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Bridging Academia and Industry: Translating Nigerian University Research into Market-Driven Innovations for Sustainable Development

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Abstract

This overview explores how Nigerian universities can better convert research into market-driven innovations that promote sustainable development. It places Nigerian higher education within a changing national innovation ecosystem that includes policies, funding agencies, governance structures, and emerging university–industry partnerships. The paper highlights ongoing challenges, including fragmented technology transfer systems, weak intellectual property (IP) management, misaligned funding mechanisms, limited expertise in technology transfer offices (TTOs), and underutilised patents, all of which hinder university research from becoming market-ready products and services. It then defines five key translational pathways: university-based TTOs and governance; industry–university collaboration models; IP ownership and commercialisation; public funding channels throughout the research and innovation cycle; and regulatory and ethical compliance. These pathways are demonstrated through case studies in agriculture, energy, waste management, health, and digital health, showcasing both successful innovations and stalled commercialisation efforts. Based on this analysis, the paper proposes a roadmap to enhance skills, institutional culture, and policies, while raising strategic questions about funding, support mechanisms, and technology transfer modes- both inbound and outbound- needed to align university research with Nigeria's sustainable development goals. Overall, it advocates for a structured, three-tier model of research, innovation, and entrepreneurship that integrates academic entrepreneurship and market-oriented strategies into universities' roles in national progress.

Keywords: Translational research, university–industry collaboration, technology transfer, research commercialisation, innovation ecosystem, academic entrepreneurship, sustainable development, Nigeria.

1. Introduction

Nigerian universities are increasingly becoming irrelevant in the global knowledge economy. To boost their

relevance, university research and innovation need to be commercialised, thereby diversifying the economy and enhancing citizens' prosperity, aligning with the Sustainable Development Goals. The government acknowledges that universities can offer solutions to economic challenges, but only if their research is commercialised (Afuwoqi & Wu, 2011). A developing innovation ecosystem, with both strengths and limitations, has started to support research commercialisation. It includes policies, governance, funding options, pathways, and models centred on creating commercially viable innovations that generate revenue, promote sustainability, and improve wellbeing (A. Rufus & Cole, 2014). This approach supports a national strategy aimed at sustainable economic, social, and environmental development. Over 60% of the rapidly growing population is under 30. University-driven entrepreneurial activities are a key and practical way to channel youth energy, creativity, and ambition into sustainable economic, social, and environmental progress. The university-industry-policy triad serves as the main framework for implementing government R&D policies around the world. An effective governance structure is essential for successful innovation systems. Countries like Korea and Israel have adopted place-based and institution-focused R&D strategies to strengthen innovation ecosystems around research centres. These policies promote diverse public and private investments into programmes that develop market-oriented, commercially viable research. However, upstream university research conducted in government-owned institutions rarely turns into market-ready technologies, products, or services. In Nigeria, limited pathways for translating research into practical applications pose a significant obstacle to achieving national development goals.

2. Context and Rationale

The relationships among universities, industry, and government policies shape both national and global discussions about translating academic research. In Nigeria, policies supporting both market-oriented innovation and sustainable growth have been established across all levels of government. The federal government's focus on youth and skill development aligns with this broader framework (A. Rufus & Cole, 2014). However, little research has been done on how university outputs are converted into market-ready applications. This gap affects Nigeria's national goals and the university sector's reputation and standing in funding, research, and policy environments. As one of the world's poorest countries by per capita income, Nigeria faces severe hardships. To improve living standards, human and natural resources must undergo processing cycles aimed at industrialisation (Afuwoqi & Wu, 2011).

3. The Nigerian Innovation Ecosystem: Assets and Constraints

The vital contribution of research universities in promoting a country’s socio-economic and technological progress is widely recognised. There is a growing consensus that universities in developing nations should shift their research focus toward market-oriented activities and foster greater collaboration with the private sector to support national growth more effectively. Nigeria exemplifies this trend. University research plays a crucial role by converting research findings into innovations driven by market needs. The government demonstrates a strong commitment to this through various ministries, parastatals, and funding agencies promoting university-industry partnerships. Public universities deserve special attention, not only because of their significance for national development but also because they account for over 75% of Nigeria's universities, even though they receive approximately 30% of total university funding (Ukeje & Aisiku, 2022). Recognising the importance of research, science, and technological development for sustainable growth, various Nigerian administrations have established institutions dedicated to promoting research since independence. Universities engaged in pure and applied research have also played a role in this effort. Nigeria has over 60 universities with substantial research capacity, including both equipment and personnel. The National Universities Commission considers applied research and development a core function of Nigerian universities and has maintained consistent research expectations since 1975. Multiple agencies,

such as the Tertiary Education Trust Fund, the National Science and Technology Fund, the Mega Science Initiative, the National Research Fund, and the National Board for Technology Incubation, provide annual research funding (A. Rufus & Cole, 2014). However, data indicate that the post-doctoral movement, commercial publication of research findings, research consultancy, and university-industry collaborations are all underperforming by any measure. These issues largely account for the weak connection between academic research outputs and industrial applications and adoption (Egbetokun et al., 2008).

4. Translational Pathways: From Research to Commercialisation

Collaborative research is increasingly vital in addressing societal issues. Over the years, Nigerian universities have published numerous research papers, yet the translation of research findings into the commercial exploitation of innovative products remains limited. Steps are needed to extend research and development from knowledge creation to the transfer and commercialisation of research results. Collaborative research helps address pertinent societal challenges and supports national development initiatives such as the Nigerian Industrial Revolution Plan (NIRP) and the Economic Recovery and Growth Plan (ERGP). The Nigerian economy faces numerous challenges, including dwindling economic growth, high inflation and interest rates, and an over-reliance on crude oil as the primary source of income. Collaborative efforts are required to mitigate these challenges and enable development to progress. The importation of goods into Nigeria continues to increase yearly, leading to vast capital flight at the expense of local innovation and entrepreneurship. Collaborative research can help local industries and entrepreneurs effectively address society's market needs. Achieving a high level of national development is possible if university research results align with market-driven innovation requirements (Sanami et al., 2017).

4.1. Technology Transfer Offices and Governance

Nigerian universities face challenges in converting research outputs into market-ready products, despite having innovative solutions in their labs to address urgent national and global issues. Closing the gap between academia and industry requires a coordinated technology-transfer approach that involves multiple mechanisms and stakeholders. Five main pathways can support this process: establishing university-based technology transfer offices (TTOs) to promote commercialisation; fostering industry-academia collaborations that support innovation at different stages; managing intellectual property effectively to protect discoveries and improve their marketability; securing public and private funding to sustain research until products reach the market; and addressing regulatory and ethical concerns during technology development. Together, these pathways facilitate, accelerate, and oversee technology transfer, helping turn academic research into marketable products that aid national progress. They underpin Nigeria’s inclusive national innovation strategy, guiding policy development and capacity-building across universities, research institutes, and public labs (A. Rufus & Cole, 2014; Fauzan & Gooneratne, 2019).

4.2. Industry-University Collaboration Models

Industry-university collaboration models create valuable frameworks for R&D partnerships between academic and industrial entities. These collaborations help universities manage budget constraints, expand access to resources, and prepare graduates to address societal challenges. Knowledge transfer is a key feature, differing across formats such as joint projects, consultancy, research grants, and work attachments, and addressing technological issues across sectors (Afuwoqi & Wu, 2011). The Sustainable Development Goals influence two vital aspects: funding sources and innovation aims. When public funds are scarce, industry partnerships can provide significant additional resources. Additionally, to promote sustainable development in Nigeria, universities are encouraged to pursue joint R&D efforts in specific thematic areas. Such initiatives, called sponsored research, involve selected teams from both institutions working together

on targeted topics or challenges (A. Rufus & Cole, 2014).

4.3. Intellectual Property Management

Intellectual property (IP) ownership and management are critical enablers of market-driven innovations. Both the university system and government policy must clarify rights, obligations, and governance structures for institutions, researchers, and collaborative partners. Universities may choose between open and closed IP-sharing models, conditional on contextual variables such as funding sources, potential for follow-on research, and collaboration length. Relevant instruments for institutions include invention disclosures, patenting strategies, and other rights-management mechanisms. The university must establish a commercialisation-readiness classification system based on factors such as research maturity, potential external interest, remaining development, competitive outlook, and IP availability. Two broad commercial pathways emerge: the gradual, staged transfer of research from academia to industry and the simultaneous exploration of multiple pathways spanning the entire innovation value chain (Sultana et al., 2024).

4.4. Funding and financiers for translational research

Translational research converts basic scientific research into marketable aids and materials for industry use. Financial investment constitutes a crucial early step in the translational process. Therefore, this section enumerates crucial public, private, and blended funding conduits available in Nigeria to stimulate academic-to-industry translation ostensibly. Financiers and specific funding instruments are associated with distinct categories of milestone targets as depicted in Table 1. Such alignment facilitates and reduces the risk of financially unrecouped research (Garba & Saidu, 2020).

Table 1: Domestic Public Funding Conduits and Financiers for Translational Research in Nigeria

Milestone target	Indicative TRL band	Key Nigerian public financiers/programmes	Predominant funding instruments
Basic and curiosity-driven research	TRL 1–2	Tertiary Education Trust Fund (TETFund) Institution-Based Research grants; TETFund National Research Fund; University Senate and central research grants	Competitive research grants, small institutional grants, postgraduate scholarships, and fellowships
Applied research and proof of concept	TRL 2–4	TETFund National Research Fund (applied calls); National Information Technology Development Agency (NITDA) research grants; Petroleum Technology Development Fund (PTDF); federal research institutes (e.g. energy, agriculture, health)	Thematic research calls, proof-of-concept and mission-oriented grants, equipment and laboratory support grants
Prototype development and validation	TRL 4–6	National Agency for Science and Engineering Infrastructure (NASENI); Raw Materials Research and Development Council (RMRDC); Federal Ministry of Science, Technology and Innovation programmes; selected TETFund memorable intervention lines.	Prototype and pilot grants; matching grants with public or state enterprises; soft loans or recoverable grants for equipment and tooling
Incubation and early-stage spin-offs	TRL 6–8	Federal and state technology incubation centres; state ministries of science, technology and innovation; federal youth	Incubation stipends, small seed grants, subsidised workspace and technical

		and innovation schemes (e.g. youth enterprise and innovation programmes implemented through MDAs)	assistance, and matching funds with public development finance institutions
Commercial scale-up and market expansion	TRL 8–9	Development Bank of Nigeria (DBN); Bank of Industry (BOI); Bank of Agriculture (BOA); Central Bank of Nigeria (CBN) intervention funds channelled through participating financial institutions; state development finance institutions, where available	Term loans on concessional terms, credit guarantees, project finance facilities, and targeted intervention funds for priority sectors
Social and sustainability-oriented innovations (cross-cutting)	TRL 3–9	Federal and state Sustainable Development Goals (SDG) offices and innovation funds; relevant line ministries (health, agriculture, power, environment, education); Nigerian Sovereign Investment Authority (NSIA) impact and infrastructure windows	Challenge funds; impact and innovation grants; blended finance schemes (grants plus concessional loans); results-based public financing

4.5. Regulatory and Ethical Considerations

Compliance with ethical standards and regulatory frameworks is a precondition for market-driven innovations and university–industry partnerships, reinforcing societal trust in higher education as a public good, reducing regulatory risk, and enhancing the attractiveness of partnering with universities. Manufacturers and commercial entities, governmental and non-governmental organisations, and social enterprises often require evidence of compliance with relevant safety requirements, data governance policies, and ethics review procedures as inputs to research project planning and contracting. The incremental evolution of government regulations on product safety and quality assurance in Nigeria exemplifies a compliance requirement that university researchers must meet. Other important areas include data privacy, security, and ownership when data are collected from individuals or businesses; health technology assessment when health, food, and medical products or services are involved; animal welfare assurance processes if research adopts such investigations; and contingency planning for environmental hazards associated with the research.

5. Case Studies of Market-Driven University Innovations

The interactions among the agricultural sector, energy resource management, and waste management reuse in Nigeria, including research breakthroughs, technology transfers, and feedback mechanisms that incorporate regulatory frameworks, are examined. Market feedback on agricultural innovations, energy generation, and waste management technologies originating in Nigeria is presented (Ojo et al., 2023). Tracing commercialisation from concept to solution, the characterisation of pertinent innovation content and prioritised stakeholder benefits throughout the transition is followed by the identification of scalable and siting constraints. The details of national and international regulatory compliance processes for health technologies and digital health solutions based on locally developed innovations, the adoption challenges encountered, and the positive influences on health outcomes are also specified. Key insights into the eventual accessibility to end-users, a reward system to motivate behaviour change, and the potential for guidelines to improve the nexus commercial viability of waste energy generation and appropriate agricultural innovations are described (Oyinlola et al., 2024). Co-development with industry partners, licensing arrangements, and funding tool alignment with desired innovation milestones have not yet emerged as features of practice.

5.1. Case Study A: Incremental to Disruptive Solutions in Agriculture

Agricultural innovations by universities in Nigeria, such as an improved cassava-peeling technology developed at the University of Nigeria, Nsukka, provide compelling examples of the shift from incremental to potentially disruptive solutions. Several generations of incremental improvements have resulted in a cassava-peeling machine that is easily affordable, locally made, energy-efficient, and serviceable anywhere in Nigeria. The technology initially stalled at the point of transfer to industrial manufacturers because most of these were unwilling to invest in new equipment, fearing that the technology would not enjoy a sufficiently significant and sustained market. This situation has now changed. The peeling machine has been further improved and is now ready for test marketing and demonstrations in 12 states across Nigeria. The peeling machine is one of four technologies presented at a workshop held under the auspices of the African Institute for Science Policy and Development and the International Network for the Development of Innovation and Knowledge Management. Together, the machines and technologies offer potential solutions to a developmental standstill caused by insufficient agricultural processing and a lack of healthy crop availability during the mid- and late-rainy seasons. Such a standstill repeats itself in similar situations or in yield-output shortfalls in Nigeria and many other developing countries. The Peeling Machine represents the first step toward a plausible break from Nigeria's vicious cycle of agricultural equipment (Tenywa et al., 2011).

5.2. Case Study B: Energy and Waste Management Innovations

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Case Study B: Energy and Waste Management Innovations

Nigerian universities have pioneered innovations in energy and waste management, resulting in significant market adoption. Transgenerational Technology Transfer Limited (TTTL), a university spin-off, has initiated multiple projects and products that support policies promoting renewable energy and recycling efforts (Fletcher et al., 2010). TTTL works with various public and private sector partners to spread innovations in these fields. University research focuses on overcoming the challenges posed by rising energy and waste production. Several waste management technologies have been developed in collaboration with the Lagos State Waste Management Authority. The Nigerian government also plays a key role by implementing the National Renewable Energy and Energy Efficiency Policy, which aims to boost the use of renewable energy sources, such as solar, biomass, and biogas, as well as non-fossil-fuel vehicles.

5.3. Case Study C: Health Technologies and Digital Health

Despite modest performance in Nigeria’s health indicators, the country has well-regarded universities that have produced recognised innovations in health technologies. For example, the stem cell-based treatment of sickle-cell disease developed at the University of Benin has received preclinical approval by the National Agency for Food and Drug Administration and Control (NAFDAC) (Al-Bader et al., 2010). Other medical devices designed for low-income settings, such as the solar-powered refrigerator and the low-cost baby resuscitator conceived at Obafemi Awolowo University, Ife, have been adopted throughout Africa (Konduri et al., 2018). Nevertheless, acceptance by potential users remains a persistent obstacle, as indicated by the low retrieval rate of filed patents.

6. Capacity Building: Skills, Culture, and Institutional Change

Nigerian universities have a wealth of knowledge, but efforts to commercialise research are still minimal. Turning discoveries into market-ready solutions requires not just shifting research priorities but also significant changes in skills, organisational culture, policies, and support systems. Data from various sources highlight that capacity building is a substantial gap across the country. Interviews with key stakeholders

emphasise the importance of fostering private-sector involvement and organisational change (Baro & Nwabueze-Echedom, 2023). Achieving market-oriented research goals requires institutional reforms, such as establishing effective technology transfer procedures, enhancing industry-university collaboration, and fostering a supportive environment for entrepreneurship and innovation. This shift calls for new skills, behavioural changes, and incentive structures. It also necessitates relevant training programs, leadership development initiatives, and tools to monitor progress and recognise achievement. Promoting an entrepreneurial culture among faculty, staff, and students is also essential. Currently, Nigerian universities' entrepreneurial efforts primarily support early-stage student ventures, while faculty and staff engagement in commercialising research remains limited, with few opportunities for additional training or knowledge-sharing (Ogunsade et al., 2021).

7. Policy Frameworks and National Strategy for Sustainable Development

Market-driven innovations address specific societal challenges, seeking solutions that are not only useful but also commercially viable. However, even given Nigeria's acute development needs, few studies have systematically examined how the elements of the innovation system combine to spur translational activity. This gap has significant implications for the deployment of national resources to most effectively promote innovation for commercial impact, particularly by universities engaged in economically beneficial research (A. Rufus & Cole, 2014). Accordingly, the focus of the present overview is the national context for innovation and the various pathways available to university researchers seeking to translate their work into innovations with commercial potential. It surveys the Nigerian innovation ecosystem, identifies key factors relevant to translational research, and outlines models available to universities to bridge the gap between research and commercialisation (Afuwoqi & Wu, 2011).

8. Metrics, Evaluation, and Impact Assessment

Universities are often called the temples of education, with a moral responsibility to conduct research that connects their noble missions to global sustainable development and improving quality of life (A. Rufus & Cole, 2014). However, many Nigerian patents remain unused because they do not address the significant challenges faced. The innovation for commercialisation is rated below average, as market-driven technology transfer involves collaboration between research and industry. Market-driven innovations are products and services developed from university research that address Nigerian issues and aim to have a developmental impact. A survey of higher education institutions in Nigeria showed that only 40% plan to adjust their budgets despite declining research funding. Although the government's national development plan and the creation of TETFUND aim to address pressing issues, universities lag in turning research into marketable products, with the commercialisation process still unclear. Science, technology, and innovation (STI) are globally recognised as crucial for economic and sustainable growth. To this end, industry and policymakers have held various discussions to promote research commercialisation through the establishment of Technology Transfer Offices (TTOs) in universities, which provide services like patenting, marketing, and bridging university-industry gaps (Kruss, 2009).

9. Roadmap for Implementation: Short-, Medium-, and Long-Term Actions

The research agenda aims to enhance understanding of how Nigeria's universities can better motivate researchers to create innovative solutions driven by market needs. These innovations could address urgent national issues, drive significant industrial changes, and create new employment opportunities. Analysing Nigeria's innovation ecosystem, including case studies of university-based solutions and a focus on sustainable development, outlines specific pathways for research and commercialisation. By targeting these areas, universities can be catalysts for change, promoting market-driven innovations through strategic

insights, sector collaborations, and coordinated efforts among around 200 institutions. Such strategies align with the economy's need for innovation and support sustainable growth. Developing these solutions is more than academic; it can transform university research into genuine innovations that improve living standards, foster a more vibrant economy, and create jobs and new industries. Universities must recognise their critical role and actively promote innovation for the nation's progress.

10. Conclusion

Nigerian universities are vital to the country's socio-economic growth through research and innovation. Bridging academia and industry is crucial to preventing disconnection in the innovation system. Promoting market-focused innovations from universities can drive economic growth, create jobs, and reduce poverty, especially with rising youth unemployment and population growth. Nigeria can meet Sustainable Development Goals by fostering academic entrepreneurship and market-oriented innovations, improving its global innovation index, promoting local content, and adopting new teaching methods aligned with labour-market needs. Addressing key questions will help align university research with the innovation ecosystem, support sustainable progress, and develop strategies to close the academic-industry gap, especially in oil and gas. These include identifying funding institutions, support structures for translating research into market innovations, and effective technology-transfer mechanisms. Nigeria's sustainable development depends on universities adopting a comprehensive model of research, innovation, and entrepreneurship, integrating these outputs into national planning to achieve development goals and facilitate technology transfer and social engineering.

Bridging the gap between academia and industry in the global and local innovation landscape is urgent. This involves addressing issues such as the shift from a knowledge-based to a digital, intelligent, and innovative economy. There is also increasing global demand for research focused on attention and health, along with national efforts to advance technology and promote local content. Additionally, growing interest in entrepreneurship calls for a comprehensive reengineering of frameworks and structures for research, innovation, and entrepreneurship, complemented by a strong university-industry policy framework. Developing a clear, science-based, unified blueprint for the interconnected layers of research, innovation, and social transformation is a key step. This approach aims to better align technological progress and local content with the needs of health and attention science, while reconciling the knowledge economy with technology- and concept-based frameworks. A strategic action plan catalysing collaborative efforts among all relevant stakeholders is fundamental to effective execution. Mobilizing a wide range of stakeholders and constituents- local, state, and federal governments, ministries and agencies, major monitoring bodies such as the National Universities Commission, and non-governmental organizations- to gather further input and validation from scientists, citizens, and other innovators on how local universities can expand their educational scope safely and effectively, without jeopardizing productivity under the three interlinked pillars, and on how the national innovation system can more effectively embrace a university-driven techno-socioeconomic path of advancement, evolving into a proactive knowledge- and technology-based economy, is a significant next step toward fully realising the vision outlined above.

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