

POOR FUNDING OF RESEARCH AND DEVELOPMENT: AN ACHILLES HEEL TO TECHNOLOGICAL GROWTH IN NIGERIA

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ABSTRACT

The capacity of any society to produce its material needs is determined by the extent of development and transformation of its productive forces. Among the triad of productive forces, namely, the object of nature, labor power and instrument of labor, the last two- human ingenuity and technology stand out in the procurement of societal needs from the gifts of nature. Investment in research and development (R&D) offers the most reliable pathway through which progressive societies harness their human and material resources to create relevant technologies and effectively exploit the prodigality of nature for sustainable development. Meanwhile, the nexus between poor R&D funding and slow technological growth in Nigeria is understudied in the existing literature. The objective of the study was to ascertain if poor R&D funding is implicated in the slow growth of indigenous technology in Nigeria. Methodologically, the study relied on the qualitative data collected through secondary sources such as textbooks, journal articles, official documents, media reports, etc.; and analyzed them using qualitative descriptive method. The study revealed, among others, that meager budgetary allocation to education and R&D is implicated in the slow technological growth in Nigeria. Thus, the study recommended, inter alia, increased funding of R&D through broad-based public-private partnership.

Keywords: Education, productive forces, R&D funding, technological growth, sustainable development.

JEL Classification Codes: A2, P42, Q16, Q55, Q01.

1. INTRODUCTION

The capacity of any society to produce its material needs is determined by the extent of development and transformation of its productive forces. Among the key components of productive forces (i.e., the objects of labour, labour power and means of labour), the development and transformation of human ingenuity and technologies are essential in the procurements of insatiable human needs from the abundance of naturally existing resources. Understanding the crux of socio-economic activities in the evolution of societies, Ake (1981, p. 1) argued:

Just as economic need is the primary need, so is economic activity a man's primary activity. The primacy of work, that is economic productivity, is the corollary of the primacy of economic need. Man is first and foremost a worker or a producer. It is by man's productive activity that he is able to obtain the economic means which he needs to sustain life. In short, man must eat in order to live but must work in order to eat. Thus, productive activity is the condition for all other activities.

The above assertion underscores the centrality of human capital (labour power) and the importance of technology in facilitating man's productive activities and exploiting the prodigality of nature. On this note, Okigbo (1993) in his *'Brain as a Capital Asset'* argued that a society is admired by the qualities it possesses and possibility of progress determined by the state of technological arts and the status of intellectuals in that society. Okigbo further stated that the ultimate test of labour power as a *'national asset'* is its impact on knowledge creation, on inventions and innovations as well as on extension of production possibilities. Historically, several epochs in human civilization are driven by rigorous development of man's creative energies which are made manifest in the milestones of technological innovations achieved by human societies. Also, various advancements in material technologies and innovations which have set varying defining moments of human civilization, namely, the Stone Age, Bronze Age, the Steel Age and the ICT Age, among others, are positive results of aggressive investments in research and human capital development (R&D) especially in advanced economies.

In Nigeria, several efforts have been made by successive administrations to grow local technologies that are capable of driving industrialization and development of the country. However, these government's commitments aimed at putting Nigeria on a path to technological growth were mainstreamed in various successive development plans, namely, the First National Development Plan (1962-1968), the Second National Development Plan (1970-1974), the Third National Development Plan (1975-1980), the Fourth National Development Plan (1981-1985), and the National Economic Empowerment and Development Strategy (2003-2007), among others (Okigbo, 1993; Ibietan & Ekhosuehi, 2013; Deedam, Akpe & Emeto, 2019; Chukwu, 2020). The foremost of these development initiatives was the establishment of multi-billion-dollar Ajaokuta Iron and Steel Complex and Ovwian-Aladja Direct Steel Reduction Plant in Kogi and Delta states respectively (Obikwelu & Nebo, 2012). Other complementary efforts were the construction of Beneficiating Plant at Itakpe, Kogi state, the establishment of three Rolling Mills, each sited at Katsina, Oshogbo and Jos respectively. In line with the above efforts made by the successive administrations in Nigeria, Nadabo (2023) argued that there is a nexus between productive infrastructural development and the manufacturing sector performance in the country.

Today, R&D is among the important metrics of measuring the level of technological growth and development of a country. The "R&D provides impetus for science and technology which plays more and more essential role in economic growth in the future" (Peng, 2010, p. 1725),

and “to spend much more on expense of R&D leads to technological improvements, besides productivity and growth increase” (Tari & Alabas, 2017, p. 1). In all the trajectories of technological advancement and industrial growth especially in the advanced and more progressively developing economies, investments in R&D have remained a recurring concatenation. For instance, Bizri (2018) examined some Arab economies and their development policies and found that investments in education and infrastructure (namely, science, technology, innovation and development) resulted in decades of annual GDP growth in the range of 4 percent to 5 percent, with commensurate improvements in the living conditions of their citizens. This highlights the reciprocal effects of the nexus between R&D and technological advancement of any society. Other studies such as Epstein (2011), Fleming (2020) and EURYDICE (2021) are in agreement with the organic link between the knowledge-based economy and technological growth. In the same vein, Andow, Gugong and Kwagga (2023) argued that raising government spending on education, research and development at all levels will aid knowledge advancement, increasing production, and fostering national progress.

In Nigeria, the government created a number of R&D funding schemes to serve as catalysts for the promotion of science, technology and innovation in the country. Some of these R&D funding programmes include the Agricultural Research Council of Nigeria (ARCN), Medical Research Council of Nigeria (MRCN), Natural Sciences Research Council of Nigeria (NSRCN), Industrial Research Council of Nigeria (IRCN), the Nigerian Tertiary Education Trust Fund (TETFund), and the R&D Department of the Nigerian Communications Commission (NCC), among others. These were designed to provide essential infrastructure and funds for teaching and learning, institutional material and equipment, research and publications, academic staff training and development, and a cutting edge research into emerging technologies that promote and stimulate innovation in Nigeria (TETFund, 2022; NCC, 2022; Akinwale, Dada, Oluwadare, Jesuyele & Siyanbola, 2012). Although several government’s funded R&D schemes exist in Nigeria, there is paucity of data on the country’s R&D spending (Center for the Study of the Economy of Africa, 2014). Moreover, not only that R&D spending in Nigeria is shrouded in opacity, the country has continued to rank low in the world in all indices of economic growth and technological advancement, such as, infrastructure index, innovation index, knowledge and technological outputs, human capital development index, literacy index, etc. (World Intellectual Property Organization- WIPO, 2021).

While scholars have assessed the nexus between R&D spending and technological growth especially in advanced economies (Huergo & Moreno, 2011; Czarnitzki & Hussinger, 2004; Tubbs, 2015, etc.), how investment in R&D or lack of it is connected with technological innovation in Nigeria has not received adequate systematic and empirical investigation among scholars. Against this backdrop, the study examined the effects of poor funding of R&D on technological growth in Nigeria. The finding and recommendations of this study would be of immense benefit to all stakeholders saddled with the responsibility of driving technological advancement through the public and private sectors’ support to R&D in Nigeria. The study area is Nigeria, with a population of over 218 million people, out of which 90.1 million citizens live below poverty line in 2022 (Nigeria National Population Commission, 2022; World Population Review, 2022; World Bank, 2022). Also, Nigeria is Africa’s economic powerhouse with an estimated value at \$440 billion in 2021 (World Economic Forum, 2019; World Bank, 2021). Although the country is classified among the developing countries of the world (United Nations Conference on Trade and Development- UNCTAD, 2021), the country is ranked among African countries in which capacity

in science and technology is significantly lagging (World Academy of Sciences, 2022). The study is organized into different sections. Section one introduced the study while section two reviewed extant literature on the nexus between R&D and technological innovation particularly in Nigerian. The methodological requirements and discussion of findings were treated in the sections three and four of the study, while section five concluded the study with recommendations.

2. LITERATURE REVIEW

Whereas R&D studies in more progressively developing societies are focused on the best ways to improve investments on R&D to foster advancement in science and transformation of existing technologies, the equivalent research endeavors in Nigeria are concerned with how to mainstream R&D into policy frameworks and build capacity in science, technology and innovation. The same is the focus of this study. Specifically, this section of the study undertook a review of the study's units of analysis, namely, R&D spending, technological growth and economic performance in Nigeria. This section also overviewed some of the public R&D funding schemes in Nigeria.

2.1. R&D Spending, Technological Growth and Economic Performance

The link between R&D, technological innovation, economic growth and productivity has elicited myriad of academic discourses. Notably, some scholars have argued that positive relationship exist between investment in R&D and technological performance. On this context, Czarnitzki and Hussinger (2004) examined the link between R&D subsidies, R&D spending and technological performance among German firms, and concluded that both purely privately financed R&D and publicly induced R&D showed a positive productivity. This implies that positive investment on R&D is a catalyst for economic growth and development as lack of it will produce reverse effect. In the same vein, Tubbs (2015) analysed the relationship between investment in R&D and company's performance during economic downturn, and found that companies gained competitive advantage in their products and services by increasing their R&D spending during this period, leading to increased sales and market capitalization in the subsequent upward trend.

Similarly, Huergo and Moreno (2011) analyzed the nexus between R&D expenditures, innovation and productivity growth among Spanish firms between 1990 and 2005. The study's results showed the existence of mutual dependence both in the decision of R&D investment and in the production of innovations. Furthermore, Baumann and Kritikos (2016) analysed whether the effect of R&D on innovation and productivity is the same for micro firms of less than 10 employees as for small and medium sized enterprises (SMEs). The results of the above study showed that the relationship between R&D, innovation and productivity of micro firms does not largely differ from their larger counterparts in terms of boost of innovativeness and productivity. In a related study, Choi and Lee (2017) examined the impact that public R&D subsidy has on the composition of private R&D expenditures, and found that government's R&D subsidy is rather a catalyst for private R&D activities of small firms than otherwise. According to them, this finding is an empirical proof that government R&D subsidy can successfully address market failure in private R&D investment.

Additionally, Peng (2010) examined the relationship between R&D expenditure and economic growth of China, and found that even though the Chinese government's investment on R&D is lower than some countries, it grew rapidly above 15 percent since the beginning of the 21st century which has continuously fostered economic growth in the country. In a similar study, Tari and Alabas (2017) analysed the correlations between R&D expenditures and economic growth in Turkey using the ARDL model in the period, 1990 to 2014. The study established a

positive relationship between R&D spending and economic growth, and concluded that increasing R&D expenditure systematically would in the long run result in sustainability of the Turkish economy. Corroborating the above, Boeing, Eberle and Howell (2022) studied the effects of R&D subsidies and inputs on the wider economy. The study found, among others, that the effects of R&D subsidies and inputs go beyond the reinforcement of corporate R&D, to promoting technological advancement, capital deepening and economic growth.

Moreover, Siyanbola, Isola, Egbetokun and Adelowo (2011) examined the challenge of wealth creation in Nigeria in the context of R&D. They identified factors such as poor funding, infrastructural deficit and misdirected attention of researchers as militating factors against the developmental impact of R&D in the country. Also, the results of a study conducted by Adeyeye, Jegede and Akinwale (2013) on the impact of technological innovation and R&D on firms' performance in Nigeria showed that a positive relationship exists between technological acquisition, training and in-house R&D and the firms' outputs. In a related study, Olomo (2017) assessed the impact of technological innovation on SME's profitability in Nigeria. The results showed that R&D spending by the firms, coupled with product and process innovation has significant impacts on the SME's performance with high probability margin. In the same vein, Ukwuoma, Amade and Muoghalu (2013) examined the link between R&D management and commercialization in Nigeria, and found that effective management of R&D is essential for wealth creation and national development.

Conversely, Pessoa (2010) assessed the strength of relationship between R&D expenditure and economic growth within the Organization for Economic Cooperation and Development (OECD), and threw doubts on the effectiveness of an innovation policy that attempts to improve aggregate productivity only based on increasing R&D intensity. Implied in the above is that increased spending on R&D does not unilaterally guarantee positive economic performance or productivity. This could be the result of misallocation of research-oriented public funds (Boeing, Eberle & Howell, 2022). Agreeing with the above, Akinwale et al. (2012, p. 187) argued that increasing spending on R&D and innovation is not enough to bring economic growth "when there are weak institutions, high corruption practices, low interaction between the academia and the industry, and uncoordinated industrial clusters, among others".

While the existing literature provided sufficient empirical evidence showing that positive investment on R&D often has significant corresponding effects on performance and productivity, the effect of poor R&D spending on technological growth in Nigeria has been understudied. It is our aim that this study contributes to knowledge by filling the research gap.

2.2 Brief Overview of some of the Public R&D Funding Schemes in Nigeria

In the developed societies, science and technology are promoted largely through government funded R&D. The first attempt to coordinate R&D in Nigeria was with the establishment of the Nigerian Council for Science and Technology (NCST) in 1970, which was mandated to ensure ordering of national priorities in scientific research, coordinating and supervising both basic and applied research activities in the country (National Bureau of Statistics- NBS, n.d.). In 1977, the NCST was replaced with the creation of the National Science and Technology Development Agency (NSTDA). The NSTDA was charged with the responsibility of the promoting and developing science and technology through the initiation of policy in relation to scientific research and technology. NSTDA controlled all the government-funded research institutes in Nigeria. However, with the creation of a full-fledged Federal Ministry of Science and Technology in 1980,

the responsibilities of NSTDA were assumed by the ministry, with five professional departments, namely, Science and Technology Planning Department, Agricultural Science Department, Industrial Science and Energy Department, Medical and Natural Science Department, and Technology Transfer and Science Education Department.

With further efforts to promote science and technology innovation, the Federal Ministry of Science and Technology, and the Federal Ministry of Education were merged to form a Ministry of Education, Science and Technology. This merger could not last long as the Ministry of Science and Technology regained its independence in the last quarter of 1985, and was renamed the Federal Ministry of Industry and Technology, leading to the creation of National Agency for Science and Engineering Infrastructure (NBS, n.d.). In 1993, the ministry regained its previous name- the Ministry of Science and Technology and was charged with the following mandates:

- i. Promotion of scientific and technological research.
- ii. Promotion of agricultural, industrial, medical, road, building, energy research and basic sciences research.
- iii. Promotion and administration of technology transfer programmes.
- iv. Coordination and issuance of policy guidelines to all research institutes in Nigeria. It was also to approve the institutes' research programmes and sanction their capital and recurrent expenditures (NBS, n.d.).

In 2014, the National Research and Innovation Council (NRIC) was created by the Federal Ministry of Science and Technology to oversee matters of innovation in Nigeria. Specifically, the aim of NRIC was to accelerate the growth of innovation-based entrepreneurship in the country and to create the conditions for the commercialization of current and future research findings in the Nigerian universities and research institutes (Ndiomewese, 2019). Other major complementary public funded R&D schemes in Nigeria include the Tertiary Education Trust Fund (TETFund), the R&D Department of the Nigerian Communications Commission (NCC), and Nigerian Content Research and Development Fund (NCRDF), among others. The TETFund which is the most government funded R&D scheme in Nigeria was established by the Tertiary Education Trust Fund Act 2011, as an intervention agency set up to provide supplementary funding support to all level of public tertiary institutions, aimed at promoting research, development and innovation in the country. On the other hand, R&D of the NCC was established to support research in emerging technologies and innovation, while NCRDF was designed to provide funding support for research commercialization and for basic and applied research.

3. METHODOLOGY

This section explored the underpinnings of the research design and methods adopted for data collection and analysis. The study adopted an ex-post facto design, the justification being that events which we observed, in this case, the government funding of R&D has already taken place. Time series design was also used to enable us extract information relating to the recurring challenges to R&D funding and technological growth in Nigeria. The study relied on qualitative data generated from secondary sources such as textbooks, journal articles, official documents, media reports and others. We collected most of these data using generic search engines including Google, Google Scholar, ScienceDirect, and others. We utilized publications from the local and international media as well as reports from the specialized agencies that are relevant to this study especially in the discussion of results section. However, the data were analyzed using qualitative description method which enabled us to provide detailed presentation and explanation of results

and findings of the study. This method enabled us to summarize and present data contained in publications. The orientation of in-depth and comprehensive understanding of empirical evidence makes qualitative data analysis more useful to this study.

4. DISCUSSION OF FINDINGS

In this section, we examined the R&D spending in Nigeria which was compared with R&D financing in other sub-Saharan African countries. We also assessed the effects of R&D spending on technological growth in Nigeria. Discussion of results was aided by empirical reports from the reputable international organizations such as the World Economic Forum, the World Bank, UNDP, and the World Intellectual Property Organization- WIPO.

4.1 The State of R&D Expenditure in Nigeria by GDP

Historically, many nations especially the advanced economies have consistently invested massively in human capital development through R&D funding as a moving force of societal progress. In the developed countries, policy makers leverage from the research outputs of their knowledge industries in the formulation and execution of development policies. They do so by investing a lot of resources on R&D. For instance, increasing investment in education and human capital continues to drive the advanced economies of Europe to greater heights (Bilbao-Osorio and Rodriguez-Pose, 2004). Investment in R&D spurs innovation and industrialization, while lack of it decelerates the pace of progress. As shown in Table 1 below, Nigeria has an outrageous record of investment on scientific research and development (World Bank & UNESCO, 2022). Table 1 presents the most recent R&D expenditure by percentage of GDP in the selected African countries.

Table 1: R&D Expenditure in selected African Countries (% of GDP)

Countries	Most recent year	Most recent value
Algeria	2017	0.53
Botswana	2013	0.54
Congo Demo. Republic	2015	0.41
Egypt	2020	0.96
Gabon	2009	0.58
Ghana	2010	0.38
Kenya	2010	0.69
Morocco	2010	0.71
Nigeria	2007	0.13
Rwanda	2019	0.76
Senegal	2015	0.58
South Africa	2019	0.62
Tanzania	2013	0.51
Tunisia	2019	0.75

Source: World Bank and UNESCO (2022)

Table 1 shows that Nigeria not only has a dated data of its R&D spending but has performed extremely poor compared to the size of its economy and the performance of its African peers. As presented in Table 1, South Africa in 2019 invested 0.6 percent of its GDP on R&D while Kenya spent 0.69 percent in 2010. On the other hand, Egypt, Morocco and Rwanda expended 0.96 percent, 0.71 percent and 0.76 percent of their GDP on R&D in 2020, 2010 and 2019 respectively,

while Senegal, Algeria, and Botswana invested 0.58 percent, 0.53 percent and 0.54 of their GDP on R&D in 2015, 2017 and 2013 respectively. The last official update (0.13 percent of GDP) of Nigeria’s spending on R&D was released in 2007.

Nigeria’s investment of 0.13 percent of its GDP on R&D is very negligible to boost technological innovation in a country of more than 200 million people. Corroborating this, the Nigerian Minister of State for Petroleum Resources, Chief Timipre Sylva alluded that 0.2 percent currently devoted to R&D in the country is very insignificant, noting that advanced economies such as the United States, China, Japan, Germany, and South Korea, among others spend between 2.5 to 4 percent of their annual GDP on research (Majorwavesen, 2021). This explains why Nigeria has continued perform lowly in all indices of technological growth and economic development. On this note, Nigeria ranked low- 118th, 120th, 121st and 123rd out of 132 economies respectively in the Global Innovation Index, Infrastructure Index, Human Capital and Research Index, and Knowledge and Technology Outputs Index (WIPO, 2021). The current state of Nigeria’s low R&D spending and poor technological growth is corroborated in Essia and Mba (2017). According to them, inadequate long term financing and poor execution of capital budget accounted for weak capacity for developing infrastructures in Nigeria.

4.2 The State of R&D Funding in the Nigerian Tertiary Institutions

Although most of the institutions of learning in advanced economies of Europe and North America especially at the tertiary level enjoy tremendous autonomy, government continues to invest massively in R&D. According to Okigbo (1993), the ultimate test of labor power as a ‘national asset’ is its impact on knowledge creation, inventions and innovations as well as the extension of production possibilities. Education is the most comprehensive channel through which societies build their future.

Virtually all the government funded R&D programmes in Nigeria are mere portfolios and are plagued with decades of inadequate funding and misappropriation of funds meant for scientific research and development (Ogunode & Oyebanjo, 2023). Less than 2 percent of Nigeria’s GDP has been committed to education in the past 10 years (Teachers Registration Council of Nigeria, 2022), which is far below the 15 to 20 percent annual budget to public education for developing economies recommended by the UNESCO. Compared with some of its peers in Africa, Nigeria has performed abysmally in education and R&D spending. For instance, Nigeria spent 6.5 percent on public education in the 2016/2017 annual budget which trailed many African economies including Kenya with 23.10 percent spending, Lesotho- 19.20 percent, South Africa- 15 percent, Ghana- 13.50 percent and Egypt with 11.10 percent spending respectively (see Table 2 below).

Table 2: Nigeria’s Education Budget compared with selected African Countries

Country	Year	Education Budget in %
Kenya	2017/2017	23.10%
Lesotho	2016/2017	19.20%
South Africa	2016/2017	15%
Ghana	2016/2017	13.50%
Egypt	2016/2017	11.10%
Nigeria	2016/2017	6.5%

Source: *ThisDay Nigeria (25 August, 2022)*

This poor trend of education budget has continued unabated in Nigeria. In 2020, the Nigerian annual spending on education was less than \$2 billion (a sum of N691.07 billion) which represented 6.7 percent of the year’s fiscal national budget (Amoo, 2019). State of the Nigerian education has degenerated such that currently, Nigeria does not have official record of its expenditure by GDP on education since 1975. The last known official record was released in 1975 when Nigeria invested 3.1 percent of its GDP on education (see Table 3 below).

Table 3: Expenditure on Education by GDP (%) in selected African Countries

Countries	Most Recent Year	Most Recent Value
Burkina Faso	2020	5.5%
Burundi	2020	5.0%
Lesotho	2021	8.7%
Mozambique	2020	6.3%
Nigeria	1975	3.1%
Senegal	2020	5.5%
Sierra Leone	2020	8.8%
South Africa	2020	6.2%

Source: World Bank (2022)

In Table 3, Burkina Faso spent 5.5 percent of its GDP on education while Burundi invested 5.0 percent. Lesotho on the other hand spent 8.7 percent of its GDP on education in 2021 while Mozambique expended 6.3 percent of its GDP in the year 2020. Senegal, Sierra Leone and South Africa invested 5.5 percent, 8.7 percent and 6.2 percent of their GDP respectively on education in the year 2020. Compared to 3.1 percent of GDP which the Nigerian government invested in education, the sector in many African countries has performed creditably better in the past two decades following their huge investment in the knowledge industry (see Table 3).

Meanwhile, the TETFund, which is reputed for providing essential physical infrastructure and logistics for teaching and learning is also undermined by paucity of funding. The TETFund which oversees R&D in more 100 public tertiary institutions in Nigeria has managed to receive not more than \$3 billion funding from the Nigerian government in more 10 years of its operation (Erunke, 2021). Low budget and frivolous expenditure have continued to render many research institutes in Nigeria redundant and ineffective (Ogunode and Oyebanjo, 2023). The deplorable state of teaching and learning infrastructure as well as poor training and research outputs in the Nigerian institutions of higher learning are reflected in the 2022 world Universities ranking, in which the three best universities in the country could not make the top 1000 in the world or top 20 in Africa (see Table 4 below). Interestingly, South African based universities dominated the regional ranking as 8 out of 10 best African universities are located in the country. The ranking below also reflects the R&D productivity outputs of researchers in terms of journal publications, conference papers and contribution to books over a period of time.

Table 4: 2022 Ranking Web of Selected Universities

University	Country	World rank	Regional rank	National rank	Impact rank	Openness rank	Excellence rank
University of Cape Town	South Africa	245	1	1	283	244	292

University of the Witwatersrand	South Africa	393	2	2	642	388	407
Stellenbosch University	South Africa	437	3	2	695	341	470
University of Ibadan	Nigeria	1207	21	1	2623	813	1226
Covenant University Ota	Nigeria	1353	25	2	2709	1172	1410
Obafemi Awolowo University	Nigeria	1385	26	3	1749	1136	1930

Source: <https://www.webometrics.info/en/world>

The persistent poor ranking of the Nigerian universities in the world and Africa as can be seen in the table above is an indication that the resources (equipment, funding, enabling environment, etc.) devoted to R&D are too meagre and are unevenly distributed among many research works being carried out concurrently. Notwithstanding TETFund intervention, experts' reports showed that the output of R&D driven by the Nigerian tertiary institutions is still very poor due to dearth of funds and lack of enabling environment (Lawal, 2021). Most of the research grants and funding opportunities leveraged at the tertiary institutions and research institutes in Nigeria are attracted from outside the country. With heavy financial burden on the shoulders of Nigerian researchers and academics, South African universities have continued to provide funding and training opportunities to postgraduate and postdoctoral students from Nigeria. After almost a century of academic knowledge generation in higher education institutions in Nigeria, any scientific breakthrough remains rare, and lack of funding is the primary reason for a slump in research activities in Nigeria (Ibeh, 2022). The embarrassing salary of a professor in a Nigerian public university who earns less than \$600 monthly also affects R&D outputs in Nigeria (Ezeh, 2020). On this note, Ibeh (2022) stated:

A lack of interest from policy-makers is a reason for the limited research funding, inadequate government funding for education, which is affecting infrastructure at universities, including laboratories to conduct research. Instead, researchers use their salaries to conduct research, publish articles and to attend conferences. Consequently, they lack motivation and training to do research, and this could hinder the country's achievement of sustainable development goals.

The above assertion explained why Nigeria ranks low in all development indices including Global Competitiveness Index (GCI) due to inadequacy of skilled educated workforce, among others (IMF, 2017). Similarly, the infrastructural resources such as lecture halls, laboratories, students' hostels, library spaces, etc. required for effective system of education are in short supply and grossly inadequate in the Nigerian institutions of higher learning (Subair, Akotoni & Adebakin, 2012).

4.3 The Effect of Poor State of R&D on the Knowledge-based Economy in Nigeria

The aggregate index of a nation's ability to generate, adopt and diffuse knowledge is often used to measure the overall development of a country towards the knowledge-based economy. Knowledge

economy is a concept of economic development, in which innovation and access to information drive productivity growth (European Bank, 2019). According to Currie and Goodman (2020), investments in education and human capital pay off in terms of higher future earnings at both individual and societal levels. In terms of funding for R&D, the advanced economies spend the largest proportion of their GDP on R&D activities, with Israel, South Korea, Switzerland, Sweden and Japan ranked the top five, while Austria, Germany, Denmark, United States, and Belgium completed the top ten in the world (World Bank cited in Fleming, 2020).

The continued public supports for strong education system in the advanced countries have yielded a lot of dividends including the achievement of global competitiveness (competence of citizens for high-skill jobs), knowledge economy (driving innovations in ICT), economic returns (with research outputs feeding and sustaining the industrial sector) and high standards of living (including sustainable jobs and savings). For the efficacy of public policy and economic development, knowledge production is a pre-condition (Center for the Study of the Economies of Africa- CSEA, 2014). According to the CSEA, this will require developing human and technical capacity across the data generation value-chain and R&D.

Notably, the capacity in science, technology and innovation is lagging in Nigeria due to government’s neglect of R&D funding in the country. As seen in the 2020 Global Knowledge Index (GKI), Nigeria was not ranked among countries making progress in knowledge production (see Table 5 below). This shows how pathetic the state of R&D is in Nigeria. With a broken educational system and dearth of R&D funding opportunities, Bailey and Ayodele (2021) argued that Nigeria is stagnant as the world races towards “knowledge-based” economy.

Table 5: 2020 Global Knowledge Index in some selected Countries

Country	Rank	GKI	R&D and Innovation	ICT	Knowledge Economy	Enabling Environment
Malaysia	33	55.6	33.1	70.3	57.3	66.7
South Africa	71	45.1	25	55.6	41.5	59.4
Egypt	72	45	19.9	52.4	41.8	53.4
Tunisia	82	42.7	20.3	48.8	38.1	50.9
Kenya	88	42	21.3	50.9	32.5	51.4
Nigeria	Nil	Nil	Nil	Nil	Nil	Nil

Source: UNDP (2020)

Availability of quality data is essential for knowledge economy. Thus, broad-base databank is a corollary of massive investment in R&D. The absence of quality data, a consequence of marginal R&D output has continued to redirect research from the problems facing Nigeria’s economy to the problems that are researchable, given available data (CSEA, 2014). This knowledge-data lag facing the Nigerian economy is laid bare in Table 5 as the country lacked data on varying indices considered in the GKI. Part of the consequence of low knowledge-economy index in Nigeria is that the country’s economy continues to rely heavily on external capacity which makes the incentive for development of local capacity trivial. However, the inability of R&D to replicate tradable goods and services in Nigeria is captured by Femi Fana as follows:

Africa is being left behind in the global educational revolution,” arguing that, “the main pillar of knowledge in most emerging economies is to have access to knowledge. These

economies produce knowledge, use knowledge to create innovations, and these innovations finally become tradable goods” (Femi Falana quoted in Shahara Reporter, 28 January, 2018).

4.4 The Effect of Poor R&D Funding on Technological Innovation in Nigeria

In every society, the human factor plays the leading role in innovation. According to Daniel (2014), human capital building is determined by the level of support that governments and firms render to R&D. In Nigeria, there is persistent crisis in the innovation ecosystem resulting from poor investment in R&D. Data presented in Table 6 below shows that Nigeria is ranked in the bottom-low- 118 out of 132 countries in the 2021 Global Innovation Index. Due to lack of enabling environment and inadequate R&D expenditure, most of the research projects conducted in Nigeria are not development oriented. On this note, Siyanbola et al. (2011, p. 25) added that “there is an inherent discontinuity among the research activities in institutions, the development activities required to produce artefacts and subsequent manufacturing and marketing of these artefacts”.

Table 6: 2021 Global Innovation Index - GII Ranking on Selected Countries

Countries	GII Rank	Score	Income Group Rank	Regional Rank
Singapore	8	57.8	8	2
Mauritius	52	35.2	41	1
Brazil	57	34.2	11	4
Tunisia	71	30.7	7	9
Morocco	77	29.3	8	12
Kenya	85	27.5	9	3
Egypt	94	25.1	13	17
Namibia	100	24.3	32	6
Rwanda	102	23.9	1	7
Senegal	105	23.3	19	8
Botswana	106	22.9	34	9
Malawi	107	22.9	3	10
Madagascar	110	22.5	4	11
Ghana	112	22.3	23	12
Zimbabwe	113	21.9	24	13
Côte d’Ivoire	114	21.0	25	14
Burkina Faso	115	20.5	5	15
Nigeria	118	20.1	28	16

Source: WIPO (2021)

As Okeowo (2020) and UNDP (2020) noted, poor financing of human capital development and R&D is responsible for low ranking of Nigeria in the GII and Human Development Index. Besides ranking low in the GII, poor state of R&D in Nigeria is implicated in the country’s fragile conditions of public infrastructure, poor knowledge-base and technological outputs as it is ranked among the worst performers in Infrastructure Index, Human Capital and Research Index, as well as Knowledge and Technology Outputs Index (WIPO, 2021). Meanwhile, Can and Tursunbadalov (2019) analyzed the performance of Nigeria in the GII. They observed that technological innovation in Nigeria is hindered by low education level and lack of world-class research

universities, poor business models, political instability, physical infrastructure, and lack of compact technology.

From the observations on Table 6 above, one can deduce that a nation's level of technological innovation is a measure of its degree of competitiveness. With the Nigerian private sector activities shrinking and manufacturers converting their factories to warehouses (for imported products including machineries), Naira weakening to a low record and inflation rate becoming extremely high; with the service sector decimating and many citizens becoming jobless; and with the continuous disregard for R&D funding and provision of enabling environment for researchers, Nigeria became the 116th most competitive nation out of 140 countries during the 2019 edition of the Global Competitiveness Report (World Economic Forum, 2020).

Thus, the paucity of investment on human capital development in Nigeria weakens the R&D which in turn undermines the country's commitments towards technological and industrial advancement. The consequence of this is that many Nigerian intellectual assets in diaspora are reluctant to return while those at home are seeking for opportunity to migrate following the prevailing crisis in the economy and knowledge industry (Pioneer Team, 2019). The whole quagmire has its toll on the technical and industrial progress of Nigeria. Virtually all machineries and technical capacity being used for production in Nigeria are imported as the country has continued to trivialize efforts towards building local capacity and technology through sufficient investment on R&D. As a result, BusinessDay Nigeria described the Nigerian economy as a mere shell (Business Day, 13 December, 2015). Also, the Director-General of Nigeria National Office for Technology Acquisition and Promotion, Dr. Ibrahim Dan Azumi indicated that more than 90 percent of technologies powering the Nigerian economy are imported (Ogunfuwa, 2017). The Nigerian Minister of State, Petroleum Resources, Chief Timipre Sylva, also explained that the underfunding of R&D is reflecting on Nigeria's overdependence on foreign goods and services (Addeh, 22 September, 2022).

5. CONCLUSION AND RECOMMENDATIONS

Drawing from recent studies and official reports, the study analysed the effect of poor R&D funding on technological growth in Nigeria, which most previous researchers have not adequately interrogated. Relying on the data generated mainly from the secondary source and personal observations, the study concluded that underfunding of R&D in Nigeria has negative effects on the nation's quest to build capacities in technological breakthroughs. Thus, Nigeria's disregard for education and R&D is the main reason the country's capacity in science, technology and innovation is significantly lagging. The consequences of dearth of technological capacity in Nigeria include the overbearing reliance of the county's economy on foreign capital comprising technological products and external capacity. The craze for import products and services has put the Nigerian economy in a state of comatose, compelling its professionals to migrate to advanced economies where good working environment, R&D incentives, higher remuneration and access to advanced technology are guaranteed. Against the poor state of R&D and technological growth in Nigeria, the recommended the following:

- There is need to mainstream R&D funding in the Nigerian development plans which should be treated as a national priority.
- There is also need for public-private partnership (PPP) as a panacea to dwindling R&D funding in Nigeria. Increased funding of R&D in line with the international best-practices

through broad-based PPP is essential in building a technological capacity that will drive economic growth and development in Nigeria. This can be achieved by setting up a multi-stakeholder R&D funding scheme comprising government agencies and key players in the private sector where a significant percentage of income taxes from both parties should be devoted to research and development.

- Finally, there is need for the provision of quality research infrastructure and good working conditions for researchers which will intensify local and international collaborations.

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