally only be exploited (manufactured, used, sold, imported) with the authorization of the owner of the patent.[v]Patent matters in Nigeria are governed by the Patents and Designs Act, Cap. P2, Laws of the Federation of Nigeria, 2004.

According to Maskus, Dougherty and Mertha, economists have now recognized that there are stimulative effects of IPR protection on economic development and growth.[vi] An inadequate set of IPRs, according to these authors, can stifle innovation and invention processes even at low levels of economic development. Thus, as illustrated by them:

- "It is as important for firms to adapt new management and organizational systems and new product and quality control mechanisms as it is to find new technologies. Those inventions can be quite costly and will be undertaken only when the risk of their loss to unfair competition and trademark infringement is minimized. In an environment of weak protection, it is difficult also to foster attitudes of creativity, invention, and risk taking. Rather, the economy stagnates in a mode favouring copying and counterfeiting."[vii]

Patents protect innovations, which in turn promotes economic development. Accordingly,

- "Economic development involves carrying out innovative activities. Innovation involves taking of risk… the basic function of patent is to protect innovation and technology. According to Schumpeter, innovation would not occur in the absence of patent protection or alternative mechanism for protection."[viii]

The strength of IPRs enforcement efforts differs with economic development levels as noted by Maskus, Dougherty and Maskus. According to them, on the part of poor countries, this reflects both an unwillingness to pay the costly administrative expenses and an inability to manage complicated technological and judicial issues associated with IPRs.[ix]

Furthermore, there is evidence that strengthened IPRs stimulate innovation in developing nations. For example, as narrated by Sherwood, in a survey of 377 Brazilian firms by the Brazilian Ministry of Industrial Development and Commerce and the American Chamber of Commerce, it was found that 80 percent of those firms would invest more in internal research and development (R&D) and labour training if better legal Protection were available.[x]

Maskus, Dougherty and Mertha further opine that countries that have weak IPRs find themselves isolated from modern technologies. Thus, they have high technology distance.[xi]

2.2. Legal Framework for the Protection of Patentsin Nigeria

a. Patentable inventions[xii] and criteria for patentability[xiii]

The Patents and Designs Act does not define the word invention. The Act however sets out the conditions under which an invention will be deemed patentable. Accordingly, an invention is patentable:

a) If it is new, results from inventive activity and is capable of industrial application; or
b) If it constitutes an improvement upon a patentable invention and also is new, results from inventive activity and is capable of industrial application.[xiv]

The Patents and Designs Act is also silent on the meaning of 'capable of industrial application.'

Accordingly, the criteria for patentability are the following:

1. The invention must be new, must result from inventive activity and must be capable of industrial application.

The above criterion shows that newness or novelty (as it is commonly referred to) is a sine qua non for patentability. The Act currently under review further explains when an invention is new. Thus, an invention is new if it does not form part of the state of the art.[xv] State of the art means –

- "Everything concerning that art or field of knowledge which has been made available to the public anywhere and at any time whatever (by means of a written or oral description, by use or in any other way) before the date of the filing of the patent application relating to the invention or the foreign priority date validly claimed in respect thereof, so however that an invention shall not be deemed to have been made available to the public merely by reason of the fact that within the period of six months preceding the filing of a patent application in respect of the invention, the inventor or his successor in title has exhibited it in an official or officially recognized international exhibition."[xvi]

It follows from the foregoing that, apart from the singular exception of the invention being exhibited in an official or officially recognized international exhibition within the period of six months preceding the filing of the patent application, publication by the following means will invalidate novelty and render the product not patentable:

a) Oral disclosure.
b) Publication by document.[xvii]
c) Prior use.

2. The invention must constitute an improvement upon a patented invention and must also be new, must result from inventive activity and must be capable of industrial application.

This second condition demonstrates the fact that an invention will also be deemed patentable if it constitutes an improvement upon an existing patented invention.[xviii] It is, therefore, immaterial that a process similar to it has already been invented.

b. Non-Patentable Inventions

The Act also specifically enumerates inventions for which a patent can never be granted.[xix] Accordingly, a patent will not be granted for –

a) Plant or animal varieties or essentially biological processes for the production of plants or animals (other than micro-biological processes and their products).

b) Inventions, the publication or exploitation of which would be contrary to public order or morality, (it being understood for the purposes of the paragraph that the exploration of an invention is not contrary to public order or morality merely because its exploitation is prohibited by law.

c. Right to a Patent

The Patents and Designs Act provides a guide as to who has a right to a patent.

Persons who may apply to register a patent

1. Statutory Inventors

Section 2(1) of the Patents and Design Act provides –

- "… the right to a patent in respect of an invention is invested in the statutory inventor, that is to say, the person who, whether or not he is the true inventor, is the first to file, or validly to claim a foreign priority for, a patent application in respect of the invention."

The foregoing provision clearly indicates that the first to file a claim will obtain a right to a patent in respect of the invention. It is immaterial that he is not in fact the true inventor. However, the Act further provides that the true inventor is entitled to be named as such in the patent, whether or not he is also the statutory inventor, and the entitlement in question shall not be modifiable by contract.[xx] The Patents Law, however, protects the true inventor. It provides –

- "If the essential elements of a patent application have been obtained by the purported applicant from the invention of another person without the consent of that other person (or his said successor in title) without the consent of that other person (or his said successor) both to the obtaining of those essential elements and to the filing of the application, all rights in the application and in any patent granted in pursuance of it shall be deemed to be transferred to that other or his said successor, as the case may be."[xxi]

d. Procedure for Patent Application

Every patent application must be made to the Registrar of Patens and Designs.[xxii] The application must contain the applicant's full name and address; a description of the relevant invention with any appropriate plans and drawings; a claim or claims; and such other matter as may be prescribed.[xxiii] The aforementioned description must disclose the relevant invention in a manner sufficiently clear and complete for the invention to be put into effect by a person skilled in the art or field of knowledge to which the invention relates.[xxiv] Furthermore, the claim or claims as aforementioned must define the protection sought and shall not go beyond the limits of the said description.[xxv]Finally, the application for patent must be accompanied by the prescribed fees; and where appropriate, a declaration signed by the true inventor requesting that he be mentioned as such in the patent and giving his name and address; and if the application is made by an agent, a signed power of attorney.[xxvi]

e. Examination of Application for Patent Grant

Every patent application must be subjected to examination to ensure it conforms to section 3(1), (3) and (4).[xxvii] If on the examination of the application it is discovered that the formal requirements of Rule 11 of the Patent Rules in the Act have not been complied with, the Registrar must reject the application. Where, however, the examination shows that the application satisfies the requirements of Rules 8 and 11 of the Patent Rules, then the Registrar is obliged to grant the patent,[xxviii] without further examination and, in particular, without examination of the questions.[xxix]

f. Grant of Patent

Patent is granted by issuing the patentee a document containing the relevant number of the patent; the name and address of the patentee; the date of the patent application and the grant; if foreign priority is claimed, an indication of the fact, and the number and date of the application on which the claim is based and the name of the country where it was made; the description of the invention (with any relevant plans and drawings) and the claims; where appropriate, the name and address of the true inventor.[xxx]

Notwithstanding the grant, the patent is granted at the risk of the owner without guarantee of their validity.[xxxi]

g. Rights Conferred upon a Patentee

A patent confers upon the patentee the right to preclude any other person from doing any of the following acts –

a. Where the patent has been granted in respect of a product, the act of making, importing, selling or using the product, or stocking it for the purpose of sale or use; and
b. Where the patent has been granted in respect of process, the act of applying the process or doing, in respect of a product obtained directly by means of the process, any of the acts mentioned above.[xxxii]

h. The Scope of the Protection Conferred by a Patent

The scope of the protection conferred by a patent will be determined by the terms of the claims; and the description (and the plans and drawing if any) included in the patent shall be used to interpret the claims.[xxxiii]

Furthermore, the right under a patent –

a. Will extend only to acts done for industrial or commercial purposes and
b. Will not extend to acts done in respect of a product covered by the patent after the product has been lawfully sold in Nigeria, except in so far as the patent makes provision for a special application of the product, in which case the special application will continue to be reserved to the patentee.[xxxiv]

2.3. Innovation and Economic Development in Nigeria

There is virtually no sector of the Nigerian economy that does not need innovation. With time as we continue to enhance our innovation capabilities, a larger percentage of the sectors of the Nigerian economy will become strong pillars of economic development in Nigeria.

2.3.1. Oil and Gas Sector

The major compositions of energy in the world are crude oil, coal, solar etc. Crude oil however has always been the major source of energy that is most important to countries of the world that have the drive for industrialization. Petroleum provides over 50% of all commercial energy consumption in the world. The size, international characteristic and role assumed by the petroleum industry were noted to have originated from the idea that petroleum is resourceful as it currently satisfies a wide variety of energy and related needs.[xxxv] Crude oil has played an important role in our modern civilization. It has transformed agriculture and industry and has revolutionized the means of transport.[xxxvi] The production of crude oil is based on natural endowment, hence only few countries of the world have the privilege of producing the commodity in commercial quantities.[xxxvii]

Nigeria is the 10th largest oil producer in the world.[xxxviii] She is also the world's fourth largest oil exporter, with proven oil reserves ranging from 25 to 35.2 billion barrels, with current production at close to 2.3 million barrels per day.[xxxix]

The oil and gas sector plays a very dominant role in the economy of Nigeria. The oil and gas industry has been described as the largest among all industries in the Nigeria. The Nigerian economy relies heavily on the revenue derived from petroleum products, as they provide 70% of government revenue and not less than 95% of foreign exchange earnings.[xl] The Nigerian government earns income from oil through the sale of crude, gas; Petroleum Profit Tax (PPT), royalties and rent from the industry operators.[xli] Lack of technological innovation in the Nigerian oil and gas sector has had negative implications on the nation. Oil and gas are not only wasted but the Nigerian environment also depleted over the years due to lack of expertise. According to the 2008 BP Statistical Energy Survey, Nigeria had proved natural gas reserves of 5.29 trillion cubic meters, 2.98% of the world total. Due, mainly, to the lack of a gas infrastructure, 75% of associated gas is flared and 12% re-injected.[xlii] These flared gasses, if properly harnessed, will be advantageous to the Nigerian economy. Again, crude oil exploration has led to environmental problems in the producing communities. This has adversely affected livelihood activities in agriculture leading to low income.

Therefore, the oil and gas sector of Nigeria is in dire need of innovation. After decades of significant petroleum sector development, Nigeria still relies heavily on international oil companies (IOCs) and overseas contractors for 95% of this activity. The resource development has been carried out largely by the IOCs as operators in joint ventures with the Nigerian National Petroleum Corporation (NNPC).[xliii] The oil and gas sector is characterized by a low prevalence of technological innovation.[xliv] In a research conducted on the indigenous oil and gas SMEs in Nigeria, it was revealed that the dominance of product innovation was 17% while process innovation was 22%. Therefore, the dominance of technological (product and process) innovations was low.[xlv]The foregoing research also suggests that a significant proportion (84.8%) of the Nigerian indigenous oil and gas firms do seek information from external sources to support their innovativeness. Less than one quarter of the firms (15.2%) depended on internal information for innovation, either within the firms or from the parent's firm.[xlvi]

2.3.2. Agricultural Sector

In Nigeria, as in most developing countries, the main occupation of the people is agriculture and about 65% of the population is engaged in it.[xlvii] However, before the oil boom, a much more percentage of the population engaged in agriculture. In the 1960s, before it turned to oil, Nigeria was one of the most promising agricultural producers in the world. Between 1962 and 1968, export crops were the country's main foreign exchange earner. The country was number one globally in palm oil exports, well ahead of Malaysia and Indonesia, and exported 47 percent of all groundnuts, putting it ahead of the US and Argentina.[xlviii]

According to Ragasa, crops remain the dominant agricultural activity in Nigeria. The crop subsector contributes about 85 percent to the agriculture GDP, whereas livestock contributes about 10 percent, fisheries about 4 percent, and forestry about 1 percent. Of the crops subsector, roots (in particular, cassava and yam) dominate in tonnage, though cereals (maize, sorghum, rice, and millet) are becoming important for the domestic demand for food. The roots group accounts for 9 percent of GDP, whereas cereals account for 8 percent.[xlix]The Nigerian agricultural environment is highly fertile, and it is rich in bio-diversity. The lands across the country can grow and support almost all the crops that exist around the world. However, despite the natural endowment the country has, food production is deteriorating.[l] Again, her status as an agricultural powerhouse has declined, and steeply. It is noted that while Nigeria once provided 18 percent of the global production of cocoa, second in the world in the 1960s, that figure is now down to 8 percent. And while the country produces 65 percent of tomatoes in West Africa, it is now the largest importer of tomato paste.[li] Again, while Nigeria is regarded as the largest producer of cassava, output per hectare remains one of the lowest in the world principally due to poor technological development.[lii]

Today, Nigeria has transitioned from being a self-sufficient country in food to being a net importer, spending $11bn on imports of rice, fish and sugar.[liii] Nigeria imports over 1.3 Trillion Naira in wheat, rice, sugar and fish every year.[liv]The consequence of the deteriorating Nigeria's agricultural sector includes the following:

a. Nigeria's food imports are growing at an unsustainable rate of 11% per annum.
b. Relying on the import of expensive food on global markets fuels domestic inflation.
c. Excessive imports putting high pressure on the Naira and hurting the economy.
d. Nigeria is importing what it can produce in abundance.

e. Import dependency is hurting Nigerian farmers, displacing local production and creating rising unemployment.
f. Import dependency is neither acceptable, nor sustainable fiscally, economically or politically.[lv]

Furthermore, the World Bank recently predicted an up to 30 percent drop in the country's crop output due to erratic rainfall and higher temperatures.[lvi]

According to Ragasa, the agricultural innovation systems approach emphasizes a stronger link of knowledge systems (research, extension, education) with markets and other actors in the supply chains, as well as with those in the broader policy environment.[lvii] To her, strong agricultural research and development (R&D) is crucial for improving agricultural productivity and efficiency, which in turn both lead to agricultural development, food security, and poverty reduction.[lviii]

Furthermore, this agricultural innovation system changes how research is done, with a shift in focus from research outputs and productivity to the use and adoption of technologies being generated by research, as well as to how those technologies are helping to solve the problems of farmers and to alleviate the constraints of supply chain actors.[lix]However, several studies have shown that in many developing countries, in particular in sub-Saharan Africa, there is persistent underinvestment in R&D and weak research capacity, both of which continue to undermine agricultural productivity and growth in these countries.[lx]Again, in a survey conducted on the research institutes in Nigeria, it was revealed that the status of research performance presented so far indicates an overall weak innovation capacity of Nigeria's researchers and research organizations. At the individual researcher's level, about 40 percent of individual researchers do not have any knowledge regarding the adoption or impact of new varieties or breeds that they produced, and 20 percent do not have information on the adoption or use of new management practices or technologies that they developed.[lxi] Furthermore, the survey revealed that 86 percent of the research institutes do not have an intellectual property rights (IPR) strategy.[lxii]The foregoing has revealed how great and urgent the Nigeria's agricultural sector needs innovation.

2.3.3. Pharmaceutical Sector

According to Berger *et al*, the African population has the world's highest burden of infectious and neglected diseases, and faces a rapidly-rising burden of non-communicable diseases. They further stated that Africa is home to 11% of the world's population and consumes less than 1% of global health expenditure. Yet it carries 25% of the world's burden of disease.[lxiii] The hardest hit groups are women and children. Half the world's deaths of under-five's are on this continent. According to Berger *et al*, this situation is further compounded by a lack of access to essential medicines for many of the affected populations.[lxiv] It therefore appears reasonable to say, considering the significance of the Nigerian population in the African continent, that Nigeria would at least have a fair share of this percentage of the world's burden of disease. Although the foregoing is reasonably true, the International Federation of Pharmaceutical Manufacturers Associations (IFPMA) has rightly pointed out that healthcare, science and medicine challenges are global, and all parties need to collaborate to meet these challenges effectively.[lxv]Innovation is the vital element in this effort: when the public sector, industry, and civil society pull together to promote innovation, public health improves and lives are saved.[lxvi] According to the IFPMA,

- "… Indeed, pharmaceutical innovation creates real benefits for public health, such as new cures for once-fatal diseases, an increased understanding of the mechanisms of chronic conditions, and improved treatments for diseases and conditions, leading to better health outcomes, improved quality of life and a more productive society overall...."[lxvii]

The pharmaceutical industry is important because it is a major source of medical innovation.[lxviii] Moreover, medical and pharmaceutical innovations play an important economic role. Health care innovation is a key measure of economic productivity and adds value to a range of other technology applications. There is strong evidence that the overall pace of innovation is set by the pharmaceutical industry.[lxix] Accordingly, innovation linked to new medical technologies has therefore become an important source of competitive advantage, especially in the emerging field of life sciences – a key driver of economic growth in the 21st century. In most industrialized countries, health care is among the largest sectors of economic activity.[lxx]IFPMA also identifies the innovative pharmaceutical industry as another key element of the global knowledge economy. Research and development (R&D) based pharmaceutical companies accounted for 10 percent of the total of Organization for Economic Co-operation and Development (OECD) member countries R&D budget estimated at $450 billion across all sectors in 2001. According to IFPMA, both private and public investment in life sciences and development of related technologies is widely recognized as a key engine that will drive and determine economic prosperity in the long term.[lxxi]

Furthermore, Witty noted that diseases that disproportionately affect developing countries play a large role in stalling economic and social development.[lxxii] Innovation efforts in developing countries can also be important for undertaking research on diseases and conditions which particularly affect them, including the "neglected diseases" which require further R&D than is currently being undertaken.[lxxiii]

It has however been discovered that the medical and pharmaceutical industries of the developing countries suffer a number of challenges. Firstly, despite the apparent need for pharmaceutical innovation in key developing countries – a need that could contribute to finding new solutions to the problem of neglected diseases – not enough is being done to make it happen. These countries still promote policies that benefit local, copy-based pharmaceutical industries at the expense of innovation.[lxxiv] Again, drug resistance is also growing in developing countries plagued by infectious diseases such as malaria and tuberculosis. Furthermore, counterfeiting exacerbates the problem, and is particularly dangerous for the anti-retroviral therapies used to treat AIDS. In a time past, Nigeria was

forced to temporarily suspend imports of a number of essential medicines after discovering up to 80 percent of the imported volume was counterfeit.[lxxv]

However, African traditional medicine has an important role to play. Berger *et al*. noted that Africa has a comparative advantage in the area of pharmaceutical innovation, development and production using African Traditional Medicine and the continent's rich biodiversity as raw materials of choice.[lxxvi] The natural environment provides man with resources for his survival. Plants, animals and minerals constitute the major natural resources used by man for preventive, curative and rehabilitative health. The World Health Organization (WHO) estimated that some 80% of people living in developing countries use traditional medicine to address their health care needs.[lxxvii]

However, it must be noted that development of the pharmaceutical innovation sector requires the presence of a critical mass of knowledgeable, skilled and motivated professionals, and an enabling institutional environment.[lxxviii]Furthermore, it has been noted that the Nigerian local market of pharmaceutical producers (accounting for an estimated 35.0 percent of market size) is a highly fragmented one. The industry consists of 128 registered local pharmaceutical manufacturing companies, 292 registered importers, 724 registered distributors as well as large number of unregulated manufacturing, importing and distribution businesses.[lxxix]It therefore appears reasonably to opine that Nigeria is not left out in Africa's low level of medical and pharmaceutical innovation. However, it is clear from our foregoing discussions that the Nigeria's rich source of bio-diversity has placed her in a more advantageous position to maximize her output in the global pharmaceutical industry. Hence, considering the health and economic importance of the pharmaceutical industry, innovation in the Nigerian pharmaceutical becomes of great importance.

2.3.4. Information and Communication Technology (ICT)

The Information and Communication Technology (ICT) has become an important component of the modern world. Its importance can never be overemphasized. Rapid advances in information infrastructure are dramatically affecting the acquisition, creation, dissemination, and use of knowledge, which in turn affects economic and social activities, including how manufacturers, service providers, and governments are organized, and how they perform their functions.[lxxx]A good ICT backbone is an absolute requisite for a functioning knowledge economy.[lxxxi] The advent of commercial internet and telecommunication usage globally had positively impacted the business community in different ways. It essentially expanded the number of business opportunities available to people. In effect, Internet is helping to create a perfect market environment where timely access to relevant information is frictionless.[lxxxii]

Nowadays, the internet provides access to almost the entire spectrum of human knowledge, but it is also a conduit for business services and a channel to market for Nigeria's software developers and other IT-enabled services.[lxxxiii] Nigerians need to be able to communicate with one another and access the internet for business, research, academic purposes, etc. Hence, innovation in the Nigerian ICT sector becomes imperative. Although the modern ICT sector in the country has a relatively new history when compared with the case in developed and emerging economies, the Nigerian government has over the past decade put in place a number of measures to facilitate and create a progressive environment for an enterprising ICT led economy. Among such measures are:

1. The establishment of the Nigerian Communication Commission (NCC) and the subsequent enactment of the Nigerian Communication Commission Act of 2003.
2. The introduction of a national policy for information and technology in January 2002. This was geared towards the use of ICT in promoting and supporting private sector industrial growth in Nigeria.[lxxxiv]
3. The liberalization of the ICT sector which made way for the licensing of private internet service providers, GSM providers, as well as commissioning of fixed wireless telephone companies in the country.[lxxxv]

Due to accelerated liberalization over the past 10 years, the Nigerian telecom sector has experienced outstanding growth rates in excess of 37 percent.[lxxxvi] Since the liberalization programme that commenced in 1999, the Nigerian ICT sector has become an active global force, with functional information (internet and data services) and an active communication sub-sectors (digital radio spectrum and telephone services).[lxxxvii] There are however many challenges in the ICT industry. Recently, the Global Innovation Index (GII) 2014 surveyed 143 economies around the world, using 81 indicators to gauge both their innovation capabilities and measurable results. In terms of ICT development, Nigeria ranks 112 out of the 143 economies surveyed in the GII 2014. This ranking reflects that Nigeria's ICT development is only 19. 4%. Nigeria was also ranked 131 (0.6 %) in terms of online creativity.[lxxxviii]

One of the challenges in the Nigerian ICT industry is high internet accessibility cost. It has been observed that although mobile internet access is increasingly becoming the service of choice for most business and residential customers, prices are still very high.[lxxxix]

Although internet penetration and usage in Nigeria continues to grow, it is however at a much slower pace than voice services. While the household penetration is low, most of the large towns and cities have Internet cafes that service much larger populations.[xc]Furthermore, the Nigerian internet market is plagued by poor network quality and sluggish rollout, as well as low fixed line and personal computer (PC) penetration. This is further compounded by the lack of a robust national fiber backbone for trunk transmission.[xci] Summarily, the development of ICT in Nigeria is still hampered by factors such as:

1. High internet cost, including costs of connection services, communication, hosting charges of websites and soon.
2. Still-low internet penetration and usage rates by international standards.
3. Limited competition in the industry.
4. Security challenges and inadequate regulatory framework.

The foregoing reflects the need for an enlightened entrepreneurial and technological innovation in the Nigerian ICT sector.

2.3.5. Power/Energy Sector

It has been proven over the years that constant power supply is the hallmark of a developed economy.[xcii] The standard of living of a given country can be directly related to the per capita energy consumption.[xciii] Therefore, any nation whose energy need is epileptic in supply, prolongs her development and risks losing potential investors.[xciv]Throughout the world, electricity is the most widely used and desirable form of energy. It is a basic requirement for economic development, national development, meeting the Millennium Development Goals (MDGs), and for an adequate standard of living.[xcv] Energy fuels productive activities including agriculture, commerce, manufacturing, industry, and mining. Future economic growth crucially depends on the long-term availability of energy from sources that are affordable, accessible, and environmentally friendly.[xcvi] Conversely, a lack of access to energy contributes to poverty and deprivation and can contribute to the economic decline. Energy and poverty reduction are not only closely connected with each other, but also with the socioeconomic development, which involves productivity, income growth, education, and health.[xcvii]

Electricity production in Nigeria over the last forty years has varied from gas-fired, oil-fired, hydroelectric power stations to coal-fired stations with hydroelectric power systems and gas-fired systems taking precedence. This is predicated by the fact that the primary fuel sources (coal, oil, water, gas) for these power stations are readily available.[xcviii]It has been practically advocated that renewable energy has an important role to play in meeting the future energy needs in both rural and urban areas of Nigeria.[xcix] The need for sustainable energy is rapidly increasing in the world. A widespread use of renewable energy is important for achieving sustainability in the energy sectors in both developing and industrialized countries. Moreover, Nigeria is blessed with a large amount of renewable natural resources, which, when fully developed and utilized, will lead to poverty reduction and sustainable development.[c]Therefore, the energy sector is very strategic to the development of the Nigerian economy. In addition to its macroeconomic importance, it has major roles to play in reducing poverty, improving productivity, and enhancing the general quality of life.[ci]

However, Nigeria has for the past thirty-three years of establishment of the National Electric Power Authority (NEPA) now Power Holding Company of Nigeria (PHCN) empowered with the electricity generation, transmission and distribution, witnessed frequent and persistent outages.[cii] Today, 60% to 70% of the Nigerian population lacks access to electricity.[ciii] The rural areas are worst affected due to little access to electricity. The daily needs of the rural populace for heat energy are therefore met almost entirely from fuel wood,[civ] thereby resulting in their use of costly and sometimes dangerous sources of energy. In the Global Innovation Index 2014 survey, Nigeria ranked 117 (166.4%) out of the 143 countries surveyed in terms of electricity output (kWh/cap). This ranking reflects a weakness in the country's electricity output. In terms of GDP/unit of energy use (2005 PPP$/kg oil eq.), Nigeria ranks 109 (3.1%).[cv]

The inefficiency as well as the inadequate facilities to boost electricity supply also have been the major causes of the increasing gap between the demand and the supply of electricity. These acute problems in the supply of electricity in Nigeria have hindered its development despite the nation's vast natural resource. Power generation facilities are either in poor shape or have inadequate gas supply. Also, the transmission and distribution networks are poorly maintained and inefficiently operated thereby making it difficult to move power from generation sites to consumption points. The economic environment is concerned with the set of economic conditions prevalent in an economy. Power supply constitutes one of those factors that affect the economic environment.[cvi] Therefore, unreliable, inadequate or complete lack of power supply affects an economy negatively. Such a condition is not favourable to the innovator-entrepreneur.

The Council for Renewable Energy of Nigeria estimates that power outages brought about a loss of 126 billion naira (US$ 984.38 million) annually.[cvii] Apart from the huge income loss, it has also resulted in health hazards due to the exposure to carbon emissions caused by constant use of 'backyard generators' in different households and business enterprises, unemployment, and high cost of living leading to a deterioration of living conditions.[cviii]The foregoing accounts for the reason why the Nigerian environment has little or nothing to offer so as to attract foreign innovators considering that the cost of providing power is high. Furthermore, most technological activities that require constant power supply are jettisoned because of unreliable power supply. Therefore, technological and entrepreneurial innovation in the Nigerian energy/power sector becomes imperative.

2.3.6. Emerging Issue: Biotechnology

Biotechnology, at its core, is about understanding life and using this knowledge to benefit people.[cix]Biotechnology has been defined as 'the processing of materials by biological agents.' The biological agents being microorganisms, cultured cells and enzymes.[cx]Biotechnology includes industrial activities based on fermentation, cell-culture and biocatalytic processes and those areas which involve the application of cellular and molecular biology. It also embraces emerging biotechnology, which is the integrated use of biochemistry, microbiology and engineering science in order to achieve the technological applications of the capacity of the microbes and tissue cells.[cxi]

Biotechnology is intimately tied to science and scientific knowledge and has been seen by many as a significant force in improving the quality of people's lives in the 21st century.[cxii] Biotechnology has played a significant role in providing processing, designing and production of valuable commercial products utilizable in many area of the society (e.g. agriculture, medical, health care, industry, environment, etc.).[cxiii]Biotechnology plays an important role in agriculture. Plant improvement by the traditional methods of selection and crossbreeding is as old as agriculture itself. However, according to Irefin, Ilori and Solomon,

- … These methods have been improved upon in the light of recent advances in the knowledge of genetics and physiology of plants. The effects have been the increase in the varieties and per hectare yields of crops such as maize, wheat and rice…. In addition to improving yield, the main purpose of selection is to obtain new varieties, which are resistant to parasites, as well as bacterial and viral diseases. A number of new techniques have been developed with the aim of reducing considerably the

> time needed for a new variety to be put on the market and brought into large-scale cultivation. They also make possible, crossbreeding of species that are too far apart for normal sexual reproduction, thereby creating an entirely new plant variety.[cxiv]

Biotechnology is also vital in animal production. Conventional farming has also benefited from animal biotechnology. For example, while cows produce milk in greater quantities, it is an established fact that sheep produce milk that is both more nutritious and better suited chemically for the manufacture of butter and cheese, than the milk from cows. Researches are in progress towards combining these traits.[cxv]

There is no doubt that genetic engineering will enhance the sustainability of agriculture by solving the very problems affecting conventional farming, and will save farmers of the developing world from low productivity, poverty and hunger.[cxvi] Genetic engineering is being applied to increase the production of pork products, by the insertion of a gene into pigs that boosts production of growth hormones. It is now possible to market the animals in 17 weeks instead of the current 22 to 25 weeks.[cxvii] Irefin, Ilori and Solomon noted that the knowledge of genetic engineering is also employed in the improvement of 'biological insecticides' – microbes that attack pests – and have enormous ecological advantages over their chemical counterparts.[cxviii]Nowadays, biotechnology plays an enormous role in improving health. It has been noted that the benefits deriving from biotechnological innovations will lead to major improvements in the health and well-being of the world population.[cxix]More recently, the biotechnology revolution has transformed the nature of drug discovery and the structure of the pharmaceutical industry.[cxx]

It has, however, been discovered that the problems with the application of biotechnology in developing countries are enormous. Planting biotechnologically improved seeds and other materials is an expensive venture, which cannot be afforded by many farmers in developing countries. For example, the seeds from tissue cultured plants are expensive so also are the genetically engineered seeds. Studies[cxxi] showed that in Nigeria, most farmers could not adopt the biotechnologically improved crop and varieties because of lack of money to buy the seeds and maintain them. Irefin, Ilori and Solomon stated that modified seeds and planting materials need adequate water through irrigation, fertilizers, pesticides and herbicide applications, which cost a lot of money. The reagents and enzymes needed are also very costly and because of their unstable nature, they cannot be stored for a long time. Also, the laboratories must be well staffed and fully equipped.[cxxii]

Technology transfer in biotechnology requires a minimum amount of technical and legal capability which Nigeria lacks at present. According to Irefin, Ilori and Solomon, while the benefits that accrue to the countries that have been actively engaged in biotechnology are immense, especially in agriculture, Nigeria is yet to reap these benefits of biotechnology. Although the country has a biotechnology policy, there is, however, no law at present for the purpose of working this policy. However, that is not to say that the country is totally inactive in this field. They noted that the fact is that, there were no empirical studies on the impacts of biotechnology in the area of agriculture. In a study conducted by them into the nature and extent of the agricultural biotechnology R&D and innovations in Nigeria, it was discovered that:

- "About 55% of the research scientists claimed that their engagement in agricultural biotechnology R&D and innovations was mainly for promotion, in order to enhance their status in their careers. This is unlike the developed and newly industrializing countries where research outputs are directed towards commercialization in order to gain competitive advantage and improve the economic well-being of the populace… About 15% of research scientists in biotechnology were ignorant of the procedure for patenting under the Nigerian legal system, while 30% claimed that the procedure was too rigorous. Probably these scientists (45%) were interested in the commercialization of their inventions but could not do so for the reasons stated above."[cxxiii]

Furthermore, the qualifications of researchers and their areas of specialization in agricultural biotechnology and other related areas indicate that, majority of the researchers had MSc (51.43%), and PhD (40%) as their highest qualifications in biotechnology and other related fields. This trend is expected because biotechnology R&D and innovations has high scientific R&D content and requires availability of highly qualified manpower that could handle very sophisticated equipment and processes. This outcome emphasizes the need for investment in capability building, most especially human resources development in this discipline. Hence, for any meaningful research output to be achieved the research institutes must be adequately staffed with highly qualified biotechnologists.[cxxiv] These highly qualified biotechnologists will indeed help to drive innovation in biotechnology R&D in Nigeria.

3. The Role of Innovation in the Economic Development of Nigeria

Innovation is a key driver of competitiveness, job growth, and a higher standard of living for future generations.[cxxv] This is because innovation is not just about invention and discovery, just as critical is the application of invention and discovery to economic good.[cxxvi]

According to the United Nations Development Programme (UNDP), technological breakthroughs 'are pushing forward the frontiers of how people can use technology to eradicate poverty', as they 'are creating new possibilities for improving health and nutrition, expanding knowledge, [and] stimulating economic growth.[cxxvii]

According to Odia and Omofonmwan, a review of Nigeria's economic development between 2000 to date revealed that overall macroeconomic policies and development strategies have failed to provide an enabling environment that could alter the structure of production and consumption activities in order to diversify the economic base. The country has continued to be a mono-cultural economy, depending on oil, indicating that the export base is yet to be diversified.[cxxviii] They further noted that Poverty and inequality

is wide spread with about 71 million Nigerians living below $1 a day. Socio statistics such as infant, (under 5) and maternal mortality rate as well as unemployment rate are higher than the averages for developing countries.[cxxix]
We shall at this point consider the roles innovation will play in the economic development of Nigeria.

3.1.1. Diversification of the Economy

From time immemorial, diversification of economies plays an important role in increasing the wealth of nations. A nation which has diverse sources through which it earns its income has greater potentials to defeat the risk of failure in its economy. The case of the United States has taught that science and technological innovation is necessary for the diversification of an economy. All other economic advantages to a great extent hinge on the diversification of the economy. Economic diversification brings about increased productivity which in turn is more likely to enhance economic growth. However, it is not enough that the economy is diversified. A relative balance of the proportions of the diversification is also as important as the diversification itself. It is for this reason that diversifying African economies is not an easy task. One of the key challenges is how to overcome over-specialization, whereby some countries have developed systems and know-how for one specific area of the economy but find it difficult to transfer these to other sectors and activities.[cxxx] This indeed speaks true of the case of Nigeria since its mono-cultural economy has made little impacts on its citizens, notwithstanding its rich natural resources.
Diversification of the Nigerian economy is long overdue. This is because countries dependent on just a few commodities for their revenue are vulnerable to boom and bust cycles as the prices of commodities are subject to wide fluctuations.[cxxxi] Salomon indeed rightly pointed out that heavy dependence on a small number of primary commodity products exposes a country to the negative effects of unfavorable characteristics of world demand and negative supply side features of these primary products.[cxxxii] Therefore, the need for expanding the beneficiation of such products, and seeking sustainable utilization where possible, are priorities for Nigerian economic growth and diversification.
It has been noted that among the various factors that have the potential to drive economic diversification, a country's natural resources are crucially important. These resources can be exploited to increase the range of exports and goods a country produces, especially through beneficiation, whereby additional value can be created from the resources extracted.[cxxxiii] Therefore, Nigeria in this regard has great advantages in the diversification of its economy.
However, as we have noted earlier in this work, the significance of technology over natural resources cannot be overemphasized. Whereas, a country that invests more in technology in the present relative to sole dependency on natural resources will have more of both technological goods and natural resources products in the future. The nation will thus experience more economic development.[cxxxiv]There is nothing that enhances diversification of the economy more than innovation. Advances in science and technological innovation have over the years helped to diversify the economies of the western world. The result is increased productivity which led to economic growth. Moreover, consistent economic growth is more likely to bring about economic development. It has also been noted that advances in Science and technology can help to diversify the Nigerian economy, by improving productivity in sectors like agriculture, while defining new ones.[cxxxv] Innovation in the Nigerian agricultural sector can help to incentivize a greater population of Nigeria to venture into the agricultural sector. This is realizable since the country has viable environment necessary for plant and animal productions.
Nigeria is blessed with a large population. A large population can to a great extent indicate large availability of market. Certain economic activities thrive where there is large availability of market. For instance, investments in information and communication (I&C), energy/power, pharmaceutical activities, etc., pay better where there is a large market for them. Moreover, as we have noted earlier in this work, information and communication technology (ICT) has made a recommendable impact on the Nigerian economy. Therefore, diversification of Nigerian economy by innovating in the ICT sector can boost the Nigerian economy the more by reducing the cost of communication, internet services, etc. Same is true in the case of other mentioned sectors. Just like the United States, diversification of the Nigerian economy will bring about increase in manufacturing activities. With time, these activities will mature to exportation activities which in turn will earn the country foreign exchanges. The Nigerian economy will thus be boosted.

3.1.2. Economic Growth

Economic growth results from several factors, but among the most important in recent decades has been innovation.[cxxxvi] Technological progress can, in principle, drive economic growth without limit, thanks to the unique properties of technological knowledge as an economic asset.[cxxxvii]
Economic growth closely depends on the synergies between new knowledge and human capital, which is why large increases in education and training have accompanied major advances in technological knowledge in all countries that have achieved significant economic growth.[cxxxviii] Therefore, the enhancement of a nation's human capital will lead to economic growth by means of the development of new forms of technology and efficient and effective means of production.[cxxxix]In today's knowledge-based world, information and communication technology (ICT) plays an increasingly central role in economic growth and productivity. According to Ismail and Giulia, recent evidence has shown that an increase of 10 mobile phones per 100 people can boost GDP growth by 0.6 percent and a 1 percent increase in the number of Internet users can increase total exports by 4.3 percent.[cxl]Innovation linked to new medical technologies has also become an important source of competitive advantage, especially in the emerging field of life sciences – a key driver of economic growth in the 21st century.[cxli]

Productivity, Export Growth and Foreign Exchange Earnings

Innovation is necessary for export growth. Countries that engage in export activities have greater potentials to earn foreign exchange. The words of Salomon are indeed worthy of note:

> "As recognized since the mercantilist era, export growth is critical for any country for a variety of reasons. At the macro level:
>
> 1) exports help generate foreign exchange;
> 2) export receipts are vital to finance import and exports;
> 3) the small size of many developing countries and their negligible purchasing power call for the need to explore larger market scales;
> 4) exports contribute to employment and growth of national product.
>
> At the micro level, it is now well established that:
>
> Exporting firms are more efficient than their counterparts selling primarily on domestic markets; and exporting firms serve as conduit for technology transfer and in generating technological spillovers with positive backward and forward linkages to domestic economy… Exporting firms are more productive than domestically oriented firms and help achieve higher growth."[cxlii]

According to Salomon, when export is concentrated in a few primary commodities, there can be serious economic and political risks. According to him, export diversification aims at mitigating these economic and political risks.[cxliii]Economic risks to be mitigated include: in the short term, volatility and instability in foreign exchange earning which have adverse macroeconomic effects (on growth, employment, investment planning, import and export capacity, foreign exchange cash flow, inflation, capital flight an undersupply of investments by risk averse investors, debt repayment); and in the long term, secular and unpredictable declining terms of trade trends which exacerbate short run effects.[cxliv] Manufactured exports are particularly highly employment intensive, especially when inputs (Capital and raw materials, labor) are sourced locally.[cxlv]

Increased productivity will help to boost Nigerian export potentials. For instance, Irefin and Ilori noted that the agricultural biotechnology R&D and innovations, if properly managed, will increase the level of production by increasing the yields and the nutritional levels of the crops. Nigerian export potentials and the provision of raw materials for the agro-industries will also get a boost by way of increased productivity.[cxlvi]Therefore, innovation is the cornerstone of the foregoing important roles of exports on an economy. Export diversification will help to put across the globe made-in-Nigeria goods, thereby bringing about economic development in the country.

3.1.3. Employment Opportunity, Standard of Living and Reduction of Poverty

In the 21st century, innovation is what produces wealth and creates jobs. History is quite clear on the importance of innovation to sustained job creation. The nations that have leveraged the fruits of science and technology for greater social and economic good have led the world in well-paying jobs and standard of living.[cxlvii]

Innovation is the key driver of competitiveness, wage and job growth, and long term economic growth.[cxlviii] Furthermore, ensuring a country is competitive and has sufficient capacity to innovate is also crucial because the number and quality of jobs is strongly dependent on these two concepts. As competitive businesses grow, they hire more workers and they also tend to pay well; a number of studies have shown that highly productive firms pay above-average wages.[cxlix] Furthermore, competitive and innovative firms create good jobs. Wages for workers in innovative and competitive firms tend to be higher than wages elsewhere.[cl]The United States Department of Commerce indicated that innovation leads to new firms. It stated that between 1980 and 2007, on average over 500,000 new businesses with employees started each year. These new firms produced an average of 3 million new jobs a year.[cli]

Indeed, science and technological innovations create more jobs than non-science firms and industries. According to the United States Department of Commerce, a report shows that the science, technology, engineering, and mathematics (STEM) workforce earned about 26 percent more than their counterparts in non-STEM occupations. The United States public investment in the human genome project, for example, had a return on investment of more than 14,000 percent in terms of economic output per federal dollar invested since 1988, and has led to the creation of millions of biotech jobs that could not have existed without it. Similarly, a seemingly tiny investment of the Defense Advanced Research Projects Agency (DARPA) spawned the Internet, giving rise to billions of dollars in economic activity, new businesses, and, more importantly, new ways of doing business.[clii]

The foregoing discussions have revealed that science and technological innovation enhances the standard of living of nations. Indeed, innovation will help to enhance the standard of living of Nigerians. For instance, incentivizing innovation in the pharmaceutical, power, ICT sector[cliii], biotechnological activities, etc., has the capacity to enable many Nigerians to put food on their table. Innovation in the power sector of Nigeria is a potential source of employment. When a good number of electricity companies crop up, invariably they will need human labour to operate and maintain the companies, which means creation of employment opportunities for the vast majority of Nigerians that are jobless.[cliv] Many graduate engineers and technologists roaming the streets in search of unavailable jobs will finally heave a sigh of relief as most of them will be absorbed by the emerging independent power producers.[clv]The private sector of course will play an important role in creating jobs. This will go a long way to reduce the level of poverty in Nigeria.

3.1.4. Improved Health Standard

Better health creates more wealth. Some decision makers recognize that the ultimate benefit of stronger pharmaceutical innovation in Africa goes beyond curing disease and delivering medicines; saying that a healthier workforce brings significant economic gains to a country, as people can better contribute to economic development.[clvi]Science and technology also play a key role in improving the quality of life. For instance, research in healthcare has proven vital to the prevention, diagnosis and treatment of various killer

diseases.[clvii] Furthermore, the genetic engineering or r-DNA techniques have applications in areas of health.[clviii] Technology and innovation can introduce significant improvement and services into health services. One of the best examples in this regard is the use of ICTs to introduce telemedicine services and to improve the management of health records.[clix]

It has been noted that the intellectual property (IP) system, and in particular the patent system, can play a pivotal role in relation to health-related development objectives as an incentive for innovation in the pharmaceutical field and as a policy tool to facilitate technology diffusion and access to essential drugs. Conversely, poorly structured IP systems, with an inappropriate balance between innovation and access, can hamper the ability of governments to deliver one of their primary development objectives, safeguarding the health of their populations.[clx]Therefore, pharmaceutical innovation is a vital part of improving and saving lives around the world. New medicines, vaccines and other medical tools have revolutionized medical practice in the past century, leading to incredible health improvements. Indirectly, these medical technology advances have contributed to economic and social development, by building healthier and more productive societies.[clxi]

Accordingly, innovation linked to new medical technologies has therefore become an important source of competitive advantage, especially in the emerging field of life sciences – a key driver of economic growth in the 21st century. In most industrialized countries, health care is among the largest sectors of economic activity.[clxii]

4. Challenges to Innovation in Nigeria

4.1.1. Institutional Framework

Our institutional framework focuses on the institutions that promote and protect innovation in Nigeria.

Nigeria lacks the manpower and modern technology for the efficient protection of innovations. The administration of intellectual property rights (IPRs) in Nigeria is incapacitated by inadequate skills and competence. Nigerian patent office lacks the wherewithal necessary for proper examination of inventions in respect of which patent is sought. Moreover, persons involved in the administration of the office and IPRs are usually not experts. The infrastructure for operation of IPR in Nigeria is still largely undeveloped. Information Technology has not been fully developed and applied towards encouraging proper research by intellectual property (IP) experts, students and scholars.[clxiii]

Furthermore, filing of applications IPR is always slow; the process of grant of IPR could be unnecessarily long due to the limited infrastructural facilities[clxiv] at the Trade Mark and Patent Registries. These infrastructure deficiencies have not encouraged business development in Nigeria and with bottlenecks in passage of goods and services across borders in the region.[clxv]To compound the problems, the Patents and Designs Act[clxvi] expressly provides that patents are granted at the risk of the patentee and without guarantee of their validity.[clxvii] Issues as to conformity with the statutory requirements are resolved only by the court of law on the application of an aggrieved person.[clxviii]

Examination of patent application in Nigeria is devastating whereas some other countries have quite a comprehensive approach to examination of patent application.[clxix] Babafemi noted that the examiner in most countries has powers to declare an application for a patent valid or invalid, the Registrar under the Nigerian Law performs purely administrative functions.[clxx] According to the learned author, administrative functions, as necessary as they are, are not sufficient to promote the most desired innovative inventions in this country.[clxxi]

Indeed, the powers of the Registrar as regards applications are severely limited. Once an application has complied with the statutory requirements, he has no choice but to grant the application. The registrar cannot enquire as to whether the subject matter of the application is patentable.[clxxii] He cannot also enquire as to whether the description and claims satisfy the statutory requirements.[clxxiii]

In some other countries (USA and India, especially), the patent office has trained examiners and the power in the first instance to resolve issues bordering on the merits of the invention against the conditions laid down for patentability, before the matter is further laid before the court for resolution. The merit of this is the reduction of litigations arising in relation to examination and grant of patent. The examination by the patent office is intended to cover all possible aspects of the patent law which may affect adversely the validity of the patent when it is granted. It is duty of the examiner to conduct search to discover the state of the art so that the novel elements of the invention can be identified. He can object that the invention is not an invention properly so-called, having regard to the nature of the subject-matter or it is not patently novel or even that the invention will not work.[clxxiv]

Therefore, procedure in Nigeria adopted for examination of inventions cannot be justified on the ground that the patent office is being over-burned with patent applications. With the present workload in our patent office, it is doubtful if the Nigerian patent office processes up to 20 patent applications a year. It is indeed baffling that under our present law, there is no provision for search at any stage of the process for patent application.[clxxv]Indeed, a situation like this holds no hope of incentivizing innovation in the country.

4.1.2. Human Capital

Burda and Wyplosz defined human capital as the education, training, or work experience acquired by individuals. Its accumulation is very similar to that of physical capital.[clxxvi] Lucas' endogenous growth theory has shown that countries with a larger stock of human capital experience higher growth rates.[clxxvii] Highly skilled and flexible human capital is essential to compete effectively in today's world and is a key building block of a knowledge-based economy. Such human capital enables a nation to adopt, adapt, use, and produce knowledge, and becomes central to its development.[clxxviii]Human capital provides an interpretation of both the lack of convergence between rich and poor countries and the link between growth, investment and saving. The more a country saves to invest

in human capital accumulation, the faster it will grow.[clxxix] Therefore, there is no reason to refrain from accumulating human capital forever.[clxxx]

The efficiency of local imitation and the potential for a country to adopt, improve a new technology is dependent on its human capital measure.[clxxxi] Highly human capital abundance has two implications: first, it implies that local imitation is efficient and less costly; on the other hand, it indicates that local workers are more capable of adapting and improving the technology, thereby implying less training and licensing cost for the innovator. In the latter case, this cost effect encourages licensing activities.[clxxxii]

Recently, the Global Innovation Index (GII) 2014 surveyed 143 economies around the world, using 81 indicators to gauge both their innovation capabilities and measurable results. In terms of human capital development, Nigeria ranks 134 out of the 143 economies surveyed in the GII 2014. This ranking reflects that Nigeria's human capital development is only 12. 2 percent.[clxxxiii] Thus, Nigeria lacks highly developed human capital in virtually all sectors of her economy.

According to Ogbu and Nwalo, no more than 10% of the Nigerian firms are approaching international standards of performance on practices such as human resources, innovation and offshore investments.[clxxxiv] This evidences the fact that both small and large Nigerian firms are adversely affected by lack of human capital. Small Nigerian firms often do not have the human resources to undertake R&D in-house. Even for those progressive firms who have developed internal R&D capabilities, the availability of required skills continues to be a major issue.[clxxxv]

Education is very imperative for the development of a nation's human capital. Economic theory also supports the idea of education as a driver of growth and innovation. Investment in education improves human capital and the capacity to innovate.[clxxxvi]While many universities around the world are at the center of innovations, Nigerian universities are yet to realize how important their role is in driving innovation in Nigeria.[clxxxvii]Hence, Nigerian Universities over the years cannot drive innovation in Nigeria.

The academic sector of Nigeria continues to witness low supply of human capital in science and technology. According to Ogbu and Nwalo,

- "Of more interest is the potential future supply of human resources in science and technology, which can be projected on the basis of student enrolments in these areas. In 1996, over 4,480 students graduated in science and engineering fields, accounting for about 20% of all graduates. This reveals a large increase over the 1990 graduate figure of 2,560. However, as a proportion of total graduates, there was a slight decrease over this period (from 24% to 20%)."[clxxxviii]

The curriculum used in the universities is such that does not support innovation and entrepreneurship. This has resulted in a big knowledge gap.[clxxxix]Many Nigerian higher education institutions have few formal linkages to industry, and as a result tend to continue teaching outdated materials and producing graduates who are ill-equipped for the working environment. The major cause of the poor standard of education is that Nigerian government over the years does not give the needed priority and attention to higher education in the country. The universities are poorly funded by the government resulting in brain drain, Infrastructural deficiency, knowledge gap, poor ethical standards and inability to drive innovation in Nigeria.

4.1.3. Research/Innovation Infrastructure

Research and development is the key to global competitiveness. Those working in Research and Development (R&D) of new technologies tend to spawn new and profitable businesses faster than others.[cxc] This, therefore, enables faster economic development of a nation. In terms of Research and Development (R&D), Nigeria ranks 108 out of the 143 economies surveyed in the GII 2014. This ranking reflects that Nigeria's R&D is only 1. 9%.[cxci]Therefore, Nigeria's research capability and output is too low.

Doing academic research for innovation is a major goal of the universities. However, in Nigeria, there is very low interest in research. Many university dons do not have the zeal to carry out research work. This is unlike the developed and newly industrializing countries where research outputs are directed towards commercialization in order to gain competitive advantage and improve the economic well-being of the populace.[cxcii]

Research facilities and innovation infrastructures are crucial for the development of a nation's research and development. Therefore, lack of them will debilitate against innovation. It is obvious that Nigeria is not only lacking human capital but lacks the necessary research facilities and innovation infrastructures. Even where they available, they are either in poor state or in shambles. Obviously, many Nigerian firms still have short rather than long term outlook. This accounts for why most view R&D as an expense and not as an investment.[cxciii] Furthermore, many Nigerian firms lack the requisite innovation infrastructure and tend to be risk averse in adopting new technologies.[cxciv]

4.1.4. Sophisticated Business Community

The competitiveness of the business community of science and technological industries makes it highly sophisticated. Hence, business sophistication becomes imperative for a nation's competitiveness in global innovation. Business sophistication concerns the quality of a country's overall business networks as well as the quality of individual firms' operations and strategies. This is particularly important for countries at an advanced stage of development, when the more basic sources of productivity improvements have been exhausted to a large extent. Business sophistication is conducive to higher efficiency in the production of goods and services. This leads, in turn, to increased productivity, thus enhancing a nation's competitiveness.[cxcv]

Therefore, higher productivity in the production of produce and services is the result of business sophistication, which in turn, results in increasing of efficiency, thus enhancing the competitiveness of a nation. Moreover, business sophistication plays a main role in a country's economy which means that it controls the quality of a country's business networks and strategy of individual firms in

general.[cxcvi]However, the Global Innovation Index (GII) 2014 survey has indicated Nigeria's low level of business sophistication. Nigeria, therefore, ranked 128 out of 143 economies surveyed in the GII. Her business sophistication is only 21.3 percent. Science and technology business is a competitive and sophisticated business community. The score indeed reveals Nigeria's low level of competitiveness in science and technology. She, therefore, cannot measure up in such business community.

5. Observations

Undoubtedly, Nigeria is lagging behind in global innovation. There are many factors contributing to this state of predicament.

1. After decades of independence, Nigeria has not made any significant change in its IP laws, the laws have remained outdated. Nigeria still lags behind in developing an indigenous law that will address basic issues on IPRs germane to its economic and social-cultural environment.
2. At present, Nigeria's innovation policy is yet to make an impact on its economy. Moreover, her biotechnology policy lacks a law that will help to achieve the policy.
3. Nigeria lacks the manpower and modern technology for the efficient operation of intellectual property right (IPR) and protection of innovations.
4. The level of innovation and technology in Nigeria is indeed very low. It is practically evident that Nigerian scientists, industries and firms lag behind in the field of science and engineering.
5. Nigeria imports petroleum products despite being a major producer of crude.
6. Inadequate or lack of supply of human capital and skill may continue to plague the development of technological innovation in Nigeria over time if not tackled. Poor education system has contributed to this predicament. The three key problems of the Nigerian education system are access, quality, and funding.
7. Nigeria's research capability and output is too low. Moreover, there is very low interest in research. Nigeria lacks the necessary research facilities and innovation infrastructures. Even where they available, they are either in poor state or in shambles.
8. The country is currently faced with acute problems in the supply of electricity, which has hindered its development despite the nation's vast natural resource. Power generation facilities are either in poor shape or have inadequate gas supply. Also, the transmission and distribution networks are poorly maintained and inefficiently operated thereby making it difficult to move power from generation sites to consumption points. The foregoing accounts for the reason why the Nigerian environment cannot attract foreign innovators considering that the cost of providing power is high. Furthermore, most technological activities that require constant power supply are jettisoned because of unreliable power supply.
9. Nigeria's status as an agricultural powerhouse has declined, and steeply.
10. One of the challenges in the Nigerian ICT industry is high Internet accessibility cost. The country continues to face an inadequate supply of more and better ICT services for Nigerians as well as significant gaps in key market segments, especially Internet.
11. The Nigerian local market of pharmaceutical producers (accounting for an estimated 35.0 percent of market size) is a highly fragmented one. It therefore appears reasonably to opine that Nigeria is not left out in Africa's low level of medical and pharmaceutical innovation.

6. Recommendations

1. This study recommends that the Nigerian Patent and Designs Act should be amended. In addition to the weaknesses in the said Act exposed in this study, the purports of the amendment specifically include putting the Registrar of patents and Design in a position to examine and invalidate any patent on grounds of non-compliance with the requirements of the law. The Act should also be amended to make provision for publication of patent application prior to grant of patent, so as to afford the public the opportunity to oppose applications for patent grant, where they warrant such opposition.
2. Nigeria's innovation policy should center on a number of critical policy domains: economic, regional and industry development, labour market and industrial relations policy, education policy, science and technology policy and immigration policy. This article recommends positive technology policy which should provide sufficient protection to indigenous technology and also open doors to import technology from foreign countries for general national development and productivity. Policy objectives should minimize the risks associated with innovation (e.g. a stable and supportive macroeconomic policy). Innovation policy should act to enhance returns to investment in R&D, and innovation generally, while keeping costs to a minimum. This is because firms will only invest in innovation if they can expect sufficient private returns. Furthermore, there should be fiscal policies that act to reduce expenditures on innovation-related investment in order to incentivize people to innovate. Policy objectives should be geared towards disseminating to the public information with respect to innovation and intellectual property right, especially patent.
3. Capable hands should be employed to administer intellectual property rights in Nigeria. Provisions should be made for adequate infrastructure for operation of IPR in Nigeria.
4. Emphasis should be placed on the acquisition and adoption of foreign technology through licensing, purchasing, know-how, patents, brands, consulting services and technology transfer agreements. Nigeria should not yet venture into bogus and sophisticated technologies (research and development in same should be encouraged). However, this should not discourage Nigeria from moving into innovation. We recommend that rather than avoiding technological innovation, we should begin

with simple innovations, while placing emphasis on adopting technology. Nigeria can always work with technological powers where situation warrants it.

5. In spite of the drive for economic diversification, Nigeria should continue to develop the oil and gas sector due to the nation's huge reserves**.** The government should continue to encourage the establishment of private refineries and upgrade existing ones to increase the production of refined oil. Oil and gas producing companies should be encouraged to gather and utilize associated gas to eliminate flaring.
6. It is paramount that Nigeria focuses on education and invests in the sector. The Government should increase its funding on education by allocating more to the sector in its budget. This will make education to be accessible to a greater population of Nigeria. Government has the duty to create the enabling environment for the universities to drive innovation in Nigeria. Therefore, education facilities and infrastructures should be unsparingly provided in all levels of education in Nigeria. Nigeria needs to strengthen the quality of teaching in math and science if we must become a full-fledged knowledge economy. A sizable cohort of people educated in math and the sciences helps a country internalize technology and innovations developed abroad, and one day make the jump and develop new ones locally. In this way, the human capital of Nigeria will be greatly improved. Like India, Nigerian Government should be encouraging expatriate Nigerians to return home and help build our local human capital so as to meet up with international competitiveness.
7. Research and development is the key to global competitiveness. Therefore, Government should provide direct support for research in government funded institutions. The capacity of existing research and development facilities should be enhanced. Strong alliances with universities should be formed to develop intensive new curricula in science and technology and to conduct joint research on new technologies. Manufacturing companies should be encouraged to invest a certain percentage of their annual turnover on research and development. Institutions are identified as critical; thus the existing ones, especially research institutes, need to be funded and equipped to conduct value added R&D for the economic development of Nigeria. Government should encourage research collaboration between higher institutions (national and international), research institutions and industries.
8. Since Nigeria is blessed with abundant renewable energy resources such as hydroelectric, solar, wind, tidal, and biomass, there is a need to harness these resources and chart a new energy future for Nigeria. In this regard, the government has a responsibility to make renewable energy available and affordable to all. This will go a long way to provide constant, high quality power supply in the country which will improve the Nigerian business environment.
9. Government policy for the agricultural sector should be geared towards providing for more training and learning support for enhancing both technical knowledge and organizational and management skills. The policy should also be intended to make modern agricultural equipments for sale and hire available to farmers at a subsidized price.
10. Policy for the ICT sector should be targeted at encouraging research and development as well as that would facilitate and enhance local management, capacity and content development in the key areas of ICT. The implementation of this policy should be driven mainly by the private sector, promoting entrepreneurship, innovation and local capacity development, while the government will be the facilitator and catalyst for the projected growth.
11. Since Nigeria has a comparative advantage in the area of pharmaceutical innovation, which includes development and production using African Traditional Medicine and the continent's rich biodiversity as raw materials of choice, emphasis should be placed on sourcing materials locally. Furthermore, faking, smuggling and dumping of sub-standard products into the country should be stopped to ensure a level playing field for local manufacturers.

7. Conclusion

In the present era, in all ramifications of economic development, technology-dependent economies surpass economies dependent on their natural resources. Therefore, the economies that can remain flexible, adaptive, and innovative will reap the benefits of world trade. This is because the global competitiveness of any economy depends on its science, technology and innovation (STI) capabilities.

Based on the result generated through the analysis of our data which revealed that Nigeria is currently lagging behind technologically, our hypothesis that innovation in science and technology will bring about the diversification of the Nigerian economy, leading to economic growth: employment, productivity, export growth and increased foreign exchange earnings, including healthy and prosperous Nigeria, were all upheld.

8. References

i. Okoye, I. K., 'Political Leadership in African Development: Imperatives for the 21st Century, in Ojiakor Ngozi E., Unachukwu G.C. & Obiajulu Andrew, (eds.),Challenges of National Growth and Development in Nigeria (Enugu: John Jacob's Classic Publishers Ltd, 2000), p. 104.

ii. Adeoti et al., 2008, cited in Dada, A. D., 'Evaluation of Technological Capability and Innovations in the Nigeria Cassava Processing Industry,' p. 2 (WWW document) URL http://www.redesist.ie.ufrj.br/ga2012/paper/AbolajiDaudaDada.pdf (visited 2014, July 31).

iii. Dubey, R. C., A Textbook of Biotechnology, (New Delhi: S Schand & Co. Ltd., 1993) (revised edition, 2006), p. 606.

iv. Jide Babafemi, Intellectual Property: The Law and Practice of Copyright, Trademarks, Patents and Industrial Designs in Nigeria (Ibadan: Justinian Books Ltd, 2006), p.342.

v. Uchechukwu Uguru, 'Property and Intellectual Rights,' in Egwu U. Egwu, et al., (eds.), Entrepreneurship and Intrapreneurship: Principles and Practice (A Book of Readings) (Abakaliki: Ebonyi State University Press, 2011), p. 86.
vi. See Maskus, Dougherty and Mertha, op. cit., p. 299.
vii. Ibid.
viii. See Segun Oyedepo, op. cit.
ix. p. 298. Ibid.
x. Sherwood, Robert M., 1990, cited in Maskus, Dougherty and Mertha, op. cit., p. 299.
xi. Maskus, Dougherty and Mertha, p. 302. Ibid.
xii. Patentable inventions, simply put, are inventions which qualify under the law to be granted a patent.
xiii. Note that capability of industrial application is also a sine qua non of patentability. See the case of James Oitomen Agbonrofo v. Grain haulage and Transport Ltd (1998) F.H.C. L. 236.
xiv. See section 1(1), of the Patents and Designs Act, Cap.P2, Laws of the Federation of Nigeria, 2014.
xv. See section 1(2)(a). Ibid.
xvi. Section 1(3). Ibid.
xvii. Exhibition of the invention in a bookshop or display on a library shelf constitutes publication. Furthermore, it is not necessary that the document should have been sold in order to constitute publication. See Van der Lady v. Bamford (1963) R.P.C. 61.
xviii. See section 1(1)(b). Patents and Designs Act, Cap.P2, Laws of the Federation of Nigeria, 2014.
xix. Section I (4) (a)–(b).Ibid.
xx. Section 2(2). Ibid.
xxi. Section 2(3). Ibid.
xxii. Section 3(1)(a). Ibid.
xxiii. Section 3(1) (a)(i)-(iv). Ibid.
xxiv. Section 3(2). Ibid.
xxv. Section 3(3)(a)-(b). Ibid.
xxvi. Section 3(1)(b). See generally Rule 11 of the Patent Rules. Ibid.
xxvii. Section 4(1) of the Patents and Designs Act.
xxviii. See Rule 14; note also Section 4(2), Patents and Designs Act Patents and Designs Act, Cap.P2, Laws of the Federation of Nigeria, 2014.
xxix. Section 4(2). Ibid.
xxx. Section 5(1). Ibid.
xxxi. See section 4(4). Ibid.
xxxii. Section 6(1). Ibid.
xxxiii. Section 6(2). Ibid.
xxxiv. Section 6(3). Ibid.
xxxv. O.O. Jegede. 'Knowledge Sharing and Innovation as it Affects the Local Content in the Oil and Gas Industry in Nigeria,' https://www.academia.edu/login?cp=/attachments/31287443/download_file&cs=www p. 1 (www document) URL (visited 2014, September 10).
xxxvi. Oyejide, T. A and Adeolu, O. A. 'Enhancing Linkages of Oil and Gas Industry in the Nigerian Economy,' MMCP Discussion Paper No 8, University of Cape Town and Open University, March 2011. p. 12 (www document) URLhttp://commodities.open.ac.uk/8025750500453F86/%28httpAssets%29/6D572F58F7E2A83B8025787E003A7258/$file/Enhancing%20linkages%20of%20oil%20and%20gas%20industry%20in%20the%20Nigerian%20economy.pdf (visited 2014, September 10).
xxxvii. p. 3. Ibid.
xxxviii. Jegede O.O. 'Assessment of Technological Innovations in Selected Indigenous Oilfield Servicing Firms in Nigeria,' http://www.ungs.edu.ar/globelics/wp-content/uploads/2011/12/ID-203-Jejede-Llori-Siyanbola-Sonibare-Abereijo-Learning-and-innovation-lessons-from-sectorial-.pdf p. 1 (www document) URL (visited 2014, September 10).
xxxix. Oil and Gas Journal, http://ogj.pennnet. com/datastats/datastats.cfm), cited in O.O. Jegede,p. 2. Ibid.
xl. O.O. Jegede, op. cit., p. 1.
xli. Ibid.
xlii. Jegede O.O., op. cit., p. 2.
xliii. See http://www.eia.doe.gov/emeu/cabs/ nigeria.html, cited in O.O. Jegede,op. cit., p. 2.
xliv. Jegede et al., 2011, cited in O.O. Jegede, p. 1. Ibid.
xlv. O.O. Jegede, p. 5. Ibid.
xlvi. Ibid.
xlvii. See Onuorah, 1999, cited inIrefin, I.A., Ilori, M.O. and Solomon, B.O. (2005). 'Agricultural Biotechnology R&D and Innovations in Nigeria', Int. J. Agricultural Resources, Governance and Ecology, Vol. 4, No. 1, pp.64–80. p. 6 (www document) URL http://www.environmental-expert.com/Files/6471/articles/6357/f810512623911174.pdf (visited 2014, August 3rd).
xlviii. Adam, op. cit.

xlix. Ragasa, C. 'Strengthening Innovation Capacity of Nigerian Agricultural Research Organizations,' p. 25 (www document) URL http://www.ifpri.org/sites/default/files/publications/ifpridp01050.pdf (visited 2014, September 13th).
l. See Ogbonna, 1999, cited in Irefin, Ilori and Solomon, op. cit., p. 6.
li. Adam, op. cit.
lii. See Odebode 2008, cited in Irefin, Ilori and Solomon, op. cit., p. 6.
liii. Adam, op. cit.
liv. Akinwumi, A. 'Agricultural Transformation Agenda: Repositioning agriculture to drive Nigeria's economy' (November 2012) http://www.emrc.be/documents/document/20121205120841-agri2012-special_session-tony_bello-min_agric_nigeria.pdf (www document) URL (visited 2014, September 13).
lv. See generally, p. 1. Ibid.
lvi. Adam, op. cit.
lvii. Ragasa, op. cit., p. 11.
lviii. Ibid.
lix. p. 11. Ibid.
lx. Ibid.
lxi. p. 71. Ibid.
lxii. P. 44. Ibid.
lxiii. Berger, M, et al. 'Strengthening Pharmaceutical Innovation in Africa,' Council on Health Research for Development (COHRED); New Partnership for Africa's Development (NEPAD) 2010. p. 15 (www document) URLhttp://www.nepad.org/system/files/str.pdf (visited 2014, September 11).
lxiv. p. 12. Ibid.
lxv. International Federation of Pharmaceutical Manufacturers Associations (IFPMA) (2004, October), 'The Pharmaceutical Innovation Platform,' http://www.who.int/intellectualproperty/Pharmaceutical_innovation.pdf p. 10 (www document) URL (visited 2014, September 11).
lxvi. Ibid.
lxvii. Ibid.
lxviii. Danzon, P. M. 'Economics of the Pharmaceutical Industry,' http://www.nber.org/reporter/fall06/danzon.html (www document) URL (visited 2014, September 11).
lxix. IFPMA, op. cit., p. 10.
lxx. Ibid.
lxxi. See Organisation for Economic Co-operation and Development (OECD), Science, technology and innovation for the 21st century. Meeting of the OECD Committee for Scientific and Technological Policy at Ministerial Level, 29-30 January 2004, Final Communiqué, cited in. IFPMA, op. cit., p. 14.
lxxii. Witty, A. 'New Strategies for Innovation in Global Health: A Pharmaceutical Industry Perspective,' Health Affairs, 30, no.1 (2011):118-126 doi: 10.1377/hlthaff.2010.0933 http://content.healthaffairs.org/content/30/1/118.full.pdf+html p. 2 (www document) URL (visited 2014, September 11).
lxxiii. IFPMA, op. cit., p. 10.
lxxiv. p. 53. Ibid.
lxxv. See Fighting Fake Pharmaceuticals: small steps. Nigeria attacks fakes. Authentication News, 2003, available at
a. www.authenticationnews.info, Cited in IFPMA, op. cit., p. 14.
lxxvi. Berger, et al., op. cit., p. 16.
lxxvii. p. 20. Ibid.
lxxviii. Ibid.
lxxix. See Nigeria vision 20:2010: Economic Transformation Blueprint, December 2009, p. 56.
lxxx. See Ismail Radwan & Giulia Pellegrini. 'Knowledge, Productivity, and Innovation in Nigeria: Creating a New Economy.' p.79 (WWW document) URLhttps://openknowledge.worldbank.org/bitstream/handle/10986/2424/536450PUB0Inno101Official0use0Only1.pdf?sequence=1 (visited 2014, July 31st).
lxxxi. p. 86. Ibid.
lxxxii. Ezeoha, A. E., 'New Opportunities For Business Expansion,' in Egwu U. Egwu, et al., (eds.), Entrepreneurship and Intrapreneurship: Principles and Practice (A Book of Readings) (Abakaliki: Ebonyi State University Press, 2011), p. 389.
lxxxiii. See Ismail & Giulia, op. cit., p. 86.
lxxxiv. Ezeoha, op. cit., p. 410.
lxxxv. Ezeoha, op. cit., p. 411.
lxxxvi. See Ismail & Giulia, op. cit., p.5.
lxxxvii. See Ezeoha, op. cit., p. 408.
lxxxviii. See generally the Global Innovation Index 2014: 'The Human Factor in Innovation' p. 235 (www document) URL http://www.wipo.int/export/sites/www/freepublications/en/economics/gii/gii_2014.pdf (visited 2014, August 15).
lxxxix. Ismail & Giulia, op. cit., p. 83.

xc. See Ismail & Giulia, op. cit., p.83.
xci. p. 83. Ibid.
xcii. Okoro, O. I and Chikuni. E. 'Power Sector Reforms in Nigeria: Opportunities and Challenges,' p. 1 (www document) URL http://www.erc.uct.ac.za/jesa/volume18/18-3jesa-okoro.pdf (visited 2014, September 10).
xciii. Sunday Olayinka Oyedepo, 'Energy and Sustainable Development in Nigeria: the way forward,' http://www.energsustainsoc.com/content/pdf/2192-0567-2-15.pdfp. 8 (www document) URL (visited 2014, September 10).
xciv. Okoro and Chikuni. Op. cit.
xcv. Oyedepo, op. cit., p. 8.
xcvi. Ibid.
xcvii. Nnaji C et al (2010) In: Nnaji CE, Uzoma CC (eds), cited in Oyedepo, (front page). Ibid.
xcviii. Okoro and Chikuni. Op. cit.
xcix. See Hui SCM, 1997, cited in Oyedepo, p. 9. Ibid.
c. Oyedepo, p. 9. Ibid.
ci. p. 11. Ibid.
cii. Okoro and Chikuni, op. cit., p. 2.
ciii. Oyedepo. Op. cit., front page.
civ. p. 2. Ibid.
cv. See generally the Global Innovation Index 2014, op. cit., p. 235.
cvi. Udu, A. A., 'Entrepreneurs and Nigerian Business Environment,' in Egwu U. Egwu, et al., (eds.), Entrepreneurship and Intrapreneurship: Principles and Practice (A Book of Readings) (Abakaliki: Ebonyi State University Press, 2011), p. 56.
cvii. Council for Renewable Energy, Nigeria (CREN) (2009) Nigeria Electricity Crunch. available at www.renewablenigeria.org, cited in Oyedepo, op. cit., p. 1. Ibid.
cviii. Oyedepo, p. 1. Ibid.
cix. Dubey, R. C., A Textbook of Biotechnology, (New Delhi: S Schand & Co. Ltd., 1993) (revised edition, 2006), p. 602.
cx. See Bull, Holt and Lilly, 1982, cited in Irefin, Ilori and Solomon, p. 8. Ibid.
cxi. Ibid.
cxii. Dubey, op. cit., p. 602.
cxiii. Dubey, p. 605. Ibid.
cxiv. See Bull, Holt and Lilly, 1982, cited in Irefin, Ilori, and Solomon, op. cit., p.2.
cxv. p. 4. Ibid.
cxvi. See Gresshoff, 1996, cited in Irefin, Ilori, and Solomon, op. cit., p. 5.
cxvii. See Raines, 1988, cited in Irefin, Ilori, and Solomon, op. cit., p. 5.
cxviii. Irefin, Ilori, and Solomon, p. 5. Ibid.
cxix. Dubey, op. cit., p. 602.
cxx. Danzon, op. cit.
cxxi. Irefin, 2003, cited in Irefin, Ilori, and Solomon, op. cit., p. 4.
cxxii. UNDP, 1989, cited in Irefin, Ilori and Solomon, p. 5. Ibid.
cxxiii. Irefin, Ilori, and Solomon, p. 6. Ibid.
cxxiv. p. 9. Ibid.
cxxv. U.S. Department of Commerce. (2012, January). 'The Competitiveness and Innovative Capacity of the United States,' p. 31 (www document) URL http://www.commerce.gov/sites/default/files/documents/2012/january/competes_010511_0.pdf (visited 2014, October 10).
cxxvi. Sean, P. (2011, September 8). 'Creating Jobs by Investing in Innovation,' (www document) URL http://scienceprogress.org/2011/09/creating-jobs-by-investing-in-innovation/ (visited 2014, October 10).
cxxvii. United Nations Development Programme (UNDP), Human Development Report 2001: Making new technologies work for human development. UNDP 2001, cited in IFPMA, op. cit., p. 53.
cxxviii. Odia, L. O. and Omofonmwan, S. I. (2013, May).'Research and Development Initiatives in Nigeria: Challenges and Prospects,' p. 259 (www document) URL http://www.mcser.org/journal/index.php/mjss/article/viewFile/212/197 (visited 2014, October 9).
cxxix. Fakiyesi and Ajakaiye, 2009, cited in Odia and Omofonmwan, op. cit., p. 259.
cxxx. OECD, United Nations OSAA. (2011). 'Economic Diversification in Africa: A Review of Selected Countries,' p. 8 (www document) URL economic_diversification_africa_2011Jan FOR
    a. http://www.un.org/africa/osaa/reports/economic_diversification_africa_2011Jan.pdf (visited 2014, October 10).
cxxxi. p. 9. Ibid.
cxxxii. Salomon, S. (2010, May). 'A Primer on Export Diversification: Key Concepts, Theoretical Underpinnings and Empirical Evidence,' p. 7 (www document) URL https://blogs.worldbank.org/files/growth/EXPORT_DIVERSIFICATION_A_PRIMER_May2010%281%29.pdf (visited 2014, October 10).
cxxxiii. OECD, United Nations OSAA, op. cit., p. 9.

cxxxiv. Indeed, product possibilities curve in economics has evidently shown that a nation that allocates more resources in the present to the production of capital goods relative to consumer goods will have more of both kinds of goods in the future. The nation will thus experience more economic growth. Udaba, S. I., Basic Economic Theory and Principles (Enugu: Linco Press Nig. Ltd. 1999),p. 33.
cxxxv. Wale, M. 'Science and Technology – The Key to Nigeria's Transformation (by Ngozi Okonjo-Iweala) (www document) URLhttp://walemicaiah.blog.com/2012/12/19/science-and-technology-%E2%80%93-the-key-to-nigeria%E2%80%99s-transformation-dr-ngozi-okonjo-iweala/ (visited 2014, July 31).
cxxxvi. U.S. Department of Commerce, op. cit., p. 61.
cxxxvii. P.62. Ibid.
cxxxviii. p. 67. Ibid.
cxxxix. Odia and Omofonmwan, op. cit., p. 260.
cxl. National Media, 2007, cited in Ismail & Giulia, op. cit., p. 79.
cxli. IFPMA, op. cit., p. 10.
cxlii. Salomon, op. cit., p. 5.
cxliii. p. 6. Ibid.
cxliv. Ibid.
cxlv. p. 5. Ibid.
cxlvi. Irefin , Ilori and Solomon, op. cit., p. 6.
cxlvii. Sean, op. cit.
cxlviii. U.S. Department of Commerce, op. cit., p. v.
cxlix. p. 33. Ibid.
cl. p. 34. Ibid.
cli. Ibid.
clii. Sean, op. cit.
cliii. This sector has practically created diverse jobs in Nigeria such as phone call centres, Internet cyber cafes, recharge card printing jobs, to mention but a few.
cliv. Okoro and Chikuni, op. cit., p. 5.
clv. p. 4. Ibid.
clvi. Berger, M, et al., op. cit., p. 17.
clvii. Wale, op. cit.
clviii. Irefin, Ilori and Solomon, op. cit., p. 2.
clix. IAEA, ITU, UNESCO, UNOOSA, WIPO, 'Science, technology and innovation and intellectual property rights: The vision for Development,' p.7 (www document) URL http://www.un.org/millenniumgoals/pdf/Think%20Pieces/11_ips_science_innovation_technology.pdf (visited 2014, October 10).
clx. IAEA, ITU, UNESCO, UNOOSA, WIPO, op. cit., p. 7.
clxi. p. 8. Ibid.
clxii. p. 10. Ibid.
clxiii. Nwokocha, op. cit., p. 9.
clxiv. Including but not limited to inadequate electricity supply, inadequate communication system, poor road network and insufficient Information Technology know-how.
clxv. Nwokocha. Op. cit.
clxvi. Cap. P2, Laws of the Federation of Nigeria, 2004.
clxvii. See section 4(4) of the said Act.
clxviii. See section 26. Ibid.
clxix. Babafemi, op. cit., p. 379.
clxx. Ibid.
clxxi. Ibid.
clxxii. See section 4(4) (a) of the Patents and Designs Act. 2004.
clxxiii. See section 4(2) (b). Ibid.
clxxiv. Babafem, op. cit., p. 378.
clxxv. p. 379. Ibid.
clxxvi. Burda and Wyplosz, Macroeconomics: a European Text (New York: Oxford University Press Inc. second edition, 1997), p. 125.
clxxvii. Lukas, 1988, cited in Ismail & Giulia, op. cit., p. 28.
clxxviii. See Ismail & Giulia, p.27. Ibid.
clxxix. Burda and Wyplosz, Macroeconomics, op. cit., p. 125.
clxxx. p. 127. Ibid.
clxxxi. See Yang and Maskus, op. cit., p.117.

clxxxii. Ibid.
clxxxiii. The Global Innovation Index 2014, op. cit., p. 235.
clxxxiv. Ogbu and Nwalo, 'Technological Entrepreneurship,' in Egwu U. Egwu, et al., Entrepreneurship and Intrapreneurship: Principles and Practice (A Book of Readings) (Abakaliki: Ebonyi State University Press, 2011), p. 146.
clxxxv. p. 147. Ibid.
clxxxvi. See Ismail & Giulia, op. cit., p.28.
clxxxvii. Omeruo, k. (2013, October 17). 'Why Nigerian Universities Cannot Drive Innovation in Nigeria' (www document) URL http://techtrendsng.com/nigerian-universities-drive-innovation-nigeria/ (Visited 2014, July 31).
clxxxviii. Ogbu and Nwalo, op. cit., p. 147.
clxxxix. Omeruo, op. cit.
cxc. Egwu U. Egwu, The Development of Entrepreneurshio and Intrapreneurship, in Egwu U-Egwu, et al., Entrepreneurship: Principles and Practice (Books of Readings) (Abakaliki: Ebonyi State University Press, 2011), p. 8.
cxci. The Global Innovation Index 2014, op. cit., p. 235.
cxcii. Irefin, Ilori, and Solomon, op. cit., p. 14.
cxciii. Ogbu and Nwalo, op. cit., p. 146.
cxciv. Ibid.
cxcv. Parul Sethi. (2013, June 29). 'Business Sophistication Theory' (www document) URL http://www.slideshare.net/parulset/business-sophistication-theory (visited 2014, October 12).
cxcvi. Vesal, S. M. et al. (2013, June 17). 'The Relationship between "Labor Market Efficiency" and "Business Sophistication" in Global Competitiveness,' p. 1 (www document) URL http://www.ccsenet.org/journal/index.php/ijbm/article/view/26605/16979 (visited 2014, October 12).