

From the Laboratory to the Market: A Review of the Research Commercialisation Ecosystem in Nigeria

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Abstract—Nigeria’s 200-plus universities generate substantial research across agriculture, healthcare, and engineering, yet output rarely translates into commercial products. This policy and literature review synthesises evidence from 47 government documents, peer-reviewed articles, and international reports to diagnose the research commercialisation landscape through National Innovation Systems and Triple Helix lenses. Thematic analysis reveals chronic underfunding (0.22% of GDP on R&D), weak university–industry linkages, absence of professional Technology Transfer Offices, and regulatory ambiguity as systemic barriers. Comparative analysis of South Korea, Finland, Malaysia, Rwanda, and Kenya identifies transferable institutional mechanisms. The review proposes a hybrid model combining strategic state direction in priority sectors with bottom-up entrepreneurial support, offering Nigeria-specific implementation pathways including phased R&D investment, sector-focused intermediary agencies, and diaspora engagement mechanisms. Limitations and critiques of commercialisation-first approaches are discussed. Strategic recommendations target policymakers, university administrators, and development partners.

Keywords—Economic Diversification, Innovation Policy, National Innovation System, Nigeria, Research Commercialisation, Technology Transfer, Triple Helix, University–Industry Linkages.

I. INTRODUCTION

IN the contemporary global economy, innovation and knowledge constitute primary drivers of economic growth, competitiveness, and sustainable development [1]–[3]. Nations that successfully harness research for commercial application gain decisive advantages in international markets [4]. For developing economies, this represents both an opportunity for structural transformation and an imperative to avoid economic marginalisation in the emerging knowledge economy [5].

Nigeria’s higher education landscape comprises over 200 universities and numerous research institutes, generating substantial intellectual output annually across agriculture, healthcare, engineering, and materials science [6]. However, this intellectual wealth rarely translates into commercial products, processes, or tangible economic value [7], [8]. Research findings remain largely confined to academic journals, creating what scholars term the “valley of death”—the gap between proof-of-concept and commercial viability where promising innovations fail due to inadequate funding, infrastructure, and institutional support [9], [10].

Multiple converging challenges underscore the urgency of addressing this paradox. Nigeria’s economy

remains heavily dependent on crude oil, which accounted for approximately 80% of export revenues in 2022 [11], necessitating urgent economic diversification. Youth unemployment stood at 42.5% in the last quarter of 2022 [12], while the knowledge economy offers potential for high-value job creation. Annual technology imports exceeding \$2 billion perpetuate foreign exchange pressures and technological dependency [13]. The global shift toward knowledge-based economies means nations unable to commercialise research face accelerating risks of economic marginalisation [14].

While these challenges are substantial, it is important to acknowledge that research commercialisation is not the only legitimate purpose of university research. Basic scientific inquiry, social critique, cultural preservation, and the production of public goods represent equally valid research missions [15], [16]. This review proceeds from the premise that a balanced approach—strengthening commercial pathways while preserving space for curiosity-driven research—best serves Nigeria’s development interests.

This policy and literature review synthesises documentary evidence examining Nigeria’s research commercialisation ecosystem, recent policy initiatives, and potential pathways for improvement. Specifically, the review: (a) analyses recent government initiatives including the NASENI Research Commercialisation Grant Programme; (b) identifies persistent systemic barriers through thematic analysis of 47 documents; (c) examines institutional frameworks through National Innovation Systems and Triple Helix lenses; and (d) derives evidence-based strategic recommendations from comparative analysis of successful international models.

The review contributes to the literature in three ways. First, it provides the first systematic documentary analysis of Nigeria’s research commercialisation ecosystem that integrates both NIS and Triple Helix frameworks, enabling multi-level diagnosis. Second, it critically evaluates the 2025 NASENI programme against comparative evidence, assessing whether programme design matches documented barriers. Third, it develops Nigeria-specific recommendations grounded in political economy realities rather than generic prescriptions, addressing a gap identified by Siyanbola et al. [17] and Iizuka et al. [18] in the African innovation policy literature.

II. CONCEPTUAL FRAMEWORK

Research commercialisation encompasses the multi-stage process through which academic research and inventions are transformed into marketable products, services, or processes that generate economic and social value [19], [20]. This transformation typically involves

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technology disclosure, patenting, licensing, spin-off creation, and collaborative research [21]. This review is analytically grounded in two complementary theoretical frameworks: National Innovation Systems (NIS) and the Triple Helix Model.

A. National Innovation Systems (NIS)

The NIS framework, developed by Freeman [22], Lundvall [23], and Nelson [24], emphasises that a nation's capacity to innovate is determined not by individual actors but by complex interactions among firms, universities, research institutions, government agencies, and financial intermediaries. The framework highlights that institutional configurations—including regulatory environments, cultural norms, and knowledge flows—critically shape innovation outcomes [25]. For developing countries, Oyelaran-Oyeyinka and Barclay [26] argued that NIS frameworks reveal how weak institutional linkages create systemic innovation failures that cannot be addressed through isolated interventions.

Applied to Nigeria, the NIS framework exposes critical gaps. The financial intermediary component is underdeveloped, with venture capital representing less than 0.1% of GDP compared to 2–4% in successful innovation economies [27]. Knowledge flows between universities and firms are predominantly informal and ad hoc rather than structured through institutional channels [28]. Government agencies responsible for innovation support—NASNI, NOTAP, FIRO—operate with overlapping mandates and limited coordination [29]. This fragmentation means that Nigeria's NIS functions well

below its potential, a diagnosis that structures the barrier analysis in the Results section.

B. Triple Helix Model

The Triple Helix model, advanced by Etzkowitz and Leydesdorff [30], conceptualises innovation as emerging from dynamic, overlapping interactions among three institutional spheres: universities (knowledge generation), industry (commercial application), and government (regulatory framework and funding). Unlike linear models that position these actors sequentially, the Triple Helix envisions hybrid organisations and mutual role-taking—universities engaging in entrepreneurship, firms conducting research, governments acting as venture capitalists [31].

In Nigeria, the Triple Helix remains largely aspirational. The university helix is constrained: academic promotion criteria overwhelmingly reward journal publications over patents, industry collaborations, or commercialised products [7]. The industry helix is weakest: Nigeria's manufacturing sector contributes only 9% of GDP [12], limiting absorptive capacity for research outputs. The government helix shows intermittent engagement: R&D expenditure at 0.22% of GDP [14] signals low prioritisation, while frequent policy changes undermine private sector confidence [28]. Critically, the overlapping “hybrid” spaces where innovation thrives—technology parks, joint ventures, industry-sponsored research centres—are sparse and underfunded [32]. Figure 1 illustrates this diagnostic application of the Triple Helix to Nigeria.

TABLE 1. APPLICATION OF THE TRIPLE HELIX MODEL TO NIGERIA'S INNOVATION ECOSYSTEM

Helix	Expected Role	Nigeria's Reality	Key Gap
University	Knowledge generation, entrepreneurship, spin-offs	Publication-focused; 85% lack functional TTOs [6]	No incentive structures for commercialisation
Industry	R&D absorption, collaborative research, technology demand	Manufacturing = 9% GDP; low R&D investment; preference for imported technology	Weak absorptive capacity; cultural distrust of local research
Government	Enabling policy, funding, IP framework, coordination	R&D spend 0.22% GDP; fragmented agencies; no Bayh-Dole equivalent	Policy inconsistency; underfunding; regulatory ambiguity
Hybrid Spaces	Tech parks, incubators, joint ventures, spin-off companies	Very few functional incubators; minimal joint R&D projects	Critical absence of bridging institutions

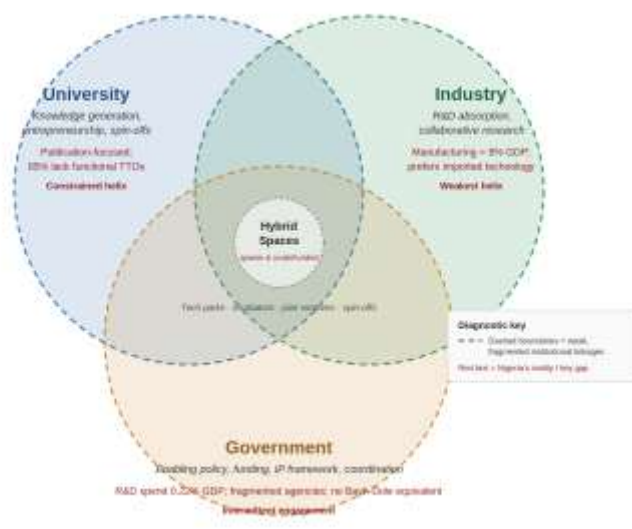


Fig. 1. Application of Triple Helix Model to Nigeria's Innovation Ecosystem
(Source: Authors' synthesis based on [30], [6], [14], and [12].)

These two frameworks are complementary: NIS provides the macro-institutional diagnostic, while Triple Helix offers a meso-level analysis of actor interactions. Together, they structure the documentary analysis by providing deductive coding categories (institutional capacity, funding mechanisms, policy environment, university–industry linkages) while remaining open to emergent themes from the data.

III. METHODOLOGY

This study employed a qualitative documentary analysis and policy review approach [33], guided by National Innovation Systems and Triple Helix frameworks. The analysis is grounded in an interpretivist paradigm, recognising that understanding research commercialisation requires examining socially constructed meanings and policy intentions as articulated in documents [34].

A. Data Collection

Data were collected from 47 documents systematically selected through purposive sampling between October 2024 and January 2025. These comprised: 12 government policy documents (including NASENI 2025 programme framework, Renewed Hope Agenda, NOTAP reports, NUC Blueprint); 23 peer-reviewed journal articles (2015–2024) identified through Scopus and Google Scholar searches using terms “Nigeria AND research commercialisation OR technology transfer OR university–industry”; 8 international organisation reports (UNESCO, World Bank, AfDB, OECD); and 4 comparative case documentation sources. Documents were selected based on publication dates (2015–2025), specific focus on Nigerian or comparator-country research ecosystems, source credibility, and relevance to research objectives. Thematic saturation—assessed by coding new documents and monitoring for novel themes—was achieved after approximately 40 documents, with 7 additional documents confirming saturation [35]. Table 2 summarises the document corpus.

TABLE 2. SUMMARY OF DOCUMENT CORPUS

Document Type	Count	Examples	Primary Contribution
Government policy documents	12	NASENI 2025 Framework; NUC Blueprint 2021; NOTAP Guidelines 2024; Renewed Hope Agenda	Policy intentions, programme design, institutional mandates
Peer-reviewed articles	23	[7]; [8]; [28]; [32]	Empirical evidence, barrier identification, analytical perspectives
International organisation reports	8	UNESCO Science Report 2021; World Bank WDR 2019; AfDB Economic Outlook 2020; OECD Innovation Reviews	Comparative data, benchmarks, international context
Comparative case sources	4	[36]; [37]; [38]; [39]	International model mechanisms and transferability
Total	47		

B. Data Analysis

Documents were analysed using thematic analysis following Braun and Clarke’s [40] six-phase approach, implemented in NVivo 12 software.

- Phase 1 (familiarisation) generated 78 preliminary codes through open reading.
- Phase 2 developed a deductive framework with six primary themes derived from the NIS and Triple Helix frameworks: Policy and Regulatory Environment, Institutional Capacity, Funding Mechanisms, University–Industry Linkages, Human Capital, and Recent Initiatives.

- Phase 3 involved systematic coding with cross-referencing across document types for triangulation.
- Phase 4 identified patterns through frequency analysis, revealing that funding inadequacy appeared in 89% of sources and weak linkages in 76%.
- Phase 5 synthesised findings through the theoretical lenses, distinguishing factual claims from analytical inferences. Table 3 presents the thematic framework with coding frequencies.

TABLE 3. THEMATIC FRAMEWORK WITH CODING FREQUENCIES

Primary Theme	Sub-themes	Frequency	Representative Source
Funding Mechanisms	R&D expenditure levels; venture capital gaps; valley of death; grant programmes	42/47 (89%)	[14]; [41]; [42]
University–Industry Linkages	Cultural divide; collaboration models; trust deficits; co-research	36/47 (76%)	[8]; [7]
Policy & Regulatory Environment	IP legislation; patent processes; policy inconsistency; bureaucracy	34/47 (72%)	[43]; [29]; [44]
Institutional Capacity	TTO presence; intermediary agencies; infrastructure; laboratories	31/47 (66%)	[6]; [32]
Human Capital	Brain drain; skills gaps; entrepreneurship training; diaspora	28/47 (60%)	[45]; [27]
Recent Initiatives	NASENI grants; student venture fund; academia–industry committees	18/47 (38%)	[46]; [42]; [44]

C. Limitations and Reflexivity

As a documentary analysis, this study lacks primary stakeholder perspectives through interviews. Claims about barriers reflect documentary characterisations rather than

direct observation. Analysis of 2025 initiatives is based on policy design rather than implementation outcomes. The research team comprises Nigerian academics with insider experience in university research environments, providing

contextual understanding but potential confirmatory bias, mitigated through explicit assumption acknowledgement, active search for disconfirming evidence, and triangulation across source types [37]. Future research employing stakeholder interviews and longitudinal tracking would complement this documentary foundation.

IV. RESULTS

A. Current Initiatives and Institutional Framework

Documentary analysis reveals an institutional landscape characterised by substantial research capacity but weak commercialisation infrastructure. Nigeria's 200-plus universities produced over 15,000 research publications indexed in Scopus in 2022 [14], yet patent filings at the Trademarks, Patents and Designs Registry remained below 500 annually [13]. The NUC [6] Blueprint documented that approximately 85% of Nigerian universities lack functional Technology Transfer Offices—defined as offices with at least one dedicated professional staff member trained in IP management, technology assessment, and licensing negotiations.

Government documents signal renewed focus through several initiatives. The NASENI Research Commercialisation Grant Programme (2025) offers competitive grants up to ₦10 million for proof-of-concept and ₦50 million for scale-up, incorporating mentorship and business training components [42]. An initial cohort of 35 technologies has been identified. Additional initiatives include a ₦50 million Student Venture Capital Fund, a Ministerial Committee on Academia–Industry Linkages, and the Renewed Hope Agenda's innovation priorities [39]. The NASENI programme design addresses known gaps—particularly funding for later-stage development and entrepreneurial skills deficits—though the scale remains modest relative to system size (35 technologies across 200-plus universities).

B. Persistent Barriers: Thematic Analysis Findings

1. Funding Inadequacy (89% of sources).

The most pervasive barrier identified across the documentary corpus was chronic underfunding. International data from UNESCO [14] places Nigeria's R&D expenditure at 0.22% of GDP, dramatically below the 1% minimum recommended by the African Union's Science, Technology and Innovation Strategy for Africa 2024 [48] and the 2–5% typical of successful innovation economies. Okafor [41] demonstrated econometrically that Nigeria's R&D expenditure has stagnated below 0.3% for two decades. This gap manifests across the entire innovation pipeline, with the most acute deficiency at the “valley of death”—the stage between proof-of-concept and commercial viability where promising technologies fail due to inadequate translational funding [9]. Venture capital investment in Nigeria targets primarily fintech and e-commerce rather than deep-technology research commercialisation [49].

An absence of structured translational research funding mechanisms further exacerbates the funding gap. Unlike South Korea's Korea Technology Finance Corporation or Finland's Business Finland, which provide staged funding from proof of concept through pilot production, Nigerian researchers face a binary choice

between competitive academic grants (typically under ₦5 million) and venture capital that demands market-ready products [50], [51]. The NASENI 2025 programme attempts to fill this gap, but its current scale—₦500 million for 35 technologies—represents approximately 0.001% of GDP, orders of magnitude below the investment density of successful comparators [42]. Documentary evidence from the AfDB [27] suggests that achieving meaningful technology commercialisation requires sustained annual translational funding of at least 0.1–0.2% of GDP.

2. Weak University–Industry Linkages (76% of sources).

The documentary record reveals a persistent cultural divide between academia and industry. Nwosu and Ohiri [8] documented through survey data that 67% of Nigerian academics perceived industry engagement as potentially compromising intellectual integrity, while 72% of industry respondents questioned the practical relevance of university research. Oladosu and Adeyemo [7] found that fewer than 15% of Nigerian universities had any formal industry collaboration agreements. The NUC [6] Blueprint acknowledged that academic promotion criteria at most universities reward journal publications exclusively, creating a structural disincentive for commercialisation activities. Adebawale and Oyelaran-Oyeyinka [32] attributed these weak linkages to the historical evolution of Nigerian universities as primarily teaching institutions modelled on the colonial British system.

The absence of structured intermediary mechanisms compounds the linkage deficit. In successful innovation systems, organisations such as Finland's VTT, South Korea's ETRI, and Germany's Fraunhofer institutes serve as dedicated bridges between academic research and industrial application [52], [53]. Nigeria lacks equivalent institutions. While NASENI and FIRO nominally perform intermediary functions, their mandates overlap and their combined annual budgets amount to less than \$50 million—compared to VTT's annual budget exceeding €250 million [46], [37]. The result is an institutional vacuum in which promising research reaches proof-of-concept stage but finds no pathway to market testing, investor introduction, or industrial partnership [54].

3. Policy and Regulatory Barriers (72% of sources).

NOTAP [43] reported that the average patent processing time in Nigeria exceeds 36 months, compared to 18–24 months in South Korea and 12 months in Singapore. Unlike the United States' Bayh-Dole Act of 1980, which grants universities clear ownership of IP from federally funded research [55], Nigeria lacks equivalent legislation. The result is ambiguity: when a NASENI-funded researcher produces a patentable invention, ownership may be contested among the researcher, the university, and the funding agency [29]. Published scholarship further documents that frequent policy changes—including the reorganisation of science and technology ministries across three successive administrations—undermine long-term planning and private sector confidence [28], [17].

The regulatory environment extends beyond IP to encompass broader bureaucratic barriers. Oyewale [56] documented that Nigerian researchers seeking to commercialise innovations must navigate multiple

regulatory agencies—NAFDAC for health products, SON for industrial standards, NOTAP for technology transfer agreements—each with separate approval processes, timelines, and fee structures. This regulatory fragmentation creates what Bozeman [51] termed ‘technology transfer friction costs’ that disproportionately burden small-scale innovators and university spin-offs lacking administrative capacity. By contrast, Singapore’s one-stop Enterprise Development Board and Malaysia’s streamlined MIDA approval process demonstrate that regulatory coordination significantly reduces commercialisation timelines [4]. The absence of a Nigerian equivalent means that even well-funded innovations face 18–24 month regulatory delays before reaching market [43].

4. Infrastructure and Human Capital Deficits (66% and 60% of sources, respectively).

The NUC [6] Blueprint and Adejumo and Aderinto [57] documented severe infrastructure gaps including obsolete laboratory equipment, unreliable electricity supply, and a critical shortage of technology incubation centres. NASENI [46] reported that only 12 of Nigeria’s 43 federal universities operate functional fabrication workshops. Human capital challenges compound these deficiencies. While comprehensive disaggregated emigration data for Nigerian researchers remains limited, the World Bank [58] estimated that approximately 12% of

Nigeria’s tertiary-educated population resides abroad, consistent with Docquier and Rapoport’s [45] analysis of African high-skilled emigration patterns. Adesugba and Mavrotas [59] documented the resulting “brain drain” cycle in which deteriorating conditions drive researcher emigration, further weakening institutional capacity.

The interaction between infrastructure deficits and human capital challenges creates a compounding effect that is insufficiently recognised in existing policy responses. Researchers who remain in Nigerian universities report spending disproportionate time on administrative workarounds—sourcing reagents through personal networks, arranging off-campus laboratory access, and managing generator fuel supplies—rather than on productive research [57]. Guerrero and Urbano [60] demonstrated that such “institutional voids” in developing-country universities significantly reduce the probability of entrepreneurial activity, as researchers lack the cognitive bandwidth and material resources to pursue commercialisation alongside basic research obligations. Addressing these infrastructure gaps is therefore not merely an input concern but a precondition for any commercialisation strategy to succeed.

Table 4 synthesises the barrier analysis, mapping each identified barrier to its theoretical framework implication, frequency in the documentary corpus, and the comparative model most relevant to addressing it.

TABLE 4. SYNTHESIS OF BARRIERS, THEORETICAL IMPLICATIONS, AND COMPARATIVE SOLUTIONS

Barrier	NIS Implication	Percentage	Triple Helix Gap	Most Relevant Comparator
Chronic underfunding (0.22% GDP)	Financial intermediary failure	89%	Government helix underperforming	South Korea (phased escalation from 0.2% to 4.8%)
Weak university–industry linkages	Knowledge flow disruption	76%	Missing hybrid overlap spaces	Finland (VTT as bridging intermediary)
Regulatory and IP ambiguity	Institutional configuration failure	72%	Government helix: weak framework	USA (Bayh-Dole); Kenya (regulatory sandbox)
Infrastructure deficits	Physical infrastructure gap	66%	University helix constrained	Malaysia (sector-specific MPOB infrastructure)
Human capital flight	Actor depletion	60%	All helices weakened	Rwanda (governance-driven retention); Diaspora engagement
Policy inconsistency	Systemic coordination failure	55%	Government helix: instability	Rwanda (cross-administration consistency)

Source: Authors’ thematic analysis of 47 documents.

V. DISCUSSION

A. Comparative Analysis: International Models and Transferable Mechanisms

Analysis of documented challenges and international comparisons indicates Nigeria requires systemic rather than piecemeal reform. Five comparator countries offer distinct but complementary lessons, summarised in Table 5 and discussed in detail below.

TABLE 5. COMPARATIVE ANALYSIS OF NATIONAL INNOVATION SYSTEMS

Country	R&D (% GDP)	Key Mechanism	Institutional Innovation	GII Rank 2023	Lesson for Nigeria
South Korea	4.8%	State-directed R&D through ETRI, KIST; mandatory industry co-investment	Government-Research Institute (GRI) model; chaebols as anchor tenants	10th	Phased investment; anchor industry partnerships
Finland	2.8%	VTT Technical Research Centre; Tekes/Business Finland grants	Dedicated intermediary bridging basic and applied research	6th	Professional intermediary agencies
Malaysia	1.4%	MPOB model: sector-specific from lab to market	Integrated R&D-to-export agency for palm oil sector	36th	Sector-specific intermediaries for agriculture, minerals
Rwanda	0.7%	Policy consistency across administrations; governance focus	National Innovation Fund; single coordination body	93rd	Governance reform; cross-administration policy continuity
Kenya	0.8%	Enabling regulation for private innovation; M-Pesa sandbox	Regulatory sandbox; Nairobi tech hub ecosystem	78th	Regulatory innovation; bottom-up tech ecosystems
Nigeria	0.22%	Fragmented; no dedicated commercialisation agencies	NASENI, NOTAP, FIRO with overlapping mandates	117th	Requires systemic hybrid reform

Sources: [14], [58], [61], [36], [37], [38].

South Korea’s transformation from an agrarian economy to innovation leader illustrates the power of

sustained state-directed investment. Between 1966 and 2000, R&D spending increased from 0.2% to 2.4% of GDP

through deliberate policy [36]. The establishment of government research institutes (GRIs) like ETRI and KIST created bridging institutions that translated academic research into industrial applications, while mandatory co-investment requirements ensured industry participation [59]. However, South Korea's model relied on large industrial conglomerates (chaebols) as research partners—an industrial structure Nigeria lacks, suggesting direct transplantation would require significant adaptation to Nigeria's SME-dominated private sector.

Finland's success demonstrates the efficacy of professional intermediary agencies. VTT Technical Research Centre of Finland, employing over 2,000 researchers, operates as a bridge between university basic research and commercial application [37]. Business Finland provides structured grant programmes with professional evaluation and mentorship, closely resembling NASENI's new programme design but operating at far greater scale and with decades of institutional learning. Finland's experience suggests that Nigeria's NASENI programme could evolve into a similar institution if given sustained funding and operational independence.

Malaysia's Malaysian Palm Oil Board (MPOB) offers the most directly relevant model for Nigeria. MPOB integrates the entire innovation chain—from genetic research to processing technology to export marketing—for a single strategic commodity [38]. This sector-specific approach generated an industry worth \$16 billion annually from focused R&D investment. Nigeria could replicate this model for cassava, shea nut, or solid minerals beneficiation, where existing production bases and comparative advantages provide foundation for integrated commercialisation agencies [59].

Among lower-income comparators, Rwanda demonstrates that governance quality and policy consistency can partially compensate for limited resources, having improved its GII ranking from 131st to 93rd over a decade through focused institutional reform [61]. Kenya's M-Pesa case illustrates how enabling regulatory environments—specifically, the Central Bank of Kenya's regulatory sandbox approach to mobile money—can unleash bottom-up innovation without large state investment [63]. Both cases suggest approaches applicable to Nigeria's resource-constrained context.

Several critical observations emerge from this comparative analysis. First, no single model is directly transplantable; each country's success was shaped by unique historical, institutional, and economic contexts [64], [65]. Second, the timeline for transformation is long—South Korea's journey from 0.2% to 4.8% GDP R&D expenditure took over four decades of sustained commitment across multiple administrations [36]. Third, successful countries built upon existing sectoral advantages rather than attempting breadth across all sectors simultaneously [66]. For Nigeria, this suggests focusing initial commercialisation efforts on sectors where research capacity and market demand already converge: cassava processing (with Nigeria as the world's largest producer), solid minerals beneficiation, and agricultural biotechnology [59], [67]. Fourth, the role of the state varies significantly: from heavy-handed direction in South Korea to light-touch enabling in Kenya, suggesting that Nigeria's hybrid approach—state direction in strategic sectors

combined with regulatory enablement for market-driven innovation—has both comparative precedent and theoretical justification within the developmental state literature [50], [68].

B. Critical Perspectives and Counterarguments

Before advancing recommendations, it is essential to engage with critiques of commercialisation-first approaches. Slaughter and Rhoades [16] coined the concept of “academic capitalism” to describe how commercial pressures can distort research agendas toward short-term, profit-oriented projects at the expense of fundamental inquiry. Mowery and Sampat [15] cautioned that transplanting the Bayh-Dole model to developing countries often fails because the preconditions—strong patent systems, robust venture capital, experienced technology managers—are absent. Sampat [69] found that Bayh-Dole-style legislation in Brazil and South Africa produced disappointing results precisely because institutional capacity lagged behind legal reform.

Furthermore, political economy considerations cannot be ignored. Nigeria's experience with state-directed industrial policy has been mixed at best, with critics pointing to rent-seeking behaviour, corruption in public procurement, and the capture of innovation funds by politically connected actors rather than meritorious researchers [18]. The ASUU–government dynamic—marked by recurring strikes over funding and university autonomy—creates an adversarial context that complicates Triple Helix collaboration [70]. Any reform strategy must account for these political realities rather than assuming smooth implementation of technically sound policy designs.

A further counterargument concerns the appropriateness of commercialisation metrics for evaluating university research in developing countries. Brundenius et al. [71] argued that “developmental university systems” should be evaluated not solely by patents and spin-offs but by broader contributions to social problem-solving, community development, and inclusive innovation. Henderson et al. [72] demonstrated that even in the United States, university patents constitute a small fraction of total innovation output, suggesting that commercialisation metrics may overstate the economic role of formal technology transfer. For Nigeria, this implies that informal knowledge transfer—through graduate employment, consulting, and community engagement—may already contribute more to economic development than formal commercialisation channels, and should not be neglected in pursuit of patent counts and licensing revenue [73], [74].

These critiques are valid and important. However, they argue for careful, context-sensitive implementation rather than abandoning commercialisation altogether. Nigeria's demographic pressures (200 million people, 42.5% youth unemployment) and economic vulnerability (oil dependency) create urgency that cannot be addressed by basic research alone [12] (based on the 15–34 age band and pre-2023 labour-force methodology). The challenge, therefore, is to design a system that promotes commercial translation while protecting academic freedom and basic research—a balance that the following recommendations seek to achieve.

C. Strategic Recommendations

Synthesising the comparative evidence, thematic findings, and critical perspectives, the following Nigeria-specific recommendations emerge:

1. Recommendation 1: Phased R&D Investment Escalation.

Targeting 1% of GDP within five years and 2% within a decade, funded through diversified sources. Specifically, the Federal Ministry of Finance should implement a mandatory R&D levy of 0.5% on corporate profits above ₦100 million, modelled on Malaysia's CEPsi levy, administered through a transparent, independently audited National Innovation Fund. Additionally, the Debt Management Office should develop "Diaspora Innovation Bonds" offering 7–8% returns—competitive with existing FGN Savings Bonds—ring-fenced for research commercialisation infrastructure. International development finance partnerships with the AfDB and World Bank Science and Technology facilities should supplement domestic funding [27].

2. Recommendation 2: Professional Technology Transfer Offices.

The NUC should mandate establishment of staffed TTOs at all federal universities within three years, beginning with a pilot cohort of 10 universities with the strongest research output. TTO staff should undergo training through partnerships with established international TTOs (e.g., Oxford University Innovation, Stellenbosch University's Innovus) covering IP assessment, licensing negotiation, and spin-off support. Academic promotion criteria should be reformed to allocate at least 20% weight to patents, licences, and industry collaborations, following the example of South Korea's KAIST [59].

3. Recommendation 3: Sector-Specific Intermediary Agencies.

Following Malaysia's MPOB model, Nigeria should establish two pilot agencies: a National Cassava Research and Commercialisation Agency and a Solid Minerals Beneficiation Agency. Each would integrate research, technology development, quality assurance, and market linkage for its sector. Institutional design should learn from

NASENI's experience but avoid mandate overlap by clearly delineating agency-specific sectoral boundaries and reporting structures through enabling legislation passed by the National Assembly.

4. Recommendation 4: Bayh-Dole-Style Legislation with Safeguards.

Nigeria's National Assembly should enact a "Research Commercialisation and Intellectual Property Act" granting universities ownership of IP from publicly funded research, while incorporating safeguards absent from the original US legislation: mandatory march-in rights for public health emergencies, requirement for 30% of licensing revenue to fund basic research, and open-access provisions for publicly funded agricultural innovations. This addresses Sampat's [69] critique by building capacity alongside legal reform through linked TTO development. The Nigerian IP Commission should establish a fast-track patent examination system targeting 18-month processing [43].

5. Recommendation 5: Diaspora Engagement and Entrepreneurial Culture.

Structured mechanisms should include: (a) a Diaspora Research and Innovation Fellowship providing competitive funding for 50 diaspora academics annually to collaborate with Nigerian institutions for 3–6 month periods; (b) an online matchmaking platform connecting diaspora expertise with local research teams; and (c) establishment of Presidential Innovation Awards with ₦20 million prizes for successful research-to-market transitions, publicised through national media to shift cultural attitudes toward applied research. STEM curricula at all universities should integrate mandatory entrepreneurship modules following the Finnish model [37].

Implementation requires a phased approach: Phase 1 (Year 1–2) focuses on quick wins—commercialising the 35 identified NASENI technologies, launching pilot sector agencies, and initiating TTO training. Phase 2 (Year 3–5) scales successful pilots and enacts enabling legislation. Phase 3 (Year 5–10) pursues systemic targets including the 2% GDP investment goal. Coordination through a high-powered National Innovation Council—reporting directly to the Presidency to ensure cross-ministerial authority—would ensure policy coherence (Table 6).

TABLE 6. PHASED IMPLEMENTATION ROADMAP

Phase	Key Actions	Lead Agency	Success Indicators
Phase 1 (Year 1–2)	Commercialise 35 NASENI technologies; train 50 TTO staff; launch diaspora fellowship; establish Innovation Council	NASENI; NUC; Presidency	10+ technologies licensed; 10 pilot TTOs operational; R&D spend reaches 0.5% GDP
Phase 2 (Year 3–5)	Enact IP legislation; launch sector agencies; reform promotion criteria; scale TTO network	National Assembly; NUC; FMST	IP Act passed; 2 sector agencies operational; 30 TTOs active; patent filings doubled
Phase 3 (Year 5–10)	Achieve 2% GDP R&D; expand intermediary network; integrate diaspora mechanisms; target GII top-80	National Innovation Council; all stakeholders	R&D at 2% GDP; 50+ university spin-offs; GII rank below 80; measurable import substitution

VI. CONCLUSION

This policy and literature review has diagnosed a systemic paradox in Nigeria's research ecosystem: substantial intellectual capacity coexists with minimal commercial translation. Through thematic analysis of 47 documents, the study identified six interconnected barriers—chronic underfunding (0.22% of GDP), weak university–industry linkages (85% of universities lacking functional TTOs), regulatory ambiguity, infrastructure deficits, human capital flight, and policy inconsistency—

that collectively suppress the innovation pipeline from laboratory to market.

Comparative analysis of five countries demonstrates that diverse pathways to commercialisation success exist, but all share common features: sustained investment, professional intermediary institutions, clear IP frameworks, and policy consistency across political cycles. Nigeria's distinctive contribution lies in the proposed hybrid model: strategic state direction for priority sectors where comparative advantage exists (agriculture, solid minerals) combined with enabling regulation for bottom-

up innovation in sectors like fintech and ICT where entrepreneurial energy is already evident. This hybrid approach, informed by the Triple Helix framework's emphasis on overlapping institutional roles, represents an original contribution tailored to Nigeria's political economy rather than uncritical transplantation of developed-country models.

The five strategic recommendations—phased R&D investment escalation, professional TTOs, sector-specific intermediary agencies, IP legislation with safeguards, and diaspora engagement mechanisms—are designed as an integrated package rather than isolated interventions. The NIS framework underscores that innovation emerges from systemic interactions; implementing any single recommendation without the others would likely reproduce the fragmented approach that has characterised previous Nigerian innovation policy [17]. The phased implementation roadmap (Table 6) provides a realistic timeline that balances urgency with institutional capacity-building, recognising that transformative change in national innovation systems typically requires a decade or more of sustained effort [75], [76].

The review acknowledges important limitations. As documentary analysis, it captures policy intentions and scholarly assessments rather than ground-level implementation realities. The critical perspectives raised—regarding academic capitalism, Bayh-Dole transplantation failures, and political economy constraints—deserve ongoing attention in implementation design. Future research should prioritise: (a) stakeholder interviews with researchers, industry leaders, and policymakers to capture perspectives absent from documentary sources; (b) longitudinal tracking of NASENI programme outcomes; and (c) comparative institutional analysis of TTO models appropriate for resource-constrained contexts.

Ultimately, research commercialisation represents one pillar—alongside basic research, social science, and humanities—of a comprehensive university mission. The goal is not to subordinate all research to commercial imperatives but to ensure that discoveries with practical potential reach the citizens who could benefit from them. With evidence-based reform, sustained investment, and political commitment transcending electoral cycles, Nigeria can begin to unlock the economic potential latent in its research institutions.

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