

Industrial, Science and Technology Policy in Nigeria

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Abstract

Given the critical and wider transformational role of technology on industrialisation and socio-economic activities, national governments have become increasingly concerned with drawing up policies that would create the enabling environment for science and technology (S&T) to flourish and accelerate industrialisation for the benefit of the wider society. However, given the flaws in policies largely associated with African countries, including Nigeria, successive policy formulations leave much to be desired. This book chapter thus sets out to explore the Nigerian context to address policy gaps and advance the wider debate around coherent and implementable policies. We conclude with recommendations to help the Nigerian government make informed decisions when it comes to shaping S&T policies and implementation strategies for future advancement.

Keywords: Africa; Industrialisation; Nigeria; Policy; Science and Technology

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1 Introduction

According to the theory of economic development, industrial revolution is the heartbeat of successive economic development (Deane, 1979). One of the critical underlying factors that have aided industrialisation over generations is the evolution of science and technology (S&T). This is evident in the first to the fourth industrial revolution. For example, the first industrial revolution (1IR) of the 18th century was powered by the steam engine and mechanisation of production while the second (2IR) and third (3IR) industrial revolutions in the 19th and 20th centuries were powered by electricity and assembly line, and partial automation respectively (Deane, 1979; Schwab, 2016). The fourth industrial revolution (4IR) that currently prevails in the 21st is underpinned by information and communication technologies (ICTs) (Arakpogun et al., 2021; Davis, 2016; Schwab, 2016). The 4IR does not only introduce “cyber-physical systems” with new capabilities for people and machines, but its underlying technology is also fast becoming embedded within societies in an entirely new way (Davis, 2016). For example, Artificial Intelligence (AI) [which is a collection of ICTs that imitate human intelligence for the primary purpose of improving efficiency and economic growth (Arakpogun et al., 2021)] “...can identify redundancies within business processes and offer optimal resource utilization for improved performance” (Olan et al., 2022).

Moreover, since AI, machine learning and other emerging technologies in the 21st century are still unfolding with far-reaching impact across various sectors, ICTs are accelerating the scope and temporality of the 4IR at an unprecedented pace. It is estimated that 4IR ICTs such as AI have the potential of contributing over \$15 trillion to the world economy and increase the GDP of local economies by 20% as humans and technological advancement ‘work’ closely to provide solutions to world problems (PWC, 2017; Schoeman, Moore, Seedat, & Chen, 2017). S&T have thus played a critical role in accelerating industrialisation through the ages. This is even more pronounced in the 4IR where most socio-economic activities (e.g., agriculture, banking, business, education, health and national security) are driven by technological advancement (Davis, 2016; Olan et al., 2022; Schwab, 2016).

Given the critical and wider transformational role of ICTs on industrialisation and socio-economic activities, policymakers (including national governments) have become increasingly concerned with drawing up policies that would create the enabling environment for S&T to flourish with a view to accelerating industrialisation for the betterment of the wider society. Policymakers in African countries, including Nigeria are not excluded. As such successive Nigerian governments have drawn-up national S&T policies with a view to creating

an enabling environment for the advancement of industrialisation and wider economic development and transformation. For example, Nigeria's first S&T policy was created in 1986 with the mandate to harmonise the pursuit of knowledge via research and development to improve the quality of life (Adubifa, 1988; Igbinovia & Křrupka, 2019; Siyanbola et al., 2016). Having failed to fulfill its mandate, a second policy was formulated in 1997 with an amended mandate of facilitating an independent but integrated and self-sustaining economy with a key focus on various sectors such as agriculture, energy information technology and health. Nonetheless, major policy gaps (e.g., lack of relevant stakeholder engagement and issues relating to standardisation and quality assurance) persist with the consequence of the introduction of the third policy in 2003 (Ibidapo-Obe, 2012; Igbinovia & Křrupka, 2019). As with previous versions, the 2003 edition was not without its flaws – including a lack of policy harmonisation, copy and paste from previous flawed policies, and lack of institutional and legal frameworks for implementation. Subsequent Nigerian governments have continued along this path of producing 'new' policies up to and including the recent administration's S&T policy of 2022 (Federal Ministry of Science, Technology and Innovation, 2022; Olatunji, 2021).

While it is good practice to review existing policies as technologies continue to evolve, a growing body of work (see, for example, Adubifa, 1988; Arakpogun, Wanjiru, & Whalley, 2017; Arakpogun et al., 2021; Siyanbola et al., 2016) indicates that, more often than not, technology policies of successive governments in African countries, including Nigeria leaves much to be desired - especially when it comes to formulating coherent and workable policies capable of creating the enabling environment for the S&T industry to flourish.

Given the critical and wider transformational role of ICTs on industrialisation and socio-economic activities, allowing such failed policy practices to persist can lead to unintended consequences, including missed opportunities from past industrial revolutions, which have left negative legacies for Nigeria and other African countries. To address these policy gaps and advance the wider debate around coherent and implementable S&T policies, this book chapter sets out to explore Nigeria's S&T evolution and landscape, a review of the underlying government policies and the challenges and implications of policy failures on future development. Following the analysis of the preceding objectives, we conclude the book chapter with policy recommendations that can help the Nigerian government in making informed decisions when it comes to shaping S&T strategies and policies for future advancement.

2. Overview of Nigeria's science and technology landscape: evolution and performance

The first S&T policy in Nigeria was formulated in 1986 as an integral part of the fourth National Development Plan (1981-85) (Adubifa, 1988; Ibidapo-Obe, 2012). This coincided with the period when technology was fast becoming a critical tool for socio-economic development in Nigeria and the established of the Federal Ministry of Science and Technology (FMST) as a distinct entity in 1985 (Famous & Jiri, 2019). With a budget of about \$600 million, the primary mandate of the first S&T policy was to harmonise the pursuit of knowledge via research and development in a manner that S&T would contribute to improving the quality of life in Nigeria (Famous & Jiri, 2019; Federal Ministry of Science and Technology, 2011; Federal Ministry of Science, Technology and Innovation, 2022). However, its actual implementation was directed at basic research, middle-level technical staff training abroad and establishing institutions (e.g., Federal Institute of Industrial Research) with very little attention to its initial mandate, applied technological research and adoption (Igbinovia & Křupka, 2019; Siyanbola et al., 2016). Consequently, the policy lacked a robust prioritisation and measures designed to acquire technology and promote public awareness of the wider contribution of S&T to society (Adubifa, 1988). Adubifa (1988) further argued that while the government made efforts to formulate its first national S&T policy as an integral part of the fourth National Development Plan, the latter made no specific provisions on how S&T could facilitate the manufacturing sector.

Following these policy limitations, a review was initiated in 1997 with emphasis on coordinating and managing the S&T system, collaborations, sectorial developments and funding. With the aim of creating an independent, integrated and self-sustaining economy, the 1997 S&T policy was designed with a defined implementation timeframe of 25 years coupled with subsequent reviews carried out every 5 years to address and account for technological changes (Siyanbola et al., 2016). Nonetheless, major policy gaps (e.g., lack of relevant stakeholder engagement and Issues relating to standardisation and quality assurance) persisted. Eventually, the 1997 S&T policy underwent another review in 2003 with a view to closing the policy gaps highlighted above, including the need to engineer an institutional framework to nurture the interaction among the several elements of the National System of Innovation (Federal Ministry of Science, Technology and Innovation, 2022; Ibidapo-Obe, 2012; Igbinovia & Křupka, 2019). As with previous versions, the 2003 edition was not without its flaws. For example, the 2003 version was a voluminous compendium loaded with the flawed policies from previous version due to the practice of copy and paste (Siyanbola et al., 2016). Further,

its mandate was narrow and lacked harmonisation with other socio-economic policies as well as cultural issues.

A fourth S&T policy review was necessitated in 2005 to address a system-wide reform under the Nigeria and UNESCO science, technology and innovation (STI) reform initiative (Federal Ministry of Science and Technology, 2011). In this instance, the Nigerian government collaborated with UNESCO to initiate the review process and adopted the approach of National Innovation System (NIS) framework for STI system (Federal Ministry of Science and Technology, 2012; Federal Ministry of Science, Technology and Innovation, 2022). The reform was mainly hinged on research and development agenda for Nigeria, economic development initiatives, institutional governance funding mechanisms, Intellectual Property and STI Infrastructure development (Federal Ministry of Science and Technology, 2012; Federal Ministry of Science, Technology and Innovation, 2022; Siyanbola et al., 2016). The concerns raised from the 2005 S&T led to a review to pave way for addressing implementation challenges (Federal Ministry of Science, Technology and Innovation, 2022).

Another S&T policy review was initiated in 2012 with emphasis on research and development without recourse to innovation (Federal Ministry of Science and Technology, 2012). In addition to innovation, the 2012 STI Policy review had an infusion for the creation and maintenance of a contemporary, reliable and accessible STI resources database for Nigeria, as well as the incorporation of new areas with focal technologies for sustainable development under the framework of Vision 20:20. In that light, there was a switch in focus from knowledge generation to commercialization of research outputs (Siyanbola, et al., 2016; Famous and Jiri, 2019; Federal Ministry of Science, Technology and Innovation, 2022). Some of the new areas of focus include space technology, biotechnology, building/road technology, leather technology and solar technology (Ewa, 2013).

The overwhelming impact of COVID-19 pandemic and further advancement in S&T necessitated a rethink of the 2012 S&T policy direction in Nigeria. As such, the 2022 National Science, Technology and Innovation Policy (NSTIP) stems from the evaluation of the 2012 STI policy. The review was conducted by an Inter-Ministerial Committee setup by the Federal Ministry of Science, Technology and Innovation. The members of the committee were drawn from Academics of Science and Engineering, Manufacturers Association of Nigeria, Chambers of Commerce and Industry, Academic Staff Union of Research Institutes, and members of the inter-ministerial review committee including Committee of Vice-Chancellors, National Universities Commission, Military, cognate Ministries, and Development Partners (Federal

Ministry of Science, Technology and Innovation, 2022). The 2012 STI Policy review process covered new frontiers in blue/green economy, new and emerging technologies, STI policy advocacy, agriculture, industrial growth, health, meteorology, metrology, environment, information and communications technologies, communication strategy, national security, natural resources management, human capital development, gender mainstreaming, youth, procurement, sports and recreation, creative arts, tourism and science acculturation, building and construction, energy and power, transportation systems, among others (Federal Ministry of Science, Technology and Innovation, 2022). The 2022 NSTIP was in tandem with the aims and pillars of the National Development Plan 2021-2025 (which is in-line with the Nigeria Agenda 2050) and addressing emerging technologies. To drive the implementation of the 2022 NSTIP, the Federal Government of Nigeria offered a yearly expenditure of at least 0.5% of the national GDP in supporting the development of Science, Technology and Innovation, and the activation of the National Research and Innovation Fund (Federal Ministry of Science, Technology and Innovation, 2022).

Overall, six S&T policy review has been executed in Nigeria with different mandates and limitations as summarised in Table 1.

Table 1: A summary of science and technology policy review in Nigeria (1986 – 2022)

Year	S&T Policies	Mandates	Limitations
1986	First S&T policy	The aim was to use S&T knowledge to ensure a better quality of life for the people, by creating harmony in the pursuit of knowledge about the Nigerian environment through research and development (R&D).	The 1st S&T policy lacked the structure to address the weak linkages in the National Innovation System (NIS) in solving societal challenges, as well as exploiting avenues in emerging technologies such as information and communication technology (ICT), biotechnology and nanotechnology.
1997	Second S&T policy	It is aimed at creating an independent, integrated and self-sustaining economy, through emphasis on coordinating and managing the S&T system, collaborations, sectorial developments and funding.	Weaknesses were observed in the implementation of the 2nd S&T policy, especially on the need to address the institutional frameworks that should foster interaction among the various elements of the National System of Innovation (NSI).
2003	Third S&T	The policy was aimed at incorporating a programmatic approach to STI policy formulation, by emphasizing the need for a coherent, systematic, and comprehensive approach to the determination of technological programmes in Nigeria. It was targeted at significantly giving prominence to flagship programmes of the government in areas of biotechnology, ICT, space science & technology, energy and engineering materials, etc.	The policy was seen simply as a compendium of sub-sectoral policies with failures in implementation and addressing key issues raised in previous policies, and was considered too narrow in focus, voluminous, sector-based and lacked the

			needed synergy with other national economic policies.
2005	Fourth S&T policy	The 2005 S&T policy was aimed at pursuing a robust research and development agenda for Nigeria, economic development initiatives, institutional governance, funding mechanisms, Intellectual Property and STI Infrastructure development. It adopted the National Innovation System (NIS) approach as a framework for STI system reform.	Some drawbacks of the 2005 S&T policy included obsolete plans and strategies for pursuing current economic realities and addressing emerging technologies in Nigeria. Its deployment and implementation spanned a period of 7 years.
2012	Fifth S&T policy	This policy emphasised innovation as a tool for fast-tracking sustainable development with a commitment to ensuring R&D and Innovation engagements were ultimately commercialized into the marketplace, enhancing new businesses, encouraging job creation, and wealth creation, among others.	The fifth S&T policy strategies are limited in terms of meeting the current needs of the Nigerian economy and the recent advances in global science and technology.
2022	Sixth S&T policy	The policy is aim at building a strong STI capability and capacity needed to drive a knowledge-based and innovation-driven economy as well as the need to inculcate STI culture in Nigerians for rapid socio-economic transformation. It involves addressing emerging technologies and current socio-economic changes at global and national levels. Its specific objectives are targeted at plans toward lifting 100M Nigerians out of poverty by the year 2030 through expanding business growth; entrepreneurship and industrialisation; enhanced social inclusion and reduced poverty; building systems to fight corruption, improve governance and creating national cohesion as well as improving security for all.	

3 Challenges and implications of science and technology policy failures in Nigeria

In the previous section we discussed while successive Nigerian governments have continued to review existing S&T polices, a swathe of failed policy practices persists with consequences that challenge and truncate the transformational capabilities of emerging technologies. By extension, this implicates future industrialisation and wider economic development in Nigeria. Arakpogun et al (2021) argue that such circumstance can lead to unintended consequences, including missed opportunities from past industrial revolutions, which have left negative legacies for Nigeria and other African countries.

For example, a common and fundamental underlying challenge to successive S&T policies in Nigeria (as well as other parts of Africa) stems from questionable ICTs leadership where a minority group among the ruling political class tends to capture the decision-making process and undermine government resolve to put ICTs related issues at the heart of economic and political agenda with the implication that government commitment becomes more of a rhetoric than concrete idea (Arakpogun, 2018, p. 133). The elite theory (see, for example, Mariotti, 2020; Kalama & Eseduwo, 2020) further helps to explicate this questionable ICTs

leadership and political capture in Nigeria as a minority of successive ruling political classes alter the “primary trajectory” of wider ICTs policies and “misappropriate or divert” relevant implementation resources for personal gains and/or to other sectors (Arakpogun, 2018, p.146 & p. 147). This was exemplified in Section 2 where Nigeria’s first S&T policy of 1986 paid limited attention to its initial mandate. The wider implication of this is that successive S&T policies have a limited impact on driving public interest as the views of relevant stakeholders are ignored for the personal interest of the minority ruling political class as evident in the lack of relevant stakeholder engagement that partly undermined the second S&T policy of 1997 (see Section 2). Our findings thus corroborate the submission that leadership failure is one of the primary setbacks facing the development of S&T policy in Nigeria and other African countries (Kalama & Eseduwo, 2020; Mytelka, 1986).

Since the overview outlined in Section 2 underlined that the aim of Nigeria’s first S&T policy was to facilitate the improvement of quality of life, there is clear evidence that the initial S&T policy set-up in Nigeria was designed for the people and public interest, not for the self-interest of the ruling political class who have captured the process. As such, the failure of ICTs leadership by successive governments goes against the grain of S&T policies in Nigeria with far-reaching negative implications for policy implementation and future developments of the sector. Take the recent proposal by the Federal Government to impose a 5% excise duty on telecoms services for example (Arise News, 2022; Channels Television, 2022). Under this proposal, a 5% excise duty (on top of the existing 7.5% VAT on goods and services across all sectors in Nigeria) would be applied to voice calls, SMS and data services to supplement dwindling government revenues. Stakeholders (civil society, local communities, telecoms operators, etc.) have voiced their disquiet that not only were they not consulted, but such additional tax would further stymie the sector from both the demand and supply sides. It is important to note here that even the Minister of Communication and Digital Economy (Professor Isa Ali Pantami) was reportedly not consulted on the proposed 5% excise duty (Ohwovoriole, 2022; Osuagwu & Elebeke, 2022).

From a demand-side standpoint, the cost of telecoms services would increase as telecoms operators would typically pass the 5% excise duty burden to consumers. In a country and continent where the affordability of smartphones and telecoms services such as mobile data is relatively more expensive than in other parts of the world (e.g., see A4AI, 2022; Kazeem, 2020 for details), a further increase in telecoms tariffs would alienate more people from the digital economy and increase the existing digital divides in Nigeria. This could lead

to untold unintended consequences for almost 100 million people in Nigeria who are living below the poverty line (Olawoyin, 2022; World Bank, 2022), especially when one considers the transformative role of technology in facilitating access to, for example, education, healthcare and other critical socio-economic activities. From a supply-side perspective, an additional 5% excise duty would further overburden the telecoms sector which is already subject to multiple taxations (Ohwovoriole, 2022; Osuagwu & Elebeke, 2022). According to Professor Isa Ali Pantami "...the ICT sector is overburdened by so many categories of taxes numbering up to 41. Some of these taxes... are duplicated and collected by the federal, state and local governments." (Osuagwu & Elebeke, 2022, p. 3).

An increase in tax burden on the telecoms industry would implicate transaction costs and foreign direct investment (FDI) divestment. Arakpogun (2018) has established that given the chronic lack of supporting infrastructure (e.g., electricity) that persists in Nigeria and elsewhere in Africa, the transaction costs of network deployment and maintenance are comparatively higher in African countries. Since this is the case, a further increase in taxation would limit resources for much-needed network expansion and upgrades. An increase in transaction costs could negatively impact FDI inflows into the sector, which has been fundamental to the development and transformation of the telecoms sector post-liberalisation in the late 1990s and early 2000s (Arakpogun, Wanjiru, & Whalley, 2017).

Furthermore, due to the undue influence of a minority group among the ruling political class, corrupt practices have been allowed to fester and implicate ICTs leadership failure in Nigeria as evidenced in the over 56,000 abandoned industrial-technology projects valued at over \$28 billion (Nnodim, 2021). For example, the failed Ajaokuta Steel Complex that was near completion was suddenly abandoned following funds misappropriations and unaccountable expenditure to the tune of \$8 billion for which \$650 million was initially budgeted (Oyeleke, 2022). A \$1 million radioactive waste management facility at Nigeria Nuclear Technology Centre was abandoned due to the embezzlement of funds (Busari, 2018) as well as a \$470 million CCTV project in 2011 that was awarded to China's ZTE to deploy surveillance technology for the Nigerian Police and other security agencies (Ripples Nigeria, 2020). Moreover, since successive S&T policies in Nigeria lack adequate stakeholders' engagement as highlighted in Section 6.2 and demonstrated by the recent proposal to impose a 5% excise duty on telecoms services without wider consultations, the formulation and implementation of industrial-technology related projects are often ill-thought with outcomes that do not fully align with the actual needs of the wider society.

Staying on the issue of inadequate stakeholders' engagement, there is a clear disconnect between research institutes (which have the relevant resources to support policymakers with informed decision-making) and policy formulation as demonstrated by the underlying S&T policy framework where political figures such as the President and Minister of S&T exact excessive influence over the process while technocrats are relegated to the background (see Kalama & Eseduwo, 2020, p. 80). Given the importance of research to evidence-based policymaking (Shiroishi, Uchiyama, & Suzuki, 2019; Van Woensel, 2021), we argue that the existing underlying S&T policy framework is deficient *ab initio* in the sense that politicians should be making decisions based on evidence-based scenarios and not the self-interest of ruling political class.

4 Policy recommendations

From 1986 (when Nigeria's first S&T policy was formulated) to 2022, Table 1 indicates that consecutive Nigerian governments have produced a total of six S&T policies. While the aims of successive S&T policies have varied across the years, the underlying mandate advancing industrialisation and wider economic development in a manner that facilitates the improvement of quality of life remains at the heart of S&T policy. However, given the flaws in successive policies, Nigeria's S&T agenda has fallen short of expectations, especially when it comes to formulating coherent and workable policies capable of creating the enabling environment for S&T to flourish and improve the quality of life of citizens. Given the critical and wider transformational role of S&T policy on industrialisation and socio-economic activities, allowing such failed policy practices to persist can lead to unintended consequences. These include missed opportunities from emerging industrial revolutions with the consequence that millions of Nigerians would miss out on life-changing opportunities enabled by S&T in an emerging digital economy.

To mitigate the legacy of missed opportunities associated with previous industrial revolutions, the Nigerian government needs to enact S&T policies that can facilitate an enabling environment for innovations and industrialisation to flourish for the benefit of the wider society and not a handful of the political class. Therefore, we draw from the preceding analyses to offer policy recommendations with a view to helping the Nigerian government make informed decisions and strategically tackle some of the long-term challenges facing S&T policy formulation and implementation.

Firstly, the Nigerian government needs to consider an amendment of the existing underlying S&T policy framework in a manner that brings the issue of stakeholders' collaboration and engagement to the forefront. If the current practice of inadequate stakeholder engagement persists, the government would continue to churn out ill-informed policies that do very little in addressing the needs of the wider society. Since the primary aim of developing S&T policy in Nigeria is to facilitate the improvement of quality of life as highlighted in the first policy in 1986, drawing up policies with limited outcomes is counterproductive. We draw from previous work (e.g., Arakpogun, Wanjiru, & Whalley, 2017; Arakpogun, 2018), to recommend that stakeholders' engagement should be on a continuous basis, not a one-off activity in order to reflect the constant evolution of technology, changes in users' needs and stakeholder groups.

Moreover, given the complexity that comes with technological innovations, the input from a diverse group of stakeholders would not only help the government to tackle policy confusion (e.g., the recent 5% exercise duty proposal on telecoms services) but also offer creative and dynamic ideas on how policy could keep pace with technological changes. Apart from telecoms operators, civil society, consumer protection agencies, etc., the constitution of a such diverse group of stakeholders should also include a cross-section of private actors as well as small and medium enterprises (SMEs). Particularly local and small internet service providers (ISPs) (e.g., MainOne, Smile, Suburban Broadband Ltd, and Tizeti) who offer wholesale and retail broadband services across under-and-un-served areas in Nigeria (Monzon, 2021). The role of private actors and SMEs in building sustainable innovation is significant to strengthen knowledge partnerships and capacity enhancement in public-private partnerships.

Private actors and SMEs specific knowledge initiatives should reflect a process that takes into consideration an inventory of technology and human resource capabilities to enable capabilities sharing between private and public sectors. Furthermore, every initiative should consider a strategy to establish and strengthen international collaboration, for example information technology initiative with a database on regional biodiversity that could establish an association with the Global Biodiversity Information Facility. An extended priority for S&T policy amendment should also focus on developing targeted policies and programs to ensure local partnership and sustainable development to foster capacities that serve the broadest spectrum of the population. To ensure implementable policies, a cross-sectoral council may be set up to ensure that these investments constitute a priority that will span federal, state and local councils across Nigeria. Most importantly, special attention should be given to the S&T

infrastructural needs that can help both the public and private sectors to deploy industrial-technology-related projects that target the needs of local communities.

Furthermore, continuous stakeholders' collaboration and engagement can further help to bring much-needed public scrutiny, accountability and transparency to the whole process of S&T policy formulation and implementation and loosen the grip of a handful of politicians who want to capture the process for their own self-interest. Such a strategy would further help to strengthen the failure of ICTs leadership – a common and fundamental underlying challenge associated with successive S&T policies in Nigeria. Apart from helping to improve accountability and transparency, the public scrutiny that comes with continuous stakeholders' engagement can further shine a light on the corrupt practices bedeviling current policy implementation. This, in turn, could help improve processes, limit financial misappropriation and allow resources to be deployed for the primary purpose of improving S&T development.

Finally, given the disconnect between research institutes and S&T policy formulation as evident in the underlying S&T policy framework, we recommend that government prioritises relationship building and engagement with education and training institutions that conduct research into S&T policymaking. The research outputs from such institutions are fundamental to generating evidence-based policy – one that stands a better chance of addressing the needs of local communities and impacting the wider society compared to the current ill-thought policies with limited impact.

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