African Journal of Economics and Sustainable Development
ISSN: 2689-5080
Volume 9, Issue 1, 2026 (pp. 77-102)
www.abjournals.org

POLICY FRAMEWORKS AND INVESTMENT STRATEGIES FOR SUSTAINABLE RESEARCH ECOSYSTEMS IN BAYELSA STATE

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Cite this article:

Wenibowei Korikiye, Binaebi Bariweni (2026), Policy Frameworks and Investment Strategies for Sustainable Research Ecosystems in Bayelsa State. African Journal of Economics and Sustainable Development 9(1), 77-102. DOI: 10.52589/AJESD-FJLMADOA

Manuscript History

Received: 6 Jan 2025

Accepted: 8 Feb 2026

Published: 12 Feb 2026

ABSTRACT: *Bayelsa State, despite its strategic economic significance as a major oil and gas producer in Nigeria, faces a critical development paradox: immense natural resource wealth coexists with severe infrastructural deficits and limited research capacity. This paper analyzes the existing policy landscape and proposes a comprehensive framework of integrated strategies designed to build a robust, sustainable, and impactful research infrastructure ecosystem. Such an ecosystem is fundamental for driving economic diversification, addressing unique environmental challenges like oil pollution and coastal erosion, fostering innovation, and achieving the state's long-term development goals as outlined in its "ASSURED Agenda" . By leveraging strategic partnerships, targeted investments, and smart governance structures, Bayelsa can transform its economy from resource-dependent to knowledge-driven.*

KEYWORDS: Research Infrastructure, Policy Implementation, Human Capital Development, Economic Diversification, Environmental Degradation, and Innovation Ecosystem.

Article DOI: 10.52589/AJESD-FJLMADOA
DOI URL: https://doi.org/10.52589/AJESD-FJLMADOA

African Journal of Economics and Sustainable Development
ISSN: 2689-5080
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INTRODUCTION

Bayelsa State, despite its rich natural resources and economic potential in sectors like oil and gas, maritime, tourism, technology, and agriculture, faces significant challenges in establishing a sustainable research ecosystem. The state's heavy reliance on oil exports (accounting for over 90% of state revenues) has led to neglect of diversification efforts, resulting in critical infrastructure deficits, inadequate funding for research, and fragmented policy implementation (Amos, & Idoniboye-Obu, 2024). Higher Education Institutions (HEIs) and research centers in Bayelsa lack modern laboratories, digital infrastructure, and sustainable funding mechanisms, which hinder their capacity to drive (Okorie & Eze, 2019). Additionally, despite the existence of institutions like the Ministry of Communication, Science, and Technology (MCST), there is a misalignment between policy goals and practical implementation, exacerbating issues such as youth unemployment, resource inefficiency, and weak stakeholder collaboration. The absence of a coherent policy framework and innovation strategy further impedes the development of a sustainable research ecosystem, limiting Bayelsa's ability to leverage its human capital and economic opportunities for long-term growth.

The establishment of a research infrastructure ecosystem in Bayelsa State is a strategic necessity rather than a luxury. This ecosystem should integrate physical facilities, advanced equipment, digital connectivity, skilled personnel, sustainable funding, and supportive governance. Such a framework is essential for knowledge production and addressing local and global challenges, particularly as Bayelsa seeks to diversify its economy away from hydrocarbons into areas like blue economy, aquaculture, agriculture, and renewable energy. The government's 2025 "Budget of ASSURED Prosperity Agenda" reflects this commitment, emphasizing innovation and technology, with substantial funding allocated for enhancing research capabilities. The main challenge remains developing actionable policies to maximize the impact of these investments and nurture a strong innovation ecosystem.

The policy environment in Bayelsa lacks a specific Research & Innovation Act but provides foundational elements for research development. The government's ASSURED Prosperity Agenda, focusing on areas such as Agriculture, Healthcare, and Urban Development, guides research priorities (Eboh, 2021). The 2025 Budgetary Framework allocates substantial funds for capital expenditure, which indirectly supports research infrastructure improvements through enhanced transportation access. The state promotes multi-stakeholder collaboration, exemplified by the Bayelsa E-commerce Entrepreneurship Program, which creates a model for structuring partnerships in research (Ogunyemi, 2018). Additionally, initiatives like BayelsaPRIME are building digital literacy essential for a future research workforce.

Developing a robust research infrastructure in Bayelsa State is essential for achieving sustainable prosperity and addressing environmental and social issues. This study aims to assess current policy frameworks and institutional structures related to research and innovation in the state, identify gaps, and evaluate the impact of stakeholder collaboration—including government, higher education institutions, the private sector, and communities—on fostering innovation and sustaining research infrastructure.

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www.abjournals.org

Theoretical Framework

The development of research infrastructure in Bayelsa State, Nigeria, is significantly hindered by corruption, challenging topography, and a budgetary focus on recurrent spending, which prevents a transition from a resource-dependent to a knowledge-driven economy. By applying an integrated lens of Institutional Theory and the Triple Helix Model, the study reveals that the establishment of social behavior guidelines and the necessary interactions between universities, industry, and government are often stifled by institutional constraints, such as coercive and normative pressures (Etzkowitz, 2003; Leydesdorff, 2012; Thornton, Ocasio, & Lounsbury, 2012). Despite the presence of several tertiary institutions, the state's research ecosystem remains underdeveloped due to institutional fragmentation, a lack of comprehensive innovation policy, and "bureaucratic isomorphism" within PRS departments that prioritizes data collection over dynamic research. Ultimately, the synthesis of these theories suggests that Bayelsa requires both technical infrastructure and profound institutional reforms to enhance governance and foster the stakeholder coordination necessary for a sustainable innovation ecosystem (Leydesdorff, 2012; Thornton, Ocasio, & Lounsbury, 2012).

LITERATURE REVIEW

The Concept of Research Infrastructure

Research infrastructure serves as the foundational backbone that enables scientific discovery and innovation across diverse disciplines. It encompasses the physical facilities, digital resources, and organizational frameworks necessary to support cutting-edge research activities. These interconnected components provide researchers with the tools, environments, and structures required to address complex scientific challenges, foster collaboration, and accelerate the translation of knowledge into societal benefits. The strategic development and integration of these infrastructure elements are essential for maintaining global research competitiveness and addressing grand challenges in health, environment, energy, and technology (OECD, 2016). Oladele (2018:179) defined research infrastructure as:

"The physical and organizational structures, facilities, and resources necessary for conducting scientific research and innovation activities. This includes laboratories, ICT facilities, equipment, funding mechanisms, and power supply systems that enable knowledge production and dissemination".

The importance of research infrastructure has gained increasing recognition in national and international science policies, with significant investments ‘being directed toward creating and maintaining world-class facilities. These infrastructures not only enable scientific breakthroughs but also contribute to economic growth by attracting talent, fostering innovation, and creating high-tech industries (UNESCO, 2020) .

The concept of research infrastructure extends beyond mere physical assets to include digital and virtual resources, such as high-performance computing networks and open-access repositories, which are crucial in the current era of data-driven science (Bakker, 2019). These infrastructures underpin various phases of the research process—from hypothesis formulation, experimentation, and data collection to analysis and dissemination—thus playing a pivotal role in enhancing research productivity and societal impact. They enable access to advanced

Article DOI: 10.52589/AJESD-FJLMADOA
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technologies and foster an environment conducive to innovation. Moreover, collaborative and shared infrastructures promote international partnerships and resource optimization, especially significant for developing countries aiming to networks. Accordingly, Pesch (2014) stated that:

Research infrastructure encompasses the facilities, resources, and organizational structures necessary to support scientific research activities. As research infrastructure forms the backbone of modern scientific investigation, enabling the development, testing, and validation of new knowledge across disciplines.

Consequently, robust research helps to advance science, technology, and innovation agendas worldwide.

The types of research infrastructure can be broadly categorized into physical, digital, and organizational components, each playing a vital role in facilitating research processes (Koehler, Howell, & Green, 2017; Aigbokhan, 2020). Physical research infrastructure refers to the tangible assets and facilities that provide the physical environment for conducting scientific research (Koehler et: al., 2017). According to them this includes "facilities, resources and related services that are used by the scientific community to conduct top-level research in their respective fields". Similarly, Bakker (2019) identifies research infrastructure include major scientific equipment or sets of instruments, specialized laboratory facilities, research buildings, and the associated utilities that support their operation. Physical component extends beyond research equipment to include supporting amenities such as water supply and distribution systems, electrical distribution systems, communications infrastructure, medical gases, and areas adjacent to research buildings such as parking lots and grounds (**European Commission, 2018**). In specialized contexts like healthcare research, physical infrastructure also includes;

"Facility amenities and resources essential to the provision of safe care, including water, sanitation and waste disposal/recycling, telecommunication connectivity, power supply, as well as transport systems"(Federica, 2023).

Thus, physical research infrastructure includes laboratories, specialized equipment, imaging facilities, and experimental platforms essential for conducting empirical research. For example, large-scale facilities such as particle accelerators (e.g., CERN) or telescopes (e.g., Very Large Telescope) serve as critical assets for high-energy physics and astronomy research (OECD, 2013). These infrastructures often require significant investment and maintenance, making them vital but resource-intensive components of research capabilities.

Physical research infrastructures (RI) differ by discipline and include centralized facilities like particle accelerators and distributed networks such as sensor systems **(Heath, 2020).**. These infrastructures are essential for experimental research, enabling safe work with hazardous materials and ensuring reproducibility. However, they face challenges like high costs, maintenance needs, and the necessity for specialized staff. Adaptation to evolving research demands requires strategic planning and investment, while equitable access is important for all researchers. Digital research infrastructure (DRI) consists of computational and networking resources that support data-intensive research, playing a critical role in open science and big data analytics **(Bakker, 2019)**. Key elements of DRI include advanced research computing, data management resources, research software tools, and ultra-high-

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speed networks. Initiatives like the European Open Science Cloud and Canada's Digital Research Infrastructure Strategy enhance data management and accessibility, fostering collaboration and innovation in various fields, ultimately driving advancements in healthcare, safety, and sustainability.

Organizational research infrastructure (ORI) comprises governance structures, policies, procedures, and resources that coordinate and support research activities. It includes physical, organizational, and technological resources essential for scientific research, similar to business infrastructures in directing activities and governance **(EC, 2021)**. Key aspects involve governance models for management, funding mechanisms for financial support, human resources for skilled personnel, and policies for access and ethical compliance. The effective functioning of both physical and digital infrastructures relies on organizational infrastructure, which enhances collaboration and understanding among researchers **(EC, 2021)**.

The COVID-19 pandemic underscored the need for integrated infrastructures to address emerging research needs, with challenges in interoperability and coordination at the European level. Strategic initiatives like the European Open Science Cloud and Canada's Digital Research Infrastructure Strategy are vital for maintaining competitiveness and advancing technological developments in research **(Bakker, 2021).**. Understanding the interconnectedness of these dimensions is essential for optimizing research capabilities**.**

The Concept of a Sustainable Research and Innovation Ecosystem.

Sustainable research ecosystems are critical for fostering innovation, economic development, and addressing societal challenges, particularly in emerging regions such as Bayelsa State. Developing effective policy frameworks and investment strategies is vital to strengthen research capacities, promote collaborations, and ensure the long-term sustainability of scientific endeavors within the region. According to Adeyemi, Olanipe, & Ade (2021), policies are the foundational guidelines that shape research priorities that enable a conducive environment for research activities, while research infrastructure and human capital catalyze growth and enhance aligning regional with national and international sustainability goals.

Innovative ecosystems are networks of institutions, policies, resources, and stakeholders that collaborate to promote innovation and technological advancement. They thrive on interactions that enable resource exchange, risk sharing, and collective learning, essential for nurturing startups and attracting investments. These ecosystems often lead to innovation clusters, supported by policies that ensure property rights and funding opportunities. Digital infrastructure and open innovation platforms facilitate knowledge flow and innovation. The concept of sustainable research and innovation ecosystems (SRIEs) represents a shift in how knowledge is produced, shared, and applied, emphasizing environmental, social, and economic sustainability. SRIEs aim to create interconnected systems that address global challenges like climate change and public health, moving beyond traditional, resource-intensive research models **(UNESCO, 2015)**.

Contemporarily, SRIEs importance lies in their potential to align with the pursuit of knowledge with broader sustainability goals, ensuring that research activities themselves do not inadvertently contribute to the problems they seek to solve. Thus, at its core, a Sustainable Research Ecosystem can be defined as:

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A network of interconnected elements—institutions, researchers, resources, and processes—designed to conduct research in a manner that minimizes negative environmental and societal impacts while maximizing long-term productivity and positive outcomes"(UNESCO, 2015).

This definition advocates for an integrated approach to sustainability in research, expanding beyond mere outputs to encompass the broader operational context. It highlights the importance of sustainable innovation ecosystems, where research findings contribute to environmental integrity, social welfare, and economic resilience **(Heath, 2020).**. Drawing from systems theory, it underscores the interconnectedness of research institutions, funding entities, policymakers, industry partners, and communities, promoting a coordinated approach that recognizes the multidirectional relationships within the research ecosystem, unlike traditional siloed methods.

The operational dimensions of Sustainable Research Infrastructure Ecosystems (SRIEs) include infrastructure and resource management, knowledge dissemination, human capital, and stakeholder collaboration. Essential to SRIEs is the sustainability of research infrastructure, which comprises physical facilities, laboratories, and digital resources like computing and data networks **(Mazzucato, 2018)**. This sustainability addresses both environmental impacts and long-term viability. Additionally, many research institutions are adopting green lab initiatives aimed at reducing energy and water use, minimizing waste, and promoting equipment sharing within a circular economy framework.

Resource management is crucial for the effective use of materials, funding, and human capital, focusing on minimizing consumption and utilizing renewable resources. Strategies for financial sustainability through diverse funding models support long-term research, while knowledge creation in Sustainable Research and Innovation Ecosystems (SRIEs) promotes open science for improved accessibility. Ethical practices, equity, and inclusion in research teams enhance innovation, though challenges like the "publish or perish" mentality can undermine quality and researcher well-being **(Nelson, 2021)**. Building sustainable research cultures necessitates reforming reward systems and fostering collaboration among stakeholders to align research with societal needs, despite obstacles like financial constraints and cultural resistance.

Global and National Policy Frameworks for Research and Innovation:

Research and innovation (R&I) policy frameworks have become critical instruments for national development and global competitiveness in the 21st century. These frameworks encompass the strategies, instruments, and governance structures that nations and international organizations employ to foster scientific advancement and technological innovation. The evolution of R&I policies has been shaped by globalization trends, technological disruptions, and pressing societal challenges such as climate change, health crises, and sustainable development. The significance of these frameworks lies in their ability to mobilize knowledge resources, coordinate stakeholders, and direct technological change toward economically productive and socially beneficial outcomes. As nations increasingly recognize innovation as a primary driver of economic growth and societal progress, understanding the architecture and implementation of these policy frameworks becomes essential for policymakers, researchers, and practitioners alike. This literature review examines both global and national R&I policy frameworks, analyzing their theoretical foundations, key components, implementation challenges, and future directions.

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The European Union's Global Approach to Research and Innovation, reaffirmed in 2021, promotes values-based cooperation and multilateralism, addressing challenges in green technology, digital transformation, health, and social innovation**(EC, 2021)**. It supports sustainable development, academic freedom, and research ethics, while distinguishing its approach through tools to counter foreign interference. Various international organizations, including OECD and WHO, provide frameworks for guiding global research policies. The US innovation system, characterized by a decentralized model with strong private sector involvement and government R&D funding, faces criticisms related to policy fragmentation and declining competitiveness. Different countries have diverse innovation policies shaped by their unique contexts. Effective adoption of innovation policies requires alignment with local capacities. The evolution of innovation policy is shifting towards mission-oriented strategies, emphasizing successful integration of knowledge support and innovation systems despite ongoing challenges in establishing cohesive frameworks **(Ba, Ma, Cai, & Li, 2022).**

Model of Funding Research Infrastructure

Research infrastructure (RI) comprises essential facilities, resources, and services necessary for scientific research, with funding models evolving to address the complexities of Large Scale Research Infrastructures (LSRIs) **(Novikova, 2021)**. Government funding is critical, utilizing mechanisms like direct appropriations to support RI aligned with national strategic interests, especially in areas with societal value. Public-Private Partnerships (PPPs) are increasingly common, offering a collaborative approach that combines public and private funding for projects with high economic efficiency but lower financial returns **countries (Gurara, Klyve, Mwase & Presbitero, 2025)**. International collaborations are essential for large-scale RI projects, pooling resources across borders, although they face funding distribution and governance challenges. The integration of green finance and sustainable investment models marks an important trend, aiming to finance projects that align with environmental criteria while managing technological obsolescence **(National Science Foundation, 2025).** Future directions for RI funding suggest a focus on interdisciplinary integration and adaptive governance to better tackle complex societal challenges.

This literature review examines various funding models for research infrastructure, including government-led initiatives, public-private partnerships, and green finance mechanisms. Each model addresses specific challenges related to the high costs and complex value propositions of research infrastructure. The review highlights the importance of aligning funding models with project needs and policy objectives, emphasizing transparency and efficient resource utilization. Key challenges include ensuring long-term sustainability, equitable access, and adaptive governance. As research becomes more digital, funding models must evolve to meet the needs of cyberinfrastructure and virtual environments. Continued innovation and collaboration can enhance funding approaches, maximizing scientific, economic, and social returns.

The Current State of Research Infrastructure in Bayelsa State, Nigeria

Bayelsa State presents a paradox where immense oil and gas wealth contrasts with a severely underdeveloped research infrastructure. Current research capabilities are concentrated in institutions like Niger Delta University and Bayelsa Medical University, yet these facilities suffer from critical deficits in laboratory equipment and specialized centers for oil technology or environmental remediation (Kalada, McFubara, Edoni & Ezonbodor-Akwagbe, 2012).

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This infrastructure gap is further exacerbated by the region's challenging riverine terrain and seasonal flooding, which complicates physical development. Consequently, local research into urgent issues like oil pollution and sustainable fisheries remains limited, as federal agencies and the state government have failed to establish the necessary technical frameworks required to address these systemic developmental challenges (Kalada, McFubara, Edoni & Ezonbodor-Akwagbe, 2012).

Furthermore, the research ecosystem is undermined by a lack of digital infrastructure and human capital investment. Inadequate computing facilities and unreliable internet access hinder global collaboration and digital resource utilization, while state initiatives like BayelsaPRIME focus more on basic literacy than specific research computing needs (Efosa & Hansen, 2024). Human resource challenges are equally significant, as low remuneration and poor conditions make it difficult to attract and retain qualified academics, leading to a prioritization of teaching over research (McFubara, 2010). Financially, the state lacks strategic investment, with funding often limited to periodic allocations for accreditation purposes rather than long-term infrastructure development. This inconsistent funding, combined with a failure to leverage external grants or private sector partnerships, leaves the state's research centers uncompetitive and disconnected from international capacity-building opportunities (McFubara, 2010; Efosa & Hansen, 2024).

Bayelsa State in Nigeria’s Niger Delta showcases a stark contradiction; although rich in oil and gas, it remains severely underdeveloped. This issue extends to its research infrastructure, which is vital for fostering knowledge-driven development but largely remains unexploited due to systemic hurdles. The infrastructure includes facilities, equipment, human resources, funding, and institutional support critical for addressing local challenges such as environmental degradation, poverty, healthcare, and education gaps. This literature review evaluates the current state of research infrastructure in Bayelsa, assesses its components, identifies challenges, and offers recommendations for improvement. Enhancing the research ecosystem is key to facilitating sustainable development in this strategic yet troubled region.

Baysela State's research infrastructure is concentrated in tertiary institutions like Niger Delta University, University of Africa, and Bayelsa Medical University, which suffer from significant deficits in facilities and laboratory equipment, particularly affecting health manpower development. The region's challenging terrain, characterized by river networks and seasonal flooding, compounds these issues. Despite government funding aimed at program accreditation, the infrastructure remains fragmented and poorly funded, lacking specialized research centers in critical areas such as environmental remediation and oil technology **issues (Kalada, McFubara, Edoni & Ezonbodor-Akwagbe, 2012)**. This deficiency is particularly concerning given the environmental challenges posed by oil extraction in the state, with minimal contributions from federal agencies like the NDDC. As a result, local research on vital issues such as oil pollution and sustainable fisheries is severely limited, hindering effective address of developmental challenges in Bayelsa **(Kalada, McFubara, Edoni & Ezonbodor-Akwagbe, 2012).**.

Information and communication technology (ICT) infrastructure in Bayelsa State is severely lacking, negatively impacting research capabilities in tertiary institutions and government ministries. Issues include inadequate computing facilities, unreliable internet, and limited access to digital resources, hindering literature reviews, journal access, software use, and global collaboration **Efosa & Hansen, 2024).**. The state government is addressing these gaps

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through initiatives like an ICT hub in Yenagoa for digital literacy and the BayelsaPRIME policy promoting IT in basic education. However, these efforts focus more on general digital skills rather than specific research computing needs, with no documented impact on the research ecosystem.

Effective research in Bayelsa State is undermined by inadequate data management infrastructure and a lack of clear technical frameworks. ICT infrastructure challenges, including poor system integration and security, hinder e-procurement and diminish data research quality. Furthermore, the region suffers from a shortage of qualified health professionals, impacting healthcare and research capabilities **(McFubara, 2010)**. Tertiary institutions struggle to attract and retain academics due to low remuneration and poor conditions, leading to a focus on teaching over research. Capacity development programs for researchers are limited, lacking structured training and comprehensive strategies to enhance research human capital, which is critical for addressing state development challenges through evidence-based methods **(Efosa & Hansen, 2024).**

Financial resources are essential for research infrastructure; however, Bayelsa State's investment is both inconsistent and inadequate. Funding usually comes from periodic allocations instead of strategic investments, with the Niger Delta University College of Health Sciences receiving about 900 million naira over four years for accreditation **(McFubara, 2010)**. Budget management lacks transparency regarding research allocations, suggesting that research is not a priority, resulting in insufficient infrastructure development. Bayelsa State shows limited engagement with external funding, despite potential sources like federal agencies, international partners, and private sector entities, particularly oil companies. The absence of specialized research centers and equipped universities undermines competitiveness for grants. While some industry-funded initiatives exist due to resource control debates, these seldom target research infrastructure. Additionally, international environmental organizations focus more on advocacy than capacity building, resulting in missed opportunities for Bayelsa to leverage its strategic significance and environmental challenges to attract research investments **(McFubara, 2010)**.

Governance and Policy Framework

The governance structure for research in Bayelsa State is fragmented and poorly coordinated, resulting in duplicated efforts and inefficient resource use. Tertiary institutions operate with minimal alignment to government or private needs, and the absence of a state-level research council highlights weaknesses in the research infrastructure. The literature indicates that research is not prioritized in development planning, with no comprehensive policy guiding research and technology development **(Oluwatobi & Chinadu, 2018).** Existing policies like BayelsaPRIME may support research capacity, but a lack of strategy addressing legislation and incentives hinders the research culture and investment in the state's infrastructure.

Bayelsa State encounters significant challenges in developing research infrastructure due to its difficult riverine geography, exacerbated by annual flooding which damages facilities and drives up costs for flood-proofing. Environmental degradation from oil exploration also compromises public health and research integrity. Current infrastructure planning inadequately addresses these geographical and environmental issues, rendering facilities vulnerable to disasters and impeding quality research. Socio-economic barriers, such as widespread poverty and prioritization of immediate social needs over research funding,

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compound these issues. Corruption and political instability further undermine effective investment and policy consistency (Nelson, 2023). Consequently, research infrastructure in Bayelsa is underfunded and poorly equipped, suffering from a lack of ICT resources, inadequate physical facilities, and a declining human capital due to brain drain. However, the state's role as Nigeria's leading oil producer presents potential opportunities for attracting research funding if strategic measures are implemented as noted by Nelson (2023).

Despite its oil wealth, Bayelsa State in Nigeria's Niger Delta has trouble building research infrastructure. This study looks at how the Triple Helix Model and Institutional Theory might be used to solve policy issues in the development of research infrastructure. Particularly in areas with intricate sociopolitical circumstances, the theoretical mix provides insights into stakeholder relations and institutional dynamics in innovation ecosystems (Leydesdorff, 2012**)**. Corruption, challenging topography, and a budget that prioritizes ongoing spending over capital investment in research are some of Bayelsa's unique problems. The shift from a resource-dependent to a knowledge-driven economy is hampered by these obstacles. The assessment looks at how initiatives for Bayelsa's sustainable research infrastructure might be informed by knowledge of institutional variables and teamwork.

Institutional Theory offers insights into the establishment of authoritative social behavior guidelines, particularly in developing research infrastructure (Etzkowitz, 2003; Leydesdoff. 2012). It highlights how formal and informal institutions, influenced by coercive, mimetic, and normative pressures, shape policy implementation and stakeholder actions. In Bayelsa State, political corruption and institutional frameworks impede effective research ecosystems, deterring investment in knowledge infrastructure. The Triple Helix Model, which connects universities, industry, and government, is crucial for fostering innovation but has evolved into the Quadruple and Quintuple Helix models to address broader societal and environmental needs, particularly relevant to Bayelsa's issues with oil extraction and climate change. The integration of Institutional Theory with the Triple Helix Model helps analyze research infrastructure development, revealing that ideal interactions often fail due to institutional constraints **(Thorntor, Ocasio, & Lounsbury, 2012)**. Despite multiple tertiary institutions, Bayelsa's research infrastructure is underdeveloped, hampered by facility deficits, geographical challenges, institutional fragmentation, and weak coordination among ministries, resulting in limited collaborative research effectiveness.

Applying an integrated theoretical lens to Bayelsa State's policy frameworks reveals critical gaps, especially the lack of a comprehensive research and innovation policy. Current sectoral policies do not effectively coordinate necessary interactions for a strong research infrastructure, resulting in stakeholder uncertainty and ineffective initiatives. The PRS departments operate more as data collection units than dynamic research hubs, suffering from bureaucratic isomorphism that neglects specific research needs and fails to promote inter-departmental synergies, leading to inefficient resource use and suboptimal impacts. The combined use of Institutional Theory and the Triple Helix Model offers a framework for understanding research infrastructure development, emphasizing the influence of institutional factors on university-industry-government interactions. It underscores the need for tailored strategies addressing Bayelsa's unique contexts, advocating for both technical solutions and considerable institutional reforms to enhance governance and coordination among research ecosystem stakeholders.

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African Journal of Economics and Sustainable Development
ISSN: 2689-5080
Volume 9, Issue 1, 2026 (pp. 77-102)

www.abjournals.org

METHODOLOGY

An analytical approach is crucial for understanding the complexities of developing sustainable research ecosystems in Bayelsa State. It identifies systemic failures beyond mere descriptions, revealing issues such as dependence on oil, flawed policy implementation, and misaligned incentives among stakeholders. This method analyzes the interrelationships between policies, funding issues, institutional capacities, and socioeconomic contexts, evaluating why existing frameworks like the ASSURED agenda struggled to foster innovation. It provides context-specific, evidence-based recommendations for investment models and policy reforms tailored to local strengths, ensuring these solutions can navigate Bayelsa State's political economy. This approach turns theoretical insights into a practical roadmap for actionable change.

Analysis of Policy Frameworks and Investment Strategies for Developing Research Infrastructure Ecosystems in Bayelsa State

Because of its reliance on oil income, Nigeria's Bayelsa State, which is rich in natural resources, suffers a development dilemma that is defined by underdevelopment and economic stagnation. Through research and innovation, the state hopes to transition to a knowledge-driven economy, but progress is hampered by large gaps in policy implementation **(Ovadia, 2012).** Since its founding in 1996, the government has launched a number of programs, but converting these concepts into practical results has always been difficult, mostly because of leadership issues. According to a 2010–2020 study, Bayelsa still faces development challenges in spite of its resources, highlighting the necessity of a comprehensive evaluation of the institutional frameworks and policy frameworks now in place in the area of research and innovation**(Nelson, 2021).**

An Overview of Existing Policy Frameworks

i. State Government Policy Agendas (A.S.S.U.R.E.D Prosperity Agenda): The Bayelsa State government's primary development framework is the A.S.S.U.R.E.D Agenda, which stands for Agricultural revolution, Sports development, Security, Urban renewal, robust healthcare, Energy generation, and Diversifying education. While not exclusively focused on research and innovation, this policy framework creates enabling conditions for research in priority sectors like agriculture, energy, and healthcare. The agenda emphasizes economic diversification and human capital development, which indirectly supports research infrastructure.

ii. Environmental Protection and Climate Policy Frameworks: Bayelsa State has developed policy responses to environmental degradation caused by oil exploration. The state government established the Bayelsa State Oil and Environmental Commission (BSOEC), which produced the report "An Environmental Genocide: Counting the Environmental Cost of Oil in Bayelsa State"(Ekpo, Udo, & Nwabueze, 2018). This commission represents an institutional structure for environmental research and policy formulation. Additionally, Governor Douye Diri has advocated internationally for policies imposing sanctions on polluters and establishing compensation funds for affected communities, indicating a policy orientation toward evidence-based environmental protection.

iii. Education and Human Capital Development Policies: The Bayelsa State government has identified education investment as a cornerstone of its development strategy, with

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substantial resources allocated toward enhancing educational infrastructure, fostering innovation in pedagogy, and empowering educators (Bayelsa State Government (BSG), 2015). The state's educational landscape includes over 537 primary schools, over 152 basic junior secondary schools (public and private), several senior secondary schools, and multiple tertiary institutions including Niger Delta University, Federal University Otuoke, State College of Education Sagbama, State Polytechnic Aleibiri, Federal Government Polytechnic Ekewe, State School of Nursing Tombia, and State School of Health Technology Otuogidi.

Bayelsa State's higher education institutions (HEIs) are crucial for research and innovation but face challenges like underfunding and inadequate facilities. The state government, recognizing the need for improved research capacity, has initiated the A.S.S.U.R.E.D Agenda alongside the Bayelsa Promoting Reform to Improve and Modernize Education (BayelsaPRIME) policy aimed at enhancing digital skills and IT integration in basic education. Additionally, an ICT hub has been established in Yenagoa to promote digital literacy, laying the groundwork for human capital development within the state's research ecosystem.

iv. Economic Diversification Strategies: Bayelsa State has identified five key sectors for economic growth: oil and gas, maritime, tourism, technology, and agriculture (Investbayelsa. 2023). The government plans to enhance these sectors through development policies and public-private partnerships, aiming to foster research and innovation. Business incentives such as tax holidays and land provision at subsidized rates are offered to attract investments. Recognizing its reliance on oil revenue, the state has initiated efforts for economic diversification, including a workshop that emphasized technology utilization and human capital development to improve efficiencies and competitiveness in targeted sectors.

Institutional Structures for Research and Innovation

i. State Development Planning Framework: Bayelsa State's approach to research and innovation is embedded within broader development planning instruments. The Planning, Research, and Statistics Department (PRS) across various ministries serve as the institutional anchor for these policies. The Planning, Research, and Statistics (PRS) Department exists across various ministries as the primary institutional structure governing research in Bayelsa State. For instance, the PRS department within the Ministry of Communication, Science, and Technology has the following research-related functions:

- Research & Sectoral Analysis: Conducting extensive research in sectors under the Ministry's jurisdiction, providing evidence-based insights to support policy development and project design
- Data Management: Overseeing the management, collection, processing, and dissemination of data and statistics, ensuring the Ministry's information systems are accurate, up-to-date, and accessible
- Monitoring & Evaluation: Regularly monitoring and evaluating ongoing projects and initiatives to ensure they meet predefined targets and objectives
- Development Planning & Coordination: Coordinating the preparation of the Ministry's Procurement Plans and Annual Budget collaborating with other departments and parastatals (Diri, 2024)

Article DOI: 10.52589/AJESD-FJLMADOA
DOI URL: https://doi.org/10.52589/AJESD-FJLMADOA

The PRS department oversees data collection and analysis, maintaining a vital data bank for policy-making and project planning. This decentralized research governance is evident, with PRS units functioning within ministries rather than as a centralized body. Specifically, the Ministry of Communication, Science, and Technology's PRS department focuses on developing and analyzing policies for STI, digital technologies, and communication, ensuring initiatives are data-driven. It also coordinates the Ministry's Procurement Plans and Annual Budget, promoting alignment of strategies across departments, although the actual effectiveness of this budget integration for research and innovation needs further evaluation (Diri, 2024).

ii. **Tertiary Institutions as Research Hubs:** Bayelsa State's tertiary education institutions represent another crucial component of the institutional structure for research and innovation. These include Niger Delta University (state-owned), Federal University Otuoke (federal), State College of Education Sagbama, State Polytechnic Aleibiri, Federal Government Polytechnic Ekewe, State School of Nursing Tombia, and State School of Health Technology Otuogidi. However, existing works in this area provide limited information about the research output, innovation culture, or technology transfer mechanisms of these institutions, suggesting a potential institutional gap in the state's research ecosystem.

Governor Douye Diri has implicitly acknowledged the need to strengthen these institutions' research functions by challenging "universities to lead the way in research that optimize made-in-Nigeria inventions and products" and imploring them to "embrace technology in order to produce innovators for Nigeria" (Investbayelsa, 2023). He further challenged "policy makers and education managers to develop and update curriculum at all stages of learning to meet realities of the digital age" indicating recognition of the need for better alignment between educational institutions and innovation requirements.

iii. Cross-Sectoral Coordination Mechanisms: The available information suggests limited institutional mechanisms for cross-sectoral coordination in research and innovation in Bayelsa State. The PRS departments appear to operate primarily within ministerial silos, with no evidence of a centralized coordinating body for research and innovation across sectors. The validation workshop on economic diversification brought together multiple stakeholders, including various ministries, civil society organizations, and community groups, but it is unclear whether such multi-stakeholder engagement is institutionalized or occurs on an ad hoc basis.

Strategies for Research Infrastructure Development in Bayelsa State, Nigeria

Bayelsa State, situated in Nigeria's Niger Delta, grapples with infrastructure development challenges despite its significant contribution (43%) to the nation's petroleum production (Investbayelsa, 2023). Established in 1996, the state faces geographical constraints that hinder infrastructure growth while remaining plagued by poverty and environmental degradation linked to oil activities. Developing research infrastructure is crucial for addressing these issues through evidence-based solutions and fostering technological innovation. However, there are notable deficiencies in both physical and human research infrastructure, necessitating coordinated multi-sector strategies.

i. Institutional Frameworks: The research landscape in Bayelsa State revolves around higher education institutions, primarily the Niger Delta University, and government agencies.

Article DOI: 10.52589/AJESD-FJLMADOA
DOI URL: https://doi.org/10.52589/AJESD-FJLMADOA

Despite its theoretical support for research, the university faces challenges such as inadequate staffing, funding, and bureaucracy. Similarly, the Bayelsa State College of Health Technology has graduated many health workers but struggles with accreditation due to resource limitations **(Echeme, Ifeanyuneke & Uchenna et:al, 2025)**. Government agencies also contribute through their research departments; however, they often lack the technical capacity for effective data collection and analysis. There is a clear need for improved coordination among academic, government, and private sectors to enhance the research infrastructure in Bayelsa State.

ii. **Funding and Resource Allocation Strategies:** Financial investment is crucial for the development of research infrastructure in Bayelsa State. The government has primarily relied on direct funding through budgetary allocations to institutions like the Niger Delta University College of Health Sciences (2005-2009) and recent investments in ICT, such as a hub in Yenagoa to promote digital literacy **(NCRGT, 2025).** However, current funding efforts remain insufficient to meet overall needs. The state has attempted to partner with international agencies and the private sector to enhance funding and support for research infrastructure, although these partnerships appear underdeveloped. There is a clear need for more diverse funding sources, including oil revenue, research grants, and private contributions, to effectively support this development.

iii. Information and Communication Technology (ICT) Infrastructure: The development of ICT infrastructure is crucial for enhancing research capacity in Bayelsa State. Studies indicate that ICT serves as a key enabler for modernizing governmental functions and supporting research and data analysis. Identified as the "highest critical success factor" for technology adoption in public projects, critical ICT components include system integration, standards, reliability, security, and authentication, which establish the foundation for digital research platforms. The Bayelsa government has launched initiatives such as the BayelsaPRIME policy to integrate IT into basic education for digital skills development and is constructing an ICT hub in Yenagoa for digital literacy training and research support. However, these initiatives lack a cohesive strategy for comprehensive research capacity building, limiting their impact on the research ecosystem in Bayelsa State.

iv. Human Capital Development for Research: Strategic investment in human capital development represents another crucial approach to strengthening research infrastructure in Bayelsa State. The literature emphasizes the critical shortage of qualified researchers and health professionals across various sectors, which fundamentally constrains the state's research capacity (Gurara, Kly, Mwase, & Presbitero, 2025). In response, institutional strategies have focused on developing training programs to build human resource capacity. For example, the School of Nursing at Tombia and health programs at the Niger Delta University has graduated hundreds of health professionals, though these numbers remain insufficient to meet the state's needs.

According to the study’s assessments, Niger Delta University's medical programs have difficulties in fostering high-level research skills, mostly as a result of a lack of suitable facilities and trained faculty. The situation is being improved by partnering with well-established universities for faculty development and applying for government intervention grants. Nevertheless, these efforts encounter challenges including uneven execution and inadequate distribution of resources. Although there is potential for using outside

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organizations to increase capacity, methodical implementation is required to improve Bayelsa's human capital in research.

Barriers and Challenges in Research Infrastructure Development in Bayelsa State

i. Geographical and Environmental Constraints: Bayelsa State's geography poses challenges to research infrastructure development due to its riverine and estuarine environment, which complicates road construction and limits material transport. Annual flooding, particularly in Yenagoa, further damages infrastructure and requires additional resources for flood-proofing, reducing funds available for research enhancements. Environmental degradation from oil activities worsens these issues by polluting water sources and reallocating public resources toward remediation over research investment. Effective infrastructure strategies must adapt to these geographical and ecological challenges.

ii. **Socio-economic and Political Factors:** Despite its oil resources, Bayelsa State's socioeconomic conditions impede the establishment of research infrastructure because of pervasive poverty and underdevelopment. Due to corruption and resource mismanagement, investment is constrained as urgent social needs take precedence. Implementation of policies is further hampered by political instability, as efforts frequently lose steam when leaders change. Stakeholder support and participation over political cycles are essential for effective efforts to address these issues. Despite political, economic, and geographic obstacles, current initiatives concentrate on expanding ICT and human resources as well as financing postsecondary institutions. While less successful strategies are top-down and do not take sustainability into account, successful strategies involve numerous stakeholders and are in line with larger development goals**.** To create a robust research environment in Bayelsa, a more comprehensive strategy covering institutional structures and infrastructure is required.

The Existing Policy Gaps in Bayelsa State's Research Landscape

Bayelsa State, located in Nigeria's Niger Delta, faces significant developmental challenges despite its rich natural resources, particularly oil. The state's underdevelopment spans healthcare, education, infrastructure, and socioeconomic empowerment. This literature review highlights fragmented policies and inadequate funding that impedes effective research and policymaking in Bayelsa. It underscores the need for targeted policy interventions to create a robust research culture aimed at sustainable development. Critical issues such as healthcare delivery and educational disparities require context-specific research to inform solutions. However, the research landscape is hindered by inadequate funding, weak institutional capacity, and poor coordination between research bodies and the government. Addressing these gaps is vital for improving Bayelsa's research ecosystem and fostering development.

i. Health Research Policy Gaps: The healthcare research sector in Bayelsa State faces major challenges with data integrity and reporting. A June 2025 study indicated discrepancies in health intervention coverage, such as vitamin A supplementation at 83.4% overall but varying significantly between urban (94.2% in Yenagoa) and riverine (68.9% in Southern Ijaw) areas. Notably, HPV vaccination coverage was reported at a biologically implausible 330%, highlighting severe data integrity issues **(Oweibia, Egberipou, Timighe et:al, 2025; Sawyer, 2025).**. The problems stem from a lack of standardized data collection protocols, inadequate quality assurance mechanisms, and ineffective health management information systems.

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These gaps hinder evidence-based policy making and impact health planning and resource allocation, necessitating urgent reforms to strengthen data systems through improved protocols and infrastructure.

ii. Research Infrastructure and Workforce Gaps: Bayelsa State's health research capacity is hindered by inadequate infrastructure and a lack of workforce, with only 1.2 community health workers per 10,000 residents, well below WHO standards**(Adeniyi & Adeleke, 2020).**. This shortage affects both service delivery and research capacity, especially in isolated riverine communities. Key policy gaps include the lack of a comprehensive health research strategy, insufficient investment in facilities and training, and no incentives for retaining health researchers, leading to brain drain. Consequently, the state struggles to generate essential evidence to tackle persistent health issues such as high maternal and child mortality, infectious diseases, and non-communicable diseases. Strategic investments are necessary to improve health research infrastructure and encourage researcher retention.

iii. Urban-Rural Disparities in Health Research: A critical policy gap in Bayelsa State's health research is the neglect of urban-rural disparities. Most health research is concentrated in urban centers like Yenagoa, leading to inadequate attention for rural and riverine communities. This results in significant differences in health intervention coverage and outcomes. Urban areas benefit from better healthcare infrastructure, while rural communities often lack basic services and are excluded from research. Health policies based on predominantly urban data may not suit rural contexts, perpetuating health inequalities **(Biobelemoye, Ozima, & Ezekwesiri, 2025; Ekpo, Udo & Nwabueze, 2018)**. To address these disparities, policies should promote equitable research distribution, incentivize research in rural areas, and incorporate community-based participatory research involving rural populations.

iv. ICT and Digital Research Policy Gaps: Bayelsa State is experiencing a substantial digital divide that hampers research capabilities, particularly in rural areas. A study by the European Union and the Stakeholders Democracy Network identified an 11% gender digital gap in the Niger Delta, exacerbated by insufficient internet access and digital literacy in Bayelsa (Samuel, 2025). This divide obstructs research participation and data collection, with a lack of reliable internet limiting access to necessary resources and tools. Current ICT policies fail to address the specific needs of researchers, lacking strategies for digital inclusion and infrastructure development. Consequently, the research ecosystem remains isolated from global digital trends. To improve research outcomes, policies must focus on digital inclusion, infrastructure, and supporting digital research initiatives.

v. Gender Disparities in ICT Research Access: A significant policy gap in Bayelsa State's research landscape is the lack of attention to gender disparities in ICT access and research participation. An EU-funded study highlighted an 11% digital gender gap in the Niger Delta, emphasizing inequalities in women's access to digital technologies. This gap adversely affects women's involvement in digital research initiatives and the gender responsiveness of research findings **(Ekpo, Udo & Nwabueze, 2018).** Currently, there are no specific policies targeting these disparities, resulting in additional barriers for women researchers and participants. The urgent need for gender-responsive policies includes support for women researchers, gender-sensitive research protocols, and initiatives to enhance women's digital literacy and research skills, ultimately fostering a more inclusive research ecosystem.

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vi. ICT Policy Implementation Gaps: Bayelsa State has established draft ICT policies, but implementation gaps such as insufficient funding, weak institutional capacity, and poor agency coordination limit their effectiveness in supporting research. Despite being informed by EU-supported discussions, these policies struggle to transition from theory to practice, often neglecting actual research needs. Key challenges include inadequate resource allocation and lack of accountability and evaluation systems (Investbayelsa, 2025). To enhance the relevance and effectiveness of ICT policies for researchers, there is a need for more participatory approaches in policy development and improved mechanisms for implementation through better funding and capacity building.

vii. Socioeconomic Research Policy Gaps: Bayelsa State exhibits one of Nigeria's highest rates of teenage pregnancy, with 22.6% of girls aged 15-19 having begun childbearing (Diri, 2024). Studies link teenage pregnancy to socioeconomic factors such as education level, household income, and employment status. However, there are significant policy gaps, as existing research is descriptive rather than focused on interventions, which limits its relevance. Key deficiencies include the lack of a comprehensive research agenda addressing socioeconomic determinants, insufficient studies on effective preventive measures, and an absence of evaluation of current policies on adolescent reproductive health. These gaps hinder the development of evidence-based strategies to combat teenage pregnancy in Bayelsa State.

Bayelsa State, like the rest of Nigeria, faces a demographic transition characterized by an increasing elderly population. However, there is limited research on healthy aging and elderly care services in the state, revealing significant policy gaps. A qualitative study indicates urban-rural disparities in knowledge and practices concerning healthy aging, with urban areas having better healthcare infrastructure compared to rural communities that engage in minimal elderly-focused programs (Biobelemoye, Ozims,& Ezekwesiri, 2025). Key research gaps include a lack of comprehensive agendas on healthy aging, insufficient studies on elderly needs, and limited exploration of effective elderly care models. Additionally, existing policies, such as the elder care unit under RIMCAH+E, have not been implemented, hampering the development of evidence-based interventions. More targeted research is essential to inform contextually suitable policies for promoting healthy aging in Bayelsa State (Oweibia, Egberipou, Timighe et:al., (2025).

Bayelsa State faces a contradiction of abundant oil wealth and high poverty rates, especially affecting women and youth, necessitating focused research and policy initiatives. Current research predominantly describes poverty without offering tailored reduction strategies, revealing significant policy gaps such as a lack of a comprehensive research agenda and ineffective evaluation of existing programs. Innovative strategies like entrepreneurship and vocational training are under-explored, hindering evidence-based policy-making. Funding remains critically insufficient, with only 8.2% of the 2024 budget dedicated to health, far below the Abuja Declaration's target (Biobelemoye, Ozims,& Ezekwesiri, 2025). This underfunding affects research quality and contributes to a brain drain, as researchers leave for better prospects. To improve the situation, there is an urgent need for policies that promote domestic investment, establish sustainable funding mechanisms, and align research efforts with local needs, potentially through dedicated state research funding or incentives for the private sector.

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Research in Bayelsa State faces challenges due to weak governance and coordination among institutions, resulting in fragmented efforts, resource duplication, and limited collaboration. The absence of a comprehensive research governance framework hampers quality assurance and ethical adherence, negatively affecting the reliability of findings for policymaking. There is also inadequate capacity in government agencies for effective research management and weak ties between researchers and policymakers. To remedy this, strategies should aim to enhance research governance, improve collaboration, and build institutional capacity. The political economy, particularly reliance on oil revenues, contributes to fiscal volatility impacting research funding, while political priorities favor short-term results over long-term innovation. Significant policy gaps exist across various sectors, necessitating strengthened governance and an integrated research ecosystem to ensure sustainable funding and capacity-building, ultimately supporting evidence-based policymaking and development.

The Impact of Policy Framework Gaps on Research Outcomes and Sustainable Development in Bayelsa State

Bayelsa State, despite its substantial oil wealth, faces severe underdevelopment, environmental degradation, and poverty. This analysis highlights the crucial role of research and innovation in fostering sustainable economic growth, while identifying significant policy and institutional gaps that hinder this transition. Issues such as poor coordination, insufficient funding, and a disconnect between research production and practical application contribute to underperformance, adversely affecting the quality of research outcomes and ultimately obstructing sustainable development.

i. Fragmented Governance and Lack of Strategic Direction: The lack of a centralized policy and coordinating body for research and innovation negatively impacts research quality in Bayelsa State. Research is compartmentalized across ministries and institutions without a unified strategy, resulting in duplicated efforts and misaligned resources. For example, agricultural studies often proceed without consideration of environmental impacts, leading to incomplete findings. Additionally, the absence of a State Research and Innovation Council means research agendas are often subject to individual interests rather than state development needs, resulting in underutilized research outcomes.

ii. Chronic Underfunding and Resource Deficits: Policy frameworks do not mandate a specific percentage of the state budget for research and development (R&D), leading to unstable funding that undermines research quality. Institutions like Niger Delta University (NDU) face challenges due to inadequate facilities and outdated resources, evidenced by the College of Health Sciences, which suffered accreditation issues despite receiving ₦900 million for infrastructure from 2005-2009. This situation illustrates that without a sustained strategic funding policy, allocations remain ineffective, preventing researchers from producing high-quality, applicable data, and forcing reliance on possibly irrelevant external models.

iii. Deficient Human Capital Development and Brain Drain: A critical issue is the absence of a comprehensive framework for developing and retaining research talent, leading to a severe shortage of qualified researchers. There are no clear policies for funding postgraduate studies, providing research grants, or creating attractive career pathways, prompting a "brain drain" as talented individuals move to better-funded institutions. The health sector is particularly affected, facing a critical shortage of professionals due to inadequate training

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infrastructure and poor retention policies. This lack of human capital negatively impacts research quality, with remaining faculty overburdened by teaching responsibilities that limit their research activities.

The Consequential Impact on Sustainable Development in Bayelsa State

i. Constrained Economic Diversification and Innovation: The weak research ecosystem directly undermines the state's goal of economic diversification away from oil. Policies identify priority areas like agriculture, aquaculture, and tourism but fail to establish a strong research backbone to support these sectors. For example:

- Agriculture: Without research into flood-resistant crop varieties or modern farming techniques suited to the Niger Delta's fragile ecosystem, agricultural productivity remains low.
- Aquaculture: The potential of the blue economy remains untapped due to a lack of research into sustainable fishing practices, fish disease control, and value-chain development.
- Tourism: Cultural and eco-tourism development is hampered by a lack of research into market trends, conservation strategies, and community-based tourism models.

The recommendation from a state workshop to utilize technology to improve efficiencies in these sectors remains unimplemented due to the policy-implementation gap. Without research-driven innovation, economic diversification remains a rhetorical goal rather than a achievable reality, leaving the state's economy vulnerable to fluctuations in global oil prices.

ii. Ineffective Environmental Management and Public Health Responses: Bayelsa State is experiencing a severe environmental crisis due to prolonged oil pollution. The need for effective remediation and public health interventions is hampered by a lack of high-quality, locally-generated research to assess contamination levels and health impacts like heavy metal poisoning and respiratory illnesses. Current policies inadequately mandate or fund this crucial research, often relying on data from international oil companies that may lack credibility with local stakeholders. This absence of a reliable, independent research entity, supported by state policy, results in an information vacuum, ineffective policies, continued pollution, and worsening community health, thereby hindering sustainable development.

iii. Weak Evidence-Based Policy and Planning Cycle: Sustainable development necessitates policies based on accurate and relevant data, yet the current framework in Bayelsa State fails to incorporate research into decision-making. The PRS departments lack the capacity to produce impactful research, leading to planning based on outdated information rather than evidence. For instance, urban planning in Yenagoa neglects important research on flood patterns, making infrastructure projects susceptible to flooding. This disconnects results in ineffective and unsustainable development, wasting public resources and failing to enhance citizens' quality of life. The analysis indicates a cyclical issue where inadequate policy frameworks hinder research quality, consequently undermining sustainable development.

Article DOI: 10.52589/AJESD-FJLMADOA
DOI URL: https://doi.org/10.52589/AJESD-FJLMADOA

African Journal of Economics and Sustainable Development
ISSN: 2689-5080
Volume 9, Issue 1, 2026 (pp. 77-102)

www.abjournals.org

The Role of Stakeholder Collaboration in Fostering Innovation Ecosystems and Sustaining Research Infrastructure in Bayelsa State

Located in Nigeria's Niger Delta, Bayelsa State is rich in oil but has growth obstacles, especially when it comes to building infrastructure for innovation and research. This research review stresses the need of stakeholder collaboration—encompassing government, private sector, academia, civil society, and intermediate organizations—in generating innovation ecosystems required for transitioning to a knowledge-driven economy. Effective collaborative governance is essential to establishing and maintaining the research facilities and resources required serving local development requirements, especially in light of the state's problems with poverty and environmental degradation.

i. Government Stakeholders: The Bayelsa State government is promoting innovation and research infrastructure for sustainable development through partnerships, particularly with Young Innovators of Nigeria (YIN) to enhance the ICT innovation ecosystem. This initiative includes the Bayelsa Technology Forum to train 400 youths in digital skills and entrepreneurship and the establishment of the Bayelsa State Incubation Hub **(Oluwatobi, & Chinedu, 2018).** Former Governor Seriake Dickson stressed the importance of ICT for socio-economic growth beyond crude oil. Additionally, the government is collaborating with the private sector to develop agricultural business plans aimed at promoting sustainable practices, food security, employment, and economic growth.

Government stakeholders must coordinate at the local, state, and federal levels in order to effectively support innovation ecosystems. In Bayelsa State, where the connection between institutions is complicated in managing natural resources and developmental difficulties, innovative governance structures are crucial for fostering a climate that supports innovation. Maintaining research infrastructure and innovation ecosystems depends on the state government's involvement in policy integration, which calls for strategic frameworks that address regional issues while being in line with federal objectives. Given that significant projects might be derailed by brief political cycles, stability and a sustained dedication to innovation are stressed **(Xue, Hau, & Wenhui, 2024).**

ii. Private Sector Stakeholders: Investment and Market-driven Innovation: Due to the scarcity of state resources, the private sector plays a crucial role in promoting innovation ecosystems in Bayelsa State. Notable private sector endeavors include public-private collaborations for research infrastructure, entrepreneurship in ICT and agribusiness, and corporate social responsibility by oil firms. Ebipade Wolo's agricultural business idea, which aims to build De_Kings Group Ltd., is a noteworthy endeavor. Through sustainable agriculture methods and training for local farmers and young people, this project aims to improve food security, generate employment, and accelerate economic growth. It does this by showcasing the potential of private sector innovation in tackling issues related to regional development.

Small and medium enterprises (SMEs) are crucial to innovation in developing regions such as Bayelsa State. However, they encounter significant barriers, including limited funding, technical capabilities, and market information. According to Faidah **(2021)** factors influencing innovation in SMEs include entrepreneurial traits, organizational skills, external networks, and the institutional environment. Constraints like inadequate infrastructure and weak connections with knowledge institutions hinder their innovation capacity. Therefore, it

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can be stated the role of collaborative networks that link SMEs with larger firms and research institutions help to enhance their innovation through knowledge exchange, technology transfer, and joint problem-solving.

iii. Academic and Research Institutions: Through knowledge production and human capital development, academic and research institutions in Bayelsa State, including Niger Delta University and Bayelsa Medical University, play a crucial role in the region's innovation ecosystem. Nevertheless, they encounter obstacles such as insufficient personnel, restricted financial resources, and administrative limitations that affect the efficiency of research. These problems are also made worse by a lack of facilities, such as teaching hospitals and lab apparatus. Infrastructure development is made more difficult by Bayelsa's particular geographic difficulties, which include flooding and riverine networks. Despite these challenges, these institutions are essential for developing the human capital required for research and innovation. Academic and research institutions can enhance innovation ecosystems by effectively engaging stakeholders through technology transfer and information sharing **(Leal, Vasconcelos, Dinis, & Vera, 2022)**. In Bayelsa State, intermediary organizations are vital for facilitating communication between academia and industry, shaping research agendas, and commercializing discoveries into marketable technologies. However, challenges such as limited institutional capacity, lack of incentives for collaboration, and insufficient technology transfer infrastructure hinder these efforts. To fortify the roles of these intermediaries, it is imperative to implement targeted investments and regulations promoting cooperative research and innovation.

iv. Civil Society Organizations: Alongside government initiatives, civil society groups (CSOs) in Bayelsa State are essential to development, addressing problems including political instability, environmental degradation, and poverty. Environmental issues related to oil development and deforestation is the focus of groups like the Niger Delta Development Commission (NDDC), Environmental Rights Action (ERA), and the Bayelsa Non-Governmental Organizations Forum (BANGOF)(**Efosa & Hansen, 2024)**. In order to provide a better environment for sustainable innovation, they are working to reform environmental legislation, support sustainable livelihoods, and increase public understanding of climate change. In order to ensure that innovation ecosystems meet local needs through participatory methodologies that include end users in creating solutions pertinent to disadvantaged communities, CSOs help improve social mobilization and community participation.

CSOs in Bayelsa State play a critical role in filling governance gaps by providing services and implementing projects in areas where the state is limited, such as improving local infrastructure and supporting health initiatives. According to **Efosa & Hansen (2024),** despite these efforts, they face challenges like funding issues and political interference, which impede their effectiveness in driving sustainable development. Strengthened collaborations among CSOs, government, and international partners are essential for enhancing impact and facilitating resource exchange necessary for successful project implementation in the region.

v. Intermediary Organizations: Intermediary organizations are vital in innovation ecosystems, facilitating connections, collaboration, and specialized services for innovation processes. They establish essential links for cooperation among diverse actors, enabling the sharing of technologies and knowledge to foster new product and service development (Leal et al., 2022). Functions of intermediaries include connecting actors, organizing dialogue,

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facilitating learning, and transferring knowledge (Leal et al., 2022). In Bayelsa State, intermediaries like the Young Innovators of Nigeria (YIN) play a significant role in developing the ICT innovation ecosystem, particularly in nascent and fragmented contexts that require coordinated efforts to connect resources and actors (Oluwatobi & Chinedu, 2018). In the vein, intermediary entities play a critical role in resource mobilization and capacity building by providing training and assistance to improve the capacities of SMEs and entrepreneurs. Additionally, they facilitate partnership and network management by connecting local innovators with funding resources and investors. By building relationships and improving the exchange of information, these intermediary organizations assist in overcoming cooperation hurdles in a setting where trust may be restricted as a result of past disputes, therefore establishing a supporting social infrastructure for innovation ecosystems.

Challenges and Barriers to Effective Stakeholder Collaboration

i. Structural and Institutional Constraints: Effective cooperation is hampered by a number of institutional and structural barriers, despite the acknowledged significance of stakeholder engagement for maintaining research infrastructure and promoting innovation ecosystems in Bayelsa State. Partnership coordination is limited, institutional capacity is weak, funding is insufficient, and governance is fractured. Geographical concerns as well as historical trends of exclusion and warfare exacerbate these difficulties. The region's efforts at long-term prosperity are hampered by the bureaucratic red tape and financial constraints that civil society organizations (CSOs) face when attempting to collaborate with government and international entities. Thus, relationships between various stakeholder groups in the innovation ecosystem of Bayelsa State are similarly impacted by these coordination problems.

ii. Resource Limitations and Capacity Gaps: Resource limitations and capacity gaps hinder stakeholder collaboration in Bayelsa State's innovation ecosystem. Tertiary institutions and research centers face underfunding and inadequate infrastructure, while SMEs lack financial resources and managerial expertise. Civil society organizations struggle with limited skills and resources. Targeted capacity development is needed to improve stakeholder skills and participation in innovation. The literature emphasizes the importance of stakeholder engagement in developing innovation ecosystems and research infrastructure. Sustainable development relies on strong collaborations among public, corporate sectors, academia, and civil society; however, obstacles like disjointed government and resource limitations complicate cooperation. The evaluation notes promising but poorly coordinated initiatives, such as agricultural entrepreneurship programs and government collaborations with Young Innovators of Nigeria, which diminish their impact on the state's innovation ecosystem.

CONCLUSION

This study examines the link between policy frameworks and investment strategies in fostering sustainable research ecosystems in Bayelsa State, Nigeria. It identifies challenges such as inadequate research infrastructure, fragmented governance, poor funding, and geographical constraints like flooding. The state's dependency on oil revenues has resulted in a preference for short-term funding over long-term investments, which impedes development. The integration of Institutional Theory and the Triple Helix Model reveals misalignments and

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coordination issues among universities, industry, and government. Policy gaps and ineffective implementation due to institutional weaknesses further hinder progress. Although existing policies provide a framework, they lack specificity and coordination, causing investment patterns to be unpredictable and misaligned with strategic priorities, leading to inefficient resource utilization.

The integration of Institutional Theory and the Triple Helix Model highlights issues in the research ecosystem due to misalignments and poor coordination among universities, industry, and government. It identifies policy-implementation gaps where initiatives falter because of institutional weaknesses and inadequate monitoring. Although current policies provide guidance, they lack necessary specifics and coordination for effective development. Investment patterns are also marked by unpredictability and misalignment with strategic priorities, leading to inefficient resource use.

RECOMMENDATIONS

1. Enact a Bayelsa State Research, Innovation, and Technology (RIT) Act and Establish a Dedicated Coordination Council: To address the fragmented governance in Bayelsa State, the government should implement a Bayelsa State Research, Innovation, and Technology (RIT) Act to create the Bayelsa State Research and Innovation Council (BSRIC). Chaired by the Governor or Deputy Governor, the Council should consist of key stakeholders, including government ministries, tertiary institutions, and private industry from oil/gas and agriculture, and civil society. The BSRIC's role would involve setting research priorities, reducing redundant efforts, and ensuring a unified research infrastructure, thus providing essential political support and stakeholder coordination.

2. Create a Bayelsa Research and Innovation Fund (BRIF) with a Transparent Funding Mechanism: To address chronic underfunding in research, the establishment of the Bayelsa Research and Innovation Fund (BRIF) is proposed. This fund would start with 1-1.5% of the state's annual capital expenditure, aiming to attract additional matching funds from international organizations and local oil companies through CSR initiatives. BRIF would implement a transparent and competitive grant system, focusing on areas such as environmental remediation, aquaculture, and public health to ensure effective allocation and minimize corruption risks.

3. Develop Thematically Focused, Shared-Use Research Centers of Excellence: Strategic investment in specialized, shared-use Research Centers of Excellence in Bayelsa is recommended to align with local economic and environmental needs. Proposed centers include a Centre for Deltaic Environmental Studies for oil spill remediation and climate adaptation, and an Aquaculture and Blue Economy Innovation Hub. These should be housed within existing tertiary institutions like Niger Delta University, governed as shared infrastructure to promote accessibility for researchers, government agencies, and private partners. This approach aims to maximize resources, avoid duplication, and address Bayelsa's urgent challenges.

4. Launch a Strategic Human Capital Development Program to Combat "Brain Drain": To address the shortage of research expertise in Bayelsa, a Bayelsa Research Fellowship Program should be established. This program would provide competitive postgraduate

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scholarships, postdoctoral fellowships, and sabbatical grants to attract and retain research talent, linking directly to Research Centers of Excellence. Additionally, incentives should be introduced for Bayelsa academics in the diaspora to return, supported by a "Distinguished Visiting Scholar" program aimed at facilitating knowledge transfer and enhancing local institutional capacity.

5. Institutionalize a Culture of Collaboration through Mandated Partnerships and Digital Platforms: To enhance collaboration among universities, industry, and government, it is proposed to formalize and incentivize their interactions by establishing collaborations. This could include mandating that a portion of BRIF grants support projects involving multiple partners, creating frameworks for Public-Private-Research Partnerships inspired by initiatives like the Bayelsa E-commerce Entrepreneurship Program (BEEP), and launching a central digital research portal for research outputs and data sharing. These measures aim to dismantle institutional silos and cultivate essential synergistic relationships for a robust innovation ecosystem.

ACKNOWLEDGEMENT

The researcher gratefully acknowledges the Tertiary Education Trust Fund (TETFund) for its vital financial support through the Institution-Based Research (IBR), which was instrumental in facilitating this study. The researcher also extends sincere appreciation to Isaac Jasper Boro College of Education, Sagbama, Bayelsa State, for providing the academic platform and institutional support necessary for this research.

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