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# Indigenous Knowledge System, Local Inventions and the Implementation of STI Policy in Nigeria: *Issues, Challenges and the Policy Directions*

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***Abstract*— Invention involves the transformation of ideas into novel products, processes, or services, while innovations focus on adding value to already existing systems. These creative activities have long been part of human societies and are typically driven by factors such as curiosity, problem-solving, self-reliance, and a supportive environment. In Nigeria, local inventions and Indigenous Knowledge Systems (IKS) can boost socio-economic wellbeing of individuals and communities. However, their development remains constrained by policy inconsistencies, limited funding, weak documentation systems, and inadequate intellectual property protection. These challenges reinforce the need to enhance STI policy capacity, attract sustainable financing mechanisms, and establish a more context-appropriate intellectual property framework that supports IKS and incentivizes local innovation. A qualitative, documentary analysis approach was adopted, utilizing insights from Nigeria's STI policy frameworks, national and global innovation assessment reports. A conceptual framework was used to map how indigenous technologies interact with policy structures and the wider national innovation system. Evidence from traditional medicine, agricultural practices, leather production, and other indigenous technologies shows that when supported, IKS can enhance job creation, foster industrial growth, and drive innovation-led development. The finding of this study underscore Nigeria's innovation ecosystem cannot advance meaningfully without intentionally mainstreaming indigenous knowledge into STI policy processes. Strengthening documentation practices, improving funding strategies, reforming intellectual property systems, and building stakeholder capacity combined with regular monitoring and evaluation are essential steps toward transforming IKS and local inventions into commercially viable and scalable innovations capable of driving national socio-economic transformation.**

***Keywords*— Implementation STI Policy, Indigenous Knowledge System, Innovation ecosystem, Local Inventions, Nigeria, Technology, Innovation ecosystem**

## I. INTRODUCTION

Science, technology and innovation has been the fulcrum of development in both developed and newly industrializing economies.

Nations with huge STI resources are at the forefront of technological breakthroughs, innovations and competitiveness. As catch-up strategy, developing critical mass of scientists, technologists and innovators and creating positive ambience for STI to thrive are essential for latecomer economies. Government's commitment to science and engineering infrastructure, robust innovation ecosystem and systematic mainstreaming of Indigenous Knowledge System (IKS) is essential to socio-economic prosperity of developing countries, including Nigeria.

Bringing STI to bear on existing industrial sectors, particularly the use of scientific and technological knowledge in the transformation of natural resources into useful products and services is imperative; thereby enhancing national values and wealth creation. In supporting the national values, the STI policy mission is to evolve a nation that harnesses, develops and utilises STI to build a large, strong, diversified, sustainable and competitive economy that guarantees a high standard of living and quality of life for its citizens. The policy therefore encourages the need for socio-economic transformation of actors including those operating within the indigenous knowledge systems.

To achieve the aforementioned objectives, robust STI policy is essential. First, the policy stands to coordinate government efforts towards bolstering R&D. The policy also promotes endogenous capacities for invention and innovation, sets national priority and focus for the STI agenda. It further incentivizes innovations among players in the industrial sectors and creates a platform for effective interactions among the key actors of National Innovation System (NIS).

This figure below shows clearly the flow diagram and the structure of the paper, showing the relationship between Indigenous Knowledge Systems (IKS), local inventions, challenges, and policy recommendations.

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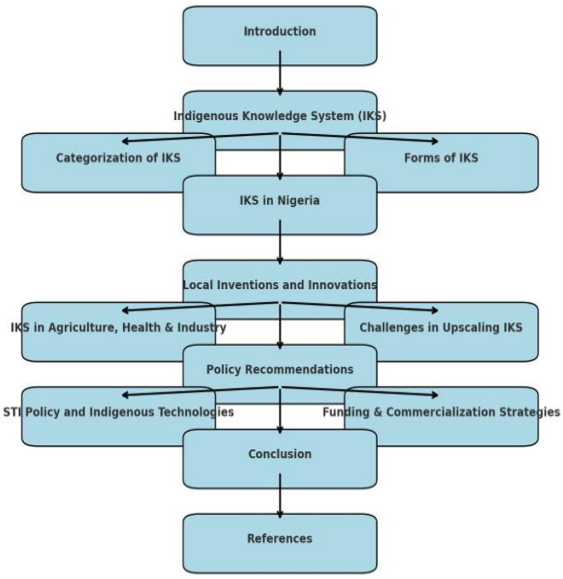


**Figure 1: Flow Diagram of Indigenous Knowledge Systems, Innovation, and STI Policy Implementation.**

## II. INDIGENOUS KNOWLEDGE SYSTEM (IKS)

*Definition*

As illustrated in figure 1 above, what constitutes indigenous knowledge (IK) is well understood even though there is no consensus definition. It is broadly regarded as local knowledge, traditional knowledge, folk knowledge, tribal knowledge, people's knowledge or ethno-science. According to Warren (1987), indigenous knowledge is defined as (local) knowledge that is unique to a given culture or society. Rajasekaran (1993) defined it as a systematic body of knowledge acquired by local people through the accumulation of experiences, informal experiments and intimate understanding of the environment in a given culture. In communities where IK exists, it has become the means of proffering solutions to health, building and essential needs as required in the management of day-to-day activities, serving as source of income. Indigenous knowledge systems (IKS) therefore comprises knowledge developed within indigenous societies, independent of, and prior to, the advent of the modern scientific knowledge system. It also represents information, knowledge, skill and technology along with standard management practices, which are defined through the cultural systems (ASTEC, 2019).

*Categorization of indigenous knowledge system*

Indigenous Knowledge System (IKS), from its domain of application and associated management approaches, can be categorised as;

i. Traditional Ecological Knowledge (TEK), which represents knowledge associated with natural resources and environmental management.
ii. Traditional Technical Knowledge (TTK) which refers to knowledge associated with tools and appliances used.
iii. Traditional Value and Ethics (TVE), which refers to value, norm, institution and policy framework which evolved from traditional knowledge-based practices.

*Forms of indigenous knowledge system*

Depending on the type of society or culture, IKS exists in different forms across the globe. These forms include;

i. Technology of subsistence, such as tools' making and techniques for agriculture, fishing or hunting
ii. Traditional medicine, such as bone-setting in Nigeria, acupuncture in China, and Ayurveda and Unani in India.
iii. Midwifery
iv. Ecological knowledge,
v. Celestial navigation,
vi. Craft skills (Makinde and Shorunke, 2013).

### A. *Indigenous Knowledge System In Nigeria*

Nigeria has diverse Indigenous Knowledge Systems which have been transferred over a long period of time and are still in use despite the advent of modern knowledge systems. The indigenous knowledge systems in Nigeria covers areas such as agriculture tools and practices, leather tanning, bronze artefacts, local fabric weaving, iron smelting, traditional medicine and environmental management.

The impact of IKS is felt in the building, agriculture and health sectors etc. For example, the local extracts of some plants are used in crop diseases treatment, as a source of green innovation which is more sustainable than many agrochemicals that are not sustainable to the environment. Nigerian leather products, artefacts, fabrics and herbal medicines, which are products of IKS are great sources of employment and economic gains. If these IKS are developed, they have the potential of higher positive economic impact on the nation.

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The study carried out by Siyanbola *et al* (2012) to evaluate the indigenous technologies and innovation in Nigeria, examined indigenous technology clusters across the country. The findings revealed that the various technologies and innovation in Nigeria presents a great potential to the small and medium scale enterprises in the country.

Compared with other indigenous knowledge elsewhere in the world, upscaling the indigenous technologies in Nigeria needs to be given the required attention in order to maximize the potential benefits to the owners, the immediate community and the society at large. For example, the Ayurveda and Unani traditional medicine in India are studied in universities and research institutes to promote them as alternatives to orthodox medicine. There is no reason why Nigerian government cannot adopt similar strategies.

The above scenario calls for the need to further develop and deploy indigenous technologies for socio-economic transformation as reflected in the specific sectoral strategies of the extinct STI policy. Particularly, in agriculture, biotechnology, health, industrial research, raw materials and manufacturing, works and housing among other sections. Table 1 presents the intersection of STI policy and indigenous technologies in each specific strategic area. For instance, in the agriculture sector, the policy expressly articulated the need to develop indigenous technologies to enhance value addition to farm produce, reduce wastes and post-harvest losses.

Other font types may be used if needed for special purposes.

**Table 1:**
**Intersection of the STI policy and Indigenous Technologies in Nigeria**

| **STI Policy Area and Strategy** | **Indigenous Technology Components** |
|---|---|
| Section 2.1: Agriculture | Developing indigenous technologies for value addition of agricultural produce |
| Section 2.2: Water resources | Facilitating the adaptation of appropriate water technologies for rural development |
| 2.3: Biotechnology Research | Harnessing indigenous knowledge on natural products and commercializing discoveries as well as positioning Nigeria in the bio-genetic market. |
| | Promoting the documentation and use of biogenetic resources and eliminating bio-piracy |
| 2.4: Health Research and Innovation | Strengthening demand-driven R&D in natural and orthodox medicines as well as pharmaceutical research |
| | Promoting documentation and dissemination of natural health research |
| 2.6: Environmental S&T | Developing an appropriate and effective waste management system to reduce pollution emission from waste generation. |

*Source (Nigeria STI Policy, 2022)*

In addition, the STI policy clearly sets appropriate tone for technology transfer, promotion and commercialisation and articulated implementation framework to make innovation happen, not only in the research system but also in the IKS. Government therefore needs to pay particular attention to the funding mechanisms to stimulate innovation in the IKS.

Indigenous knowledge system in Nigeria is developing slowly because their activities have not been properly mainstreamed into typical economic and industrial sectors, due to several reasons. The tacit nature of the knowledge, communal ownership and associated traditional secrecy embedded in its application makes its codification difficult and application more cultural-dependent. For instance, the major means of acquiring the knowledge are through words of mouth, observation, learning by doing, trial and error, apprenticeship, proverbs and folklores among others (Siringinidi, 2006). The knowledge is deployed in diverse areas including agriculture, health, education, disaster management, utilisation of natural resources, transmission of culture and poverty alleviation (Makinde and Shorunke, 2013).

In Nigeria, efforts by the government at a time to create positive environment for indigenous knowledge practitioners and scientist to work together has yielded some positive results. For instance, the development of Sickle Cell Drug by the Nigerian Institute for Pharmaceutical Research and Development became popular and brought economic gains as a result of joint efforts of scientists and traditional herbal healers in the 90's (Adelowo, Akinwale and Olaopa, 2017). The drug generated huge revenue for the economy and boosted international recognition at the time.

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## III. LOCAL INVENTIONS/ INNOVATIONS:

*Definition of concepts: inventions*

The thought of inventions was seen as any idea or concept that is entirely new or hitherto unheard of. However, the fact that the idea is in existence in the human brain alone does not translate to an invention unless it is transformed into concrete information (The Open University, 2021) which may be inform of description of a process, drawn in a sketch form or presented inform of a model (NRF, 2018). Strumsky, et al (2010) opined that an invention may also be an idea for a new or improved device, product or process. The key point to justify an idea as invention is the originality of such idea and the fact that such concept or process has never been heard of which represents a leap, a creation truly novel and different.

From the foregoing, local inventions are ideas, processes and products that are developed by indigenous knowledge holders to offer or proffer solutions to identified challenges. These inventions are usually applied in the health, fabrics, fashion, agriculture and building industry. However, is was reported that local inventors are most times hereditary (Teresa and Mba, 2013) and suffers from adequate documentation as they are tacit in nature (Makinde and Shorunke, 2013).

Inventors are idea generators and transformers. Inventive ideas often occur as a result of associative thinking, which pulls together ideas, knowledge and techniques from different areas (Akpomuvie, 2011). The process of transforming the idea into something that is real such as drawings or a prototype with the potential for practical application is the main step to demonstrate the value of such an idea. This process involves five (5) steps of: identification, exploration, incubation, act of insight and critical revision. Inventors also use adaptation, transfer, combination and analogy (Chiwanza, Musingafi and Mupa, 2013).

### A. *Definition of innovation*

According to Makinde and Shorunke, (2013), innovation is a process of disrupting or enhancing a pre-existing idea or concept. For an innovation to be local, it means it is confined to a particular geographical location or family (Akpomuvie, 2011). Furthermore, the concept of innovation was seen as a process of practical implementation of inventions leading to the offering of new goods or services or improvement in offering goods or services (Bhasin, 2012). From another perspective, innovation was viewed as modifications leading to a new or improved product or services with value addition (Siyanbola *et al*., 2012).

Apparently, there are different perspectives to the definition of the concept of innovations. On a general note, there are three (3) key elements that are common to these definitions which are newness, improvement and spread (Bhasin, 2012). When improved products, processes, technologies, art works, services or business models are offered to the market, then innovation has taken place.

In the case of local innovations, the transformation of ideas that are passed from one generation to another through information and informal education system leading to the improvement of say farm implements and herbs used in the health sector is termed local innovation. Such innovations may reside in a particular family or geographical locations, like indigenous knowledge. For instance, innovation in the leather tanning process observed in northern Nigeria, aluminium casting in Saki (South-Western Nigeria) and the bronze casting in Benin (South-South) Nigeria (Siyanbola *et al*., 2012).

### B. *Emergence and sources of local inventions*

Innovation is as old as man, from the stone-age through to the jet-age, man has always devise a means of improving on products, services and processes. For instance, over the last 100 years technologies such as telephone (1870s), motor vehicles (1880s), television (1920s), computers (1940s) were results of the patience of man to seek for an improved way of life (The Open University, 2021). Local inventions were output of unplanned and informal findings gathered from indigenous knowledge. Hence the latter covers all human interactions that can be captured, shared and used for developmental purposes (Makinde and Shorunke, 2013). In this context, the concept of developmental purpose means innovations.

Local inventions were reported to be an output of indigenous people who were more absorbed with their own ideas and feel strongly about their importance and potential. This was consistent with the opinion held by Kaya, (2013).

### C. *Enablers/ drivers/ determinants of invention and innovation*

The enablers of innovations are factors that supports or spur the innermost strength of an individual to innovate. Innovations are either inventive or commercial driven. For instance, individuals are motivated to innovate by one or more factors: curiosity; constructive discontent about a product; a desire to help others or a need to make money (Fund, 2018). Fulfilling human needs is an important enabler for innovations.

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In addition, innovators have the do-it-yourself attitude, enthusiasm and the need to satisfy their curiosity. Innovators are eager to express their creativity, hence the demand for unique solutions to challenges are also enablers of innovations.

Innovations are driven at the organisational level by the need to redesign business strategies; request for improvement in existing products and processes or services. For instance, the introduction of new materials or a set of new technologies or machines or even, changes due to a change in government policy, legislation and regulations. Innovations are also enabled by the availability of business uptakes like product champions. Value additions to existing product or process are means of persuasive argument and demonstrations of consistent progress. Inventors also need to innovate to ensure funders and stakeholders are convinced that the product or process is capable of succeeding.

Enabling environment, testing ground for trials and chance, often play significant roles in invention and innovation. Inventors often have the ability to focus on a problem to the exclusion of everything else, and are single-minded and determined to finding a viable solution.

### *D. Relevance of local invention/innovation to development*

There are social, cultural and economic significance of local inventions and innovations (Akpomuvie, 2011). The adoption and adaption of local innovations was opined to improve the livelihoods of traditional knowledge holders and communities. Hitherto the disruption of the indigenous systems of knowledge, indigenous peoples explored traditional knowledge in conducting daily activities and the well-being of the people of a particular geographical location. This knowledge was used in exploiting the local ecosystems. The health benefit of local innovators was evidenced in the dependency of local communities on traditional medicines for their primary health care.

Beside the aforementioned benefits, South (2004) opined that the protection and commercialization of traditional knowledge may attract benefits to the individuals, communities and national economies. In the current form, traditional products in Nigeria such as handcrafts, medicine, agricultural products and non-wood forest products (NWFP) were reported to be traded locally and internationally. This has supported the provision of substantial benefits for the exporters. Internationally, NWFP trade alone generated around US$11 billion per year.

The contributions of the indigenous knowledge to the pharmaceutical industry have been used as critical inputs to deliver breakthrough products.

Indigenous knowledge is also used in supporting industries like cosmetics, leather industry, biological pesticides, botanical and agriculture. It is worthy mention that the need for adequate and systematic documentation of the set of indigenous knowledge is pertinent to the protection and commercialization of indigenous knowledge (Siyanbola *et al*., 2012).

To conserve the environment, traditional farming methods by nature ensure the protection of the environment upon which they depend. Land fallowing, rotation of crops and other methods not only protects the land, but in fact increases harvest yields (Muzah, 2016).

### *E. Commercialization of local innovations; a case of smedan*

The case study used was demonstrated in a paper presented by Radda, (2016) where a local invention on Agrolyzer Micronutrient Fertilizer was explored to demonstrate the relevance of indigenous knowledge in innovations. A value added fertilizer was developed to serve as a supplement to Macro Nutrient Fertilizer, an innovation on NPK. The drive was the need to exploit new ideas which was absolutely essential to deliver more environmentally friendly products and safeguard the ecosystem. However, the process of obtaining an Intellectual Property Rights (Patents) in Nigeria was delayed due to poor documentation of such local innovations. This scenario was in concurrent with the report of Muzah (2016) wherein it was reported that Southern Africa countries were yet to design a suitable model to protect local inventions and innovations.

## IV. THE STI POLICY AND THE POLICY IMPLEMENTATION

Since independence, various administrations have shown keen interests and deep appreciation of the role of STI in national growth and development. Although, the FMST has had a chequered history, the country produced its first S&T policy in 1986. After about a decade of the policy implementation, it was reviewed in 1997. That effort was quickly followed by a more elaborate review in 2003. Each policy review effort offered something new and valuable to the policy especially in terms of adequacy, scope, quality and institutional frameworks to drive the policy implementation. Although the 2003 policy gave prominence to flagship programmes including the Space Science and Technology initiative of government, the Biotechnology as well as the ICT, amongst others; it was rather voluminous and viewed simply as a compendium of S&T sub-sectoral policies with minimal harmonization with other key socio-economic policies.

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These short comings and other challenges brought to light following a nation system-wide study consummated and executed under the FMST-UNESCO Special Plan of Cooperation I (2005-2009) led to a complete rethink of the National Innovation System and the evolution of Nigeria's STI policy in 2012.

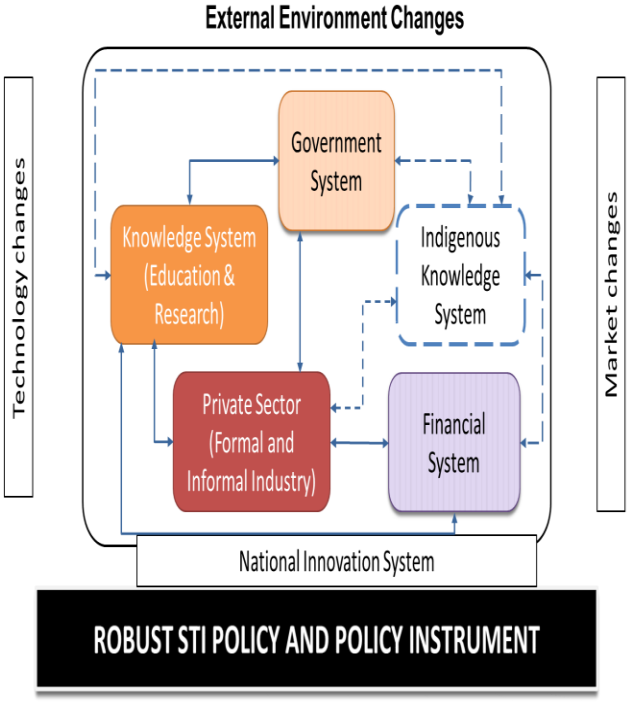


**Figure 2: STI policy and implementation framework (Authors' idea)**

The 2012 STI policy was deliberate in the inclusion of innovation as the policy articulated key roles of relevant stakeholders to improve national innovation system. In fact, the policy was developed to bridge prevailing gaps in the innovation system, promote technology commercialisation and improve socio-economic landscape while also strengthening linkages among key stakeholders. The policy was anchored on five key philosophies including leadership, priority setting, funding, partnership and culturisation. All these were largely missing in the previous national S&T policies thereby disconnecting them from realities.

*A. Indigenous Technology-Local Inventions- STI Policy Nexus*

Science, Technology and Innovation (STI) policy is a document that governments could utilize to help meet its economic, social and environmental challenges and to promote inclusive and sustainable development.

STI plays a pivotal role in poverty eradication and sustainable development. Yet, tapping into the benefits of STI can only be achieved by creating robust STI systems and appropriate policy frameworks. According to UNESCO (2021), to address present-day challenges, countries need to reorient their STI policies to adopt holistic frameworks, and strategically link integral parts of their national development policies and plans to other sectorial policies such as education, industry, health, etc.

Since knowledge production and role of knowledge networks, collaborations and the complex distributions of expertise, equipment and know-how are central to STI policy, promotion of indigenous knowledge System (IKS) is equally vital in the Innovation System (IS) of developing countries. IKS is one strategic direction of the innovation policy in many sub-Saharan African countries and elsewhere in developing countries (Jauhiainen and Hooli, 2017). The STI policies of developing countries should be well crafted to promote substitution technology/indigenous technology using local resources combined with indigenous knowledge before moving towards export-oriented technology and should focus on overcoming the prevalent challenges.

In developing STI policy, there is a need to pay attention to the potential of socially inclusive innovations which leads to indigenous technologies. IK is substantially important for inclusive innovations that are novel to the context and consist of heterogeneous products, processes, institutions, services, business models, and supply chains (George *et al*., 2012).

Recently, in sub-Saharan Africa, IK has been incorporated into official document and/or innovation policies (e.g., in Botswana, Ghana, Namibia, South Africa, and Tanzania) (Nfila and Jain, 2011). Nigeria's STI policy is not left out in this development. Nigeria's 2012 STI policy contains sections that address how indigenous technology will be harnessed to strengthen the country economically.

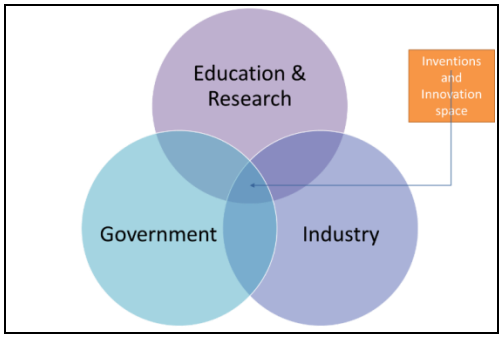


**Figure 3: STI policy Nexus (Authors' idea)**

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Section 3.3 sub-sections 1(vi), 3(iii) and 4(iii) of the Nigeria's STI Policy states that part of the specific sectorial strategies in agriculture, biotechnology and health research and innovation are: "developing indigenous technologies for value addition of agricultural produce" and "harnessing indigenous knowledge on natural products and commercialising discoveries as well as positioning Nigeria in the bio-genetic market" and "strengthening demand-driven R&D in natural and orthodox medicines as well as pharmaceutical research".

However, a critical appraisal of the policy documents reveals that Indigenous knowledge and technology is not well situated prominently in every sector with appropriate strategies to position the country on technological development trajectory.

## V. Issues And Challenges

*Quantity And Quality Of Local Invention (IP/IPR)*

The quantity and quality of local inventions in Nigeria is far less than expectation with the abundance of human and material resources despite the performance of Nigerians in diaspora. The qualities of selected inventions are low compared to the global standards. This may be the rationale for low patronage of some local innovations, suggesting the role of the Standards Organization of Nigeria.

Per capital output of inventions and local innovations are inadequate. This may be ascribed to low awareness and deficit in capacity of the IP registration stakeholders. This is obvious in many intellectual property indices. For instance, in the year 2020, Nigeria ranked 117th in Global Innovation Index (GII) among 131 economies featured in that year. The GII ranks world economies according to their innovation capabilities using roughly 80 indicators grouped into innovation inputs and outputs. Nigeria also recorded double-digit decreases (–10%) in trademark filing activity from 2018 to 2019 (WIPO, 2020a). The country's Intellectual Property Rights Index (IPRI) score decreased by -0.069 to 3.719 placing it 26th in the Africa region and 123rd in the world. (WIPO, 2020b). If the country's indices in these areas must improve, a lot of efforts are required to promote local invention. The implications are that there is need for more IKs to be transformed to inventions and innovations which can be captured by the aforementioned indicators.

*A. Infrastructural Deficit*

Adequate infrastructure is very important in driving creativity and innovation. The infrastructural deficit in Nigeria is quite obvious and uncoordinated attempts by Nigerian Government to tackle the issue of infrastructure deficit in the country have not yielded the desirable results. The 2013 National Integrated Infrastructure Master Plan (NIIMP), which is expected to run from 2013-2043, was estimated to cost $3trillion, which covers core infrastructure such as Energy, Housing, Water and ICT. According to the former Minister of Finance, Dr Ngozi Okonjo-Iweala, the country needs about $14.2billion annually, continuously over an initial period of 10 years to fund infrastructure. Eagerly, the Federal Government wasanticipated to provide $10.6 billion but was spending only $5.9 billion on federal infrastructure needs, leaving a substantial deficit of $4.6 billion (Adesoji, 2019). Without bridging these infrastructure gaps in the country, indigenous knowledge promotion and innovation will be seriously undermined.

*B. Poor Funding (R&D Funds, Seed Fund, Venture Capital)*

Among the maxims of the indigenous Yoruba people in Nigeria is "Ẹni tí kò bá lè fi ẹ̀tù sòfò , kò lè pa akọ àáyá" (The hunter that cannot risk the loss of gun powder cannot kill a male baboon). Promotion of indigenous knowledge system to the level of innovation requires serious research and development (R&D) funding. The stakeholders in technological development in Nigeria are not mustering enough financial strength to promote indigenous technology like some other developing countries. If R&D funds, seed funds, venture capital and other similar funds are provided to improve IKS in Nigeria, there will be many technological and economic breakthroughs for the country. However, such breakthroughs may be farfetched when the highest proportions of science and technology (S&T) activities in Nigeria are carried out by public institutions which consistently demand that it should be given more priority in the national budget. The limited funding of these ministries, departments and agencies (MDAs), in practical terms, knowledge institutes (KIs) is a reflection of low appreciation of the benefits of R&D to national development (Owolabi *et al*., 2012).

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The current funding system whereby government is the main source of funding for R&D will not translate to the realization of the desired contribution of the sector. The contributions of venture capitalists and opening of more channels to seed grants will support the deficit in funding mechanism for the local inventors and innovators to tap from.

*C. Lack Of Incentives/ Rewards For Creativity And Talents*

The economic growth of any nation is sustained by improved production of qualitative goods and services. This is an outcome of investments in human and physical capital, research and development, technological change, and improved institutional arrangements and incentives. The kinds of incentives that reward successful innovation are nose-diving in Nigeria. This is one of the challenges being faced by the indigenous knowledge system.

The weak infrastructure base and lack of active support by government to local inventors/innovators are part of the reasons these individuals are not deriving adequate benefits and recognitions from their inventions and innovations. In addition, poor and/or lack of adequate documentation of the processes leading to local innovations are serious disincentives. Lack of funds for prototype development is another. In most cases, inventors are afraid or not ready to divulge requisite information that could facilitate the application and subsequent granting of patents. For instance, the lack of appropriate documentation was reported to be responsible for the delay in patenting the Agrolyzer Micronutrient fertilizer (Radda, 2016).

*Policy inadequacies and inconsistencies*

There are perceived policy inadequacies and knowledge gap to support the IKs in Nigeria. The level of understanding of the role of indigenous knowledge and local innovations are still hazy. Unfortunately, several opinions shared by the literature on the need to draft or review existing institutional settings and policy documents in Africa were unsuccessful. However, in the context of promoting African indigenous knowledge systems for sustainable livelihood, it has generally been propagated to incorporate non-western beliefs, practices, customs, worldviews, including informal forms of education(Kaya and Seleti, 2013). It was also observed that many scholars and some academics have a negative attitude towards local inventions and the IK (Katanha and Kadziya, 2014). Such negative attitude suggests the reasons for policy inadequacies and the inconsistencies in documenting local inventions.

*The protection of iks locally and alleged ethnicization*

IK in Nigeria is usually shrouded in secrecy as a form of protection by the custodians. This is because these custodians are often not aware or not sure of how to secure intellectual property protection. The forms of protection used by these custodians need improvement in order to allow knowledge transfer and improve economic gains.

Economic benefits enjoyed by local innovations are low because there are constraints that are mitigating the ease of filing indigenous innovations for intellectual property rights. This was because it was difficult to separate theory from practice as emphasised in western education and scholarship (Kaya and Seleti, 2013). IP protection of local inventions is difficult and time consuming. This is due, in large part, to weak documentation of ideas. There are difficulties in verifying technical specifications from local inventors. In some cases, there may be no documented evidence or research findings to support the inventions (Radda, 2016). Apparently, debates opened up by intergovernmental organisations such as UNESCO, WIPO, WTO, UNEP and UNCTAD were hinged on possible protection of indigenous knowledge, using intellectual property systems (South, 2004).

*Policy recommendations and strategies for action*

i. Traditional knowledge (IP) should first of all benefit the owners, bearers or custodians who in most cases are indigenous peoples and local communities that developed, maintain and identified culturally with this knowledge and seek to pass them on between generations.
ii. Our NIS needs to work more effectively, more coherently and better coordinated with broad common goals/objectives, well aligned to the national aspirations and priorities.
iii. We (may) need to establish formal structures meant to manage sources of IK (ITs) to facilitate technology transfers and knowledge flows between institutions and industries so that such local technologies can be further developed and commercialized.
iv. There is a need to conscientiously promote IKS in Nigeria by all means necessary such as capacity building, incentives and by integrating it fully with the STI policy. If the STI policy is reviewed and it makes adequate provision for the promotion of every aspect of IKS, it will allow the stakeholders to look inwards for technological development rather than looking outwards.

The indigenous inventors, if adequately trained will be able to improve on their skills and their capability to tackle most of the challenges facing many sectors of the economy. The STI policy should make adequate provision for creating enabling environment for indigenous knowledge to thrive through funding and other incentives. There should be enough provision in the STI policy for IK in every sector of the economy to meet the aspiration of local inventors.

v. Evidence-informed policymaking is very important for rapid technological development and more important in STI policy design and evaluation. It is important for the stakeholders in the science, technology and innovation drive of the country to build adequate capacity in evidence-informed STI policy design as well as policy evaluation in order to develop the right indicators for monitoring and evaluating progress along the path of technological development during STI policy implementation.

vi. Scheduling mid-term and end-term policy performance evaluation is very critical for progress measurement and should be made obligatory.

vii. Sometimes, two or more sectorial policy objectives may conflict thereby creating bottlenecks in achieving the objectives. There should be timely review of extant policy(ies) to resolve conflicts or to reflect new realities in the local and global spaces.

viii. There should be reliable funding mechanism to catalyse local invention and innovation. This is because no matter the level of creativity potential of Nigerian citizens in the IKS, if there is no adequate funding for further R&D, it will remain a potential which will eventually be buried with them.

ix. There should be a concerted effort to strengthen the national innovation system (NIS) whereby the government, academia and industry will work together to bring about the desired technological change.

x. There is the need to develop an acceptable way of systematically documenting the local inventions and IKs in a manner that the current IP system can be used in assessing local inventions. This will ensure local inventors can access the benefits accrued to their IP and equally encourage more local inventors to invent more.

xi. Serious considerations must be given to the need for mainstreaming the indigenous knowledge systems (IKS) into Nigerian education system. This will bridge the gap between the modern and local inventions while promoting the IKS, community attitudes and values for sustainable.

xii. Capacity building in the areas of policy design is key to support the need for a review of the current IP system. This will mean that the current system which may not be suitable for the IKS wherein a particular invention or innovation are family of community based must be reviewed. This is because the current IP system protects the individual only.

xiii. Sharing IK within and across communities can help enhance cross-cultural understanding and promote the cultural dimension of development. This can be done in partnership with the National Orientation Agency (NOA) and other agencies of government. It is suggested that planning commences in 2021 while the project commences in 2022.

xiv. SMid-term and end-terms policy performance evaluation is critical (M&E), hence must be made mandatory.

A reliable mechanism for funding local inventions and innovations must be designed using the global best practices. This will ensure local inventors remain competitive. The funding should target all the 774 LGAs and the process of assessing such fund should meet all standards to secure the fund, but less formal. Frameworks for this fund should be designed using the STI policy template. This design should commence in 2022 and should align with the strategic road map (e.g 2022-2026).

## VI. CONCLUSION

Indigenous Knowledge Systems, recongnised as a strategic assets for Nigeria's technological and socio-economic advancement. Strengthening policy coherence, building institutional capacity, ensuring adequate funding, and creating platforms for local inventors are essential steps in unlocking the full potential of IKS. By institutionalizing evidence-based policymaking, enhancing coordination within the National Innovation System and integrating indigenous knowledge into education and IP protection frameworks, Nigeria can accelerate innovation, promote sustainable development, and empower communities who are the original custodians of this knowledge.

A committed, well-coordinated implementation of these strategies will position the country to leverage its local ingenuity for national transformation.

*Conflict of interest disclosure*

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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