



STRENGTHENING INSTITUTIONAL RESEARCH CAPACITY THROUGH DIGITAL INNOVATION: A SYSTEM-LEVEL ANALYSIS OF NIGERIAN PUBLIC TERTIARY INSTITUTIONS

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ABSTRACT

This study examines the role of digital innovation in strengthening institutional research capacity within Nigerian public tertiary institutions through a system-level analysis. In recent years, the integration of digital technologies into higher education has emerged as a critical driver of research productivity, knowledge generation, and institutional competitiveness. Evidence suggests that digital transformation enhances administrative efficiency, supports data-driven decision-making, and improves teaching, learning, and research processes across universities and polytechnics. Adopting a qualitative and analytical approach, the study synthesizes existing literature, policy frameworks, and institutional practices to explore how digital infrastructure, digital literacy, and innovation ecosystems contribute to research capacity development. The findings reveal that digital tools such as research databases, collaborative platforms, and institutional management systems; facilitate knowledge sharing, interdisciplinary collaboration, and global research visibility. Additionally, national initiatives aimed at enhancing ICT competencies and innovation ecosystems are increasingly positioning tertiary institutions as hubs for research commercialization and technological advancement. However, the study identifies persistent systemic challenges, including inadequate digital infrastructure, limited funding, low digital competencies among staff, and fragmented policy implementation, which constrain the full realization of digital innovation benefits. The paper concludes that strengthening institutional research capacity in Nigeria requires a coordinated system-level strategy that prioritizes investment in digital infrastructure, continuous capacity building, policy coherence, and multi-stakeholder collaboration. Such an approach is essential for transforming public tertiary institutions into globally competitive knowledge hubs capable of driving sustainable development.

Keywords: Digital transformation, Knowledge management systems, ICT infrastructure development, Data-driven governance, Research collaboration networks and Innovation ecosystems

Introduction

The global higher education setting is undergoing a profound transformation driven by rapid advances in digital technologies. Across both developed and developing contexts, digital innovation has become central to enhancing research productivity, institutional efficiency, and knowledge generation. Universities and other tertiary institutions are increasingly leveraging digital tools such as big data analytics, cloud computing, and collaborative research platforms; to improve research outcomes and global competitiveness (World Bank, 2020; UNESCO, 2021). In



this context, institutional research capacity, defined as the ability of universities and research institutions to produce high-quality, policy-relevant, and globally visible research, is now closely tied to the extent of digital integration within academic systems (Altbach & Salmi, 2011).

In Nigeria, public tertiary institutions including universities, polytechnics and colleges of education, play a critical role in national development through knowledge production, human capital development, and innovation. However, despite their strategic importance, these institutions have historically faced significant constraints in building and sustaining robust research capacity. Challenges such as inadequate funding, weak research infrastructure, limited access to global knowledge networks, and bureaucratic inefficiencies have continued to undermine their performance (Saint, Hartnett, & Strassner, 2003; Aina, 2010). More recently, the emergence of digital technologies presents both an opportunity and a challenge for these institutions to reposition themselves within the global knowledge economy.

Digital innovation offers transformative potential for strengthening institutional research capacity in several ways. First, it enhances access to scholarly resources through digital libraries, open-access repositories, and online databases, thereby expanding the frontiers of academic inquiry (OECD, 2019). Second, it facilitates collaboration among researchers across geographical boundaries, enabling interdisciplinary and cross-institutional research networks that were previously difficult to establish (Castells, 2010). Third, digital tools support data-driven governance and research management, improving efficiency in grant administration, publication tracking, and institutional performance monitoring (UNESCO, 2021). These developments underscore the growing importance of integrating digital innovation into the core functions of tertiary institutions.

Notwithstanding these opportunities, the adoption and effective utilization of digital technologies in Nigerian public tertiary institutions remain uneven and constrained by systemic challenges. Persistent issues such as unreliable power supply, inadequate ICT infrastructure, low levels of digital literacy among academic staff, and fragmented policy implementation continue to limit the impact of digital innovation on research capacity (Olayinka, 2016; National Universities Commission [NUC], 2020). Furthermore, existing interventions are often implemented in isolation, lacking the system-level coordination required to achieve sustainable and scalable outcomes. This underscores the need for a holistic analytical framework that situates digital innovation within the broader institutional and policy ecosystem.

A system-level analysis is particularly relevant in this regard, as it enables a comprehensive understanding of how various components: such as institutional policies, governance structures, technological infrastructure, and human capital; interact to shape research capacity outcomes. Rather than viewing digital innovation as a standalone intervention, this approach emphasizes the



interconnectedness of actors and processes within the higher education system (Lundvall, 2010). It also highlights the importance of multi-stakeholder collaboration, including government agencies, regulatory bodies, private sector partners, and international organizations, in driving sustainable digital transformation.

This study, therefore, seeks to examine how digital innovation can be harnessed to strengthen institutional research capacity in Nigerian public tertiary institutions through a system-level perspective. By synthesizing existing literature, policy frameworks, and institutional practices, the study aims to identify key drivers, challenges, and strategic pathways for enhancing research capacity in the digital age. In doing so, it contributes to ongoing scholarly and policy debates on higher education reform, digital transformation, and sustainable development in Nigeria and other similar contexts.

Ultimately, strengthening institutional research capacity through digital innovation is not merely a technological imperative but a strategic necessity for national development. As Nigeria aspires to position itself as a knowledge-driven economy, the ability of its tertiary institutions to generate, disseminate, and apply knowledge effectively will be critical. A coordinated and system-oriented approach to digital innovation holds the promise of transforming these institutions into globally competitive hubs of research excellence and innovation.

Statement of the Problem

Despite increasing policy attention to digital transformation in Nigeria's higher education sector, institutional research capacity across public tertiary institutions remains weak, fragmented, and insufficient to meet national development needs. Empirical indicators such as low research output, limited patenting and commercialization activities, poor global ranking performance, and weak international research visibility continue to characterize many Nigerian universities and polytechnics. These deficiencies persist even as digital technologies, capable of enhancing research efficiency, collaboration, and knowledge dissemination; are gradually being introduced into the system.

A critical concern is that existing digital initiatives within Nigerian public tertiary institutions are often implemented in a piecemeal and uncoordinated manner, lacking alignment with broader institutional research goals. In many cases, digital tools are deployed without adequate integration into research workflows, governance systems, or performance evaluation mechanisms. This disconnect undermines the potential of digital innovation to significantly improve research productivity and institutional effectiveness. Furthermore, disparities in access to digital resources across institutions have created uneven capacities, thereby widening the gap between relatively better-resourced institutions and those with limited technological capabilities.



Another dimension of the problem lies in the insufficient development of human capital required to drive digital research ecosystems. Many academic staff lack the requisite competencies to effectively utilize advanced digital tools for data analysis, collaboration, and publication. In addition, institutional support systems for continuous digital skills development are either weak or non-existent, leading to underutilization of available technologies. This situation is further compounded by weak data management practices, limited adoption of research information systems, and the absence of robust frameworks for monitoring and evaluating research performance.

At the policy level, inconsistencies and lack of synergy among key stakeholders—including government agencies, regulatory bodies, and institutional management—have hindered the development of a coherent digital innovation strategy for research capacity building. While various interventions have been introduced, they often suffer from inadequate funding, poor implementation, and lack of sustainability. Consequently, the anticipated transformation of research systems through digital innovation has not been fully realized.

Given these challenges, there is a pressing need to critically examine how digital innovation can be systematically leveraged to strengthen institutional research capacity in Nigerian public tertiary institutions. Specifically, the absence of a system-level understanding of the interplay between digital infrastructure, human capital, institutional governance, and policy frameworks constitutes a significant gap in both research and practice. Addressing this gap is essential for developing sustainable strategies that can enhance research productivity, foster innovation, and position Nigerian tertiary institutions as competitive actors in the global knowledge economy.

Research Questions

1. How does digital innovation influence institutional research capacity in Nigerian public tertiary institutions?
2. What are the key systemic factors (infrastructure, human capital, governance, and policy frameworks) affecting the adoption and effectiveness of digital innovation for research capacity development?
3. What strategic system-level approaches can enhance the integration of digital innovation to improve research productivity, collaboration, and global visibility in Nigerian public tertiary institutions?

Objectives of the Study

To examine how digital innovation can be leveraged to strengthen institutional research capacity in Nigerian public tertiary institutions through a system-level analysis. The study is tied to the following specific objectives:



1. To assess the influence of digital innovation on institutional research capacity in Nigerian public tertiary institutions.
2. To identify and analyze the systemic factors (infrastructure, human capital, governance, and policy frameworks) affecting the adoption and effectiveness of digital innovation for research capacity development.
3. To propose strategic system-level approaches for enhancing the integration of digital innovation to improve research productivity, collaboration, and global visibility in Nigerian public tertiary institutions.

Review of Related Literature

Conceptual Clarification

Digital Innovation

Digital innovation refers to the application and integration of digital technologies such as cloud computing, artificial intelligence, big data analytics, and online collaborative platforms; to transform institutional processes, services, and outputs. In higher education, it involves the use of digital systems to enhance teaching, research, knowledge dissemination, and administrative efficiency. Studies show that digital transformation in tertiary institutions improves access to information, research collaboration, and institutional visibility (World Bank, 2020; UNESCO, 2021). However, digital innovation is not limited to technology adoption alone; it also includes institutional redesign and capacity alignment to ensure effective utilization of digital tools (OECD, 2019).

Institutional Research Capacity

Institutional research capacity refers to the ability of higher education institutions to generate, manage, and disseminate high-quality research outputs consistently and sustainably. It includes human capital, infrastructure, funding systems, governance structures, and access to global knowledge networks. Altbach and Salmi (2011) argue that strong research capacity is a defining feature of world-class universities, characterized by high publication output, strong citation impact, and global research collaboration.

Knowledge Management Systems

Knowledge management systems (KMS) are ICT-enabled platforms that support the creation, storage, sharing, and application of knowledge within institutions. In universities, KMS facilitate access to research outputs, institutional repositories, and digital libraries, thereby improving research efficiency and visibility.

ICT Infrastructure Development

ICT infrastructure development refers to the availability and quality of digital hardware, software, internet connectivity, data systems, and technical support that enable digital operations. In Nigerian tertiary institutions, ICT infrastructure remains uneven, with many institutions struggling with unstable connectivity and inadequate research technologies (Olayinka, 2016).



Data-Driven Governance

Data-driven governance describes decision-making processes guided by real-time data analytics and digital information systems. In academic institutions, it supports research planning, performance monitoring, and resource allocation, thereby improving efficiency and accountability.

Research Collaboration Networks

These are formal and informal partnerships among researchers, institutions, and international bodies that enhance knowledge exchange and joint research output. Digital platforms have expanded the reach of such networks by removing geographical barriers (Castells, 2010).

Innovation Ecosystems

Innovation ecosystems refer to interconnected systems of universities, government agencies, industries, and civil society organizations that collectively support research, innovation, and commercialization. In developing countries like Nigeria, weak ecosystem integration often limits the translation of research into practical outcomes (Lundvall, 2010).

Thematic Review

Digital Innovation and Institutional Research Capacity

Literature consistently shows that digital innovation enhances research capacity by improving access to scholarly resources, enabling remote collaboration, and increasing research visibility. Digital platforms such as institutional repositories and open-access journals have significantly expanded knowledge dissemination globally (OECD, 2019). In Nigeria, emerging studies indicate that ICT adoption has improved administrative efficiency and academic communication in tertiary institutions, though its impact on research productivity remains uneven (Jimoh & Jimoh, 2024). However, empirical evidence suggests that the relationship between digital innovation and research output is not automatic. A study on ICT researchers in Nigerian institutions found that while digital tools improve connectivity and collaboration, their impact on actual research outputs depends heavily on institutional support systems and researcher competencies (Adewusi & Jegede, 2025). This implies that digital innovation must be embedded within broader institutional systems to be effective.

Institutional Research Capacity in Nigerian Tertiary Institutions

Institutional research capacity in Nigeria remains constrained despite growing enrolment and expansion of tertiary institutions. Scientometric evidence from leading universities such as the University of Ibadan shows relatively high publication output but uneven citation impact and limited global collaboration compared to international benchmarks (Ahmad & Nkatv, 2025). Across the system, research productivity is hindered by inadequate funding, weak research infrastructure, and limited access to international databases. The World Bank (2020) and UNESCO (2021) both note that African universities, including those in Nigeria, face systemic capacity gaps that reduce their global competitiveness. These gaps are particularly visible in polytechnics and colleges of education, where research output is significantly lower than in federal universities.



Human Capital Needs for Digital Research Ecosystems

Human capital remains a central determinant of effective digital transformation in research systems. Studies show that limited digital literacy among academic staff is a major barrier to the effective use of ICT tools in research activities (Ogunode & Ndayebom, 2023; Adewusi & Jegede, 2025). Without adequate training in data analytics, digital publishing, and collaborative platforms, researchers are unable to fully exploit available technologies. In addition, gender disparities and uneven participation in ICT-related fields further weaken the human capital base for digital research ecosystems. For instance, studies in Nigerian tertiary institutions show that socio-cultural barriers and high cost of ICT tools reduce participation and skill acquisition, especially among female academics and students (Nwajiuba & Ukwandu, 2021). These findings underscore the need for continuous professional development, structured ICT training programs, and institutional incentives for digital skills acquisition.

Institutional Support Systems for Digital Skills Development

Institutional support systems including training programs, funding schemes, research grants, and ICT units; are critical for sustaining digital innovation in universities. However, evidence suggests that many Nigerian tertiary institutions lack structured and consistent digital capacity-building frameworks. Training opportunities are often sporadic, underfunded, and poorly aligned with research needs.

Furthermore, financial constraints significantly limit institutional ability to procure and maintain digital research infrastructure (Okekeuche, 2024). Many institutions depend on external grants, which are often unstable and insufficient to support long-term digital transformation (Orubebe, Oloniruha, & Oladokun, 2025; Ogbonna, Onuoha-Chidiebere, Ike, et al., 2025).

Systemic and Structural Constraints

The literature identifies several systemic constraints affecting digital innovation and research capacity in Nigeria. These include weak governance structures, inconsistent policies, poor electricity supply, and fragmented implementation of ICT strategies (Olayinka, 2016). Additionally, limited institutional coordination reduces the effectiveness of national digital initiatives.

Studies also emphasize that ICT adoption in Nigerian tertiary institutions is often uneven and influenced by institutional type. Universities tend to have better infrastructure than polytechnics and colleges of education, but even within universities, utilization levels vary widely (Ogbonna, Onuoha-Chidiebere, Ike, et al., 2025)

Empirical Review

Several empirical studies have examined ICT adoption and research capacity in Nigerian tertiary institutions. A mixed-method study by Adewusi and Jegede (2025) examined ICT research productivity across 30 universities and found that digital infrastructure, institutional support, and collaboration networks significantly influence research outputs. However, the study also revealed that underfunding and weak governance structures remain persistent barriers. Similarly, a scientometric analysis of the University of Ibadan revealed strong publication output but relatively weak international citation impact and collaboration networks (Ahmad & Nkatv, 2025). This



suggests that while research quantity may be improving, quality and global visibility remain challenges.

Another study on big data adoption in Nigerian tertiary institutions found that ICT tools improve student performance and institutional efficiency, but their adoption is limited by infrastructure gaps and low technical capacity (Oguine et al., 2022).

Across these studies, a consistent pattern emerges: while digital technologies are increasingly available, their effective integration into research systems is constrained by human, institutional, and policy-related factors. Most studies adopt institution-specific or sector-specific approaches, with limited emphasis on system-level analysis.

Gap in Literature and Justification for the Study

Although existing studies have explored ICT adoption, research productivity, and institutional capacity in Nigerian tertiary institutions, several gaps remain evident:

1. Most studies are fragmented and focus on single institutions rather than system-wide analysis.
2. Limited attention has been given to the interaction between digital infrastructure, human capital, and governance structures.
3. Few studies integrate digital innovation within a holistic framework of research capacity development.
4. Empirical evidence on how digital transformation translates into measurable research outcomes remains inconsistent.

These gaps justify the need for a system-level analysis that examines how digital innovation, when integrated with institutional and policy frameworks, can strengthen research capacity in Nigerian public tertiary institutions.

Theoretical Framework

This study is anchored on a combination of Systems Theory, the Technology–Organization–Environment (TOE) Framework, and the National Innovation Systems (NIS) Theory. These theories collectively provide a robust lens for explaining how digital innovation interacts with institutional structures, human capital, and policy environments to shape research capacity in Nigerian public tertiary institutions.

Systems Theory

Systems Theory, originally developed by Bertalanffy (1968), posits that organizations function as interdependent and interconnected systems in which each component influences and is influenced by others. In the context of higher education, universities and other tertiary institutions are viewed as complex systems comprising academic staff, administrative structures, infrastructure, policies, and external stakeholders. Applied to this study, Systems Theory suggests that institutional research capacity cannot be understood in isolation from its constituent elements such as ICT infrastructure, human resources, governance structures, and funding mechanisms. A weakness in any subsystem—such as inadequate digital infrastructure or poor staff ICT competence—affects the overall research performance of the institution. Therefore, strengthening research capacity requires a holistic, system-level intervention rather than fragmented or isolated reforms.



This theory is particularly relevant because it supports the study's focus on system-level analysis, emphasizing interdependence between digital innovation and institutional components.

Technology–Organization–Environment (TOE) Framework

The TOE framework, developed by Tornatzky and Fleischer (1990), explains how technological innovation adoption is influenced by three contextual dimensions:

1. **Technological context** – availability and quality of technologies such as digital research tools, databases, and ICT infrastructure.
2. **Organizational context** – internal characteristics of institutions, including size, leadership support, human capital, and organizational readiness.
3. **Environmental context** – external factors such as government policies, funding structures, regulatory frameworks, and competitive pressures.

In relation to this study, the TOE framework explains the varying levels of digital innovation adoption across Nigerian public tertiary institutions. For instance, even when digital tools are available (technological context), weak leadership support or limited staff capacity (organizational context) and inconsistent national ICT policies (environmental context) may hinder effective utilization.

The TOE framework is particularly useful in explaining why digital transformation outcomes differ across institutions despite similar policy environments. It also highlights that successful digital innovation for research capacity development requires alignment across all three dimensions.

National Innovation Systems (NIS) Theory

The National Innovation Systems theory, developed by Freeman (1987) and later expanded by Lundvall (1992), emphasizes that innovation is the result of interactions among institutions, firms, universities, and government agencies within a national context. It focuses on how knowledge is created, shared, and applied through networks of actors. Within this framework, tertiary institutions are key nodes in the innovation ecosystem responsible for generating research outputs, fostering technological development, and supporting national competitiveness. The effectiveness of these institutions depends on how well they are integrated into broader systems of innovation, including industry partnerships, government funding mechanisms, and international collaborations.

In Nigeria, weak linkages between universities, industry, and government have limited the translation of research into innovation and economic development. This study applies the NIS perspective to understand how digital innovation can strengthen these linkages by enabling collaboration platforms, improving knowledge dissemination, and enhancing research visibility.



Integrative Theoretical Model for the Study

The integration of Systems Theory, TOE framework, and NIS theory provides a comprehensive explanatory model for this study:

- a) **Systems Theory** explains the interdependence of institutional components affecting research capacity.
- b) **TOE framework** explains the determinants of digital innovation adoption within institutions.
- c) **NIS theory** explains the broader ecosystem through which research outputs are generated, shared, and utilized.

Together, these theories suggest that strengthening institutional research capacity through digital innovation requires:

- Adequate ICT infrastructure and technological readiness
- Skilled and digitally competent academic staff
- Strong institutional leadership and governance structures
- Supportive national policies and funding mechanisms
- Effective collaboration between universities, industry, and government

This integrated framework aligns directly with the study's **system-level analysis approach**, emphasizing that digital innovation is most effective when it is embedded within a coordinated institutional and national innovation ecosystem rather than treated as a standalone intervention.

The combined theoretical framework is particularly relevant because it:

1. Provides a multi-dimensional explanation of digital innovation adoption and impact.
2. Captures both internal institutional dynamics and external environmental influences.
3. Supports the system-level perspective adopted in this study.
4. Explains why digital transformation outcomes vary across Nigerian public tertiary institutions.
5. Guides the analysis of how digital innovation can be leveraged to improve research capacity, collaboration, and global visibility.

Discussion of Findings

This section presents and discusses the findings of the study based on the thematic content analysis of relevant literature, policy documents, and institutional reports. The analysis is structured in line with the study's objectives and guided by the Systems Theory, Technology–Organization–Environment (TOE) framework, and National Innovation Systems (NIS) perspective. The discussion integrates evidence on digital innovation, institutional dynamics, and research capacity outcomes in Nigerian public tertiary institutions.

Digital Innovation and Institutional Research Capacity

Findings reveal that digital innovation has significantly transformed research processes globally by enhancing access to information, facilitating collaboration, and improving knowledge dissemination. In Nigerian public tertiary institutions, digital tools such as online research



databases (e.g., Scopus, Web of Science), institutional repositories, and virtual collaboration platforms have improved academic communication and access to scholarly resources. However, the extent of impact on institutional research capacity remains uneven. While some leading universities—such as the University of Ibadan, University of Lagos, and Ahmadu Bello University—have demonstrated relatively higher research output and digital adoption, many other institutions, particularly polytechnics and colleges of education, lag behind in both digital integration and research productivity (NUC, 2020; World Bank, 2020). This disparity reflects systemic imbalances in infrastructure, funding, and institutional priorities. From a Systems Theory perspective, this suggests that digital innovation alone is insufficient; its effectiveness depends on the strength and alignment of other institutional components.

ICT Infrastructure and Research Productivity

The analysis indicates that ICT infrastructure is a foundational determinant of digital innovation effectiveness. Institutions with stable internet connectivity, functional digital libraries, and access to global research databases tend to exhibit higher levels of research productivity and visibility. Nonetheless, many Nigerian public tertiary institutions face infrastructural deficits, including poor broadband connectivity, inadequate hardware, and unreliable electricity supply. These limitations significantly constrain the use of digital tools for research activities (Olayinka, 2016). As a result, researchers in such environments often rely on outdated methods, limiting their competitiveness in the global academic community. Within the TOE framework, these findings highlight the importance of the technological context in shaping digital innovation outcomes.

Human Capital and Digital Research Ecosystems

Human capital emerges as a critical factor in the effectiveness of digital innovation. The findings show that digital literacy, research skills, and technical competence among academic staff directly influence the utilization of digital tools. Despite increasing awareness of digital technologies, many academic staff in Nigerian institutions lack advanced competencies in areas such as data analytics, digital publishing, and collaborative research platforms. This skills gap limits the potential benefits of available technologies and contributes to low research output and visibility. Furthermore, institutional support for continuous professional development is often weak or inconsistent. Training programs, where available, are sporadic and insufficient to meet the evolving demands of digital research ecosystems. This reinforces the TOE framework's emphasis on the organizational context, particularly human resource capacity, as a key determinant of innovation adoption.

Institutional Governance and Policy Frameworks

The findings also reveal that governance structures and policy frameworks significantly influence digital innovation outcomes. Effective leadership, clear institutional policies, and strategic planning are essential for integrating digital technologies into research systems. In many Nigerian



public tertiary institutions, however, digital initiatives are often implemented without comprehensive policy alignment or long-term strategic vision. This results in fragmented adoption, duplication of efforts, and inefficient resource utilization. At the national level, inconsistencies in policy implementation and limited coordination among stakeholders further undermine digital transformation efforts (NUC, 2020). From the perspective of the TOE framework, this reflects weaknesses in both the organizational and environmental contexts, which hinder the full realization of digital innovation benefits.

Research Collaboration Networks and Global Visibility

Digital innovation has expanded opportunities for research collaboration through online platforms, virtual conferences, and international research networks. Findings indicate that institutions with stronger digital capabilities are better positioned to engage in global research collaborations, thereby enhancing their visibility and citation impact. However, many Nigerian institutions remain marginal participants in global research networks due to limited digital infrastructure, weak institutional linkages, and funding constraints. This limits knowledge exchange and reduces the global competitiveness of their research outputs. The NIS theory highlights that effective research capacity development requires strong linkages among universities, industry, and government. The weak integration of Nigerian tertiary institutions into broader innovation ecosystems continues to constrain their research potential.

Institutional Support Systems for Digital Skills Development

The study finds that institutional support systems for digital skills development are generally inadequate. While some initiatives—such as TETFund-sponsored training programs—have contributed to capacity building, their coverage and sustainability remain limited. Many institutions lack structured frameworks for continuous digital training, mentorship, and research support. This results in underutilization of digital tools and reduced efficiency in research processes. Financial constraints further limit the ability of institutions to invest in capacity-building programs and maintain digital infrastructure.

System-Level Constraints and Interdependencies

A key finding of the study is that challenges affecting research capacity are deeply interconnected. Infrastructure deficits, human capital limitations, governance weaknesses, and policy inconsistencies reinforce one another, creating systemic barriers to digital innovation. For example, inadequate funding affects infrastructure development, which in turn limits digital access and reduces opportunities for skill acquisition. Similarly, weak governance structures hinder effective policy implementation, further constraining institutional performance. This interconnectedness validates the Systems Theory underpinning the study, emphasizing that interventions must be holistic and coordinated rather than isolated.



Overall, the findings demonstrate that while digital innovation holds significant potential for strengthening institutional research capacity in Nigerian public tertiary institutions, its impact is constrained by systemic challenges. The effectiveness of digital technologies depends on the interaction of multiple factors, including infrastructure, human capital, governance, and policy environments. The study also reveals that institutions with relatively stronger systems—characterized by better infrastructure, skilled personnel, and supportive policies—tend to achieve higher research productivity and global visibility. Conversely, institutions with weak systems remain marginalized in the knowledge economy.

The implications of these findings are both theoretical and practical:

- a) Theoretically, the study validates the relevance of Systems Theory, TOE framework, and NIS theory in explaining digital innovation and research capacity dynamics.
- b) Practically, it highlights the need for integrated, system-level strategies that address infrastructure, human capital, governance, and policy simultaneously.
- c) Policy-wise, it underscores the importance of coordinated efforts among government agencies, institutions, and external stakeholders to drive sustainable digital transformation.

Recommendations

Based on the findings of the study, the following recommendations are proposed:

- 1) **Strategic Investment in ICT Infrastructure:** Government and institutional management should prioritize sustained investment in ICT infrastructure, including high-speed internet connectivity, digital libraries, research databases, and reliable power supply systems. Such investments are essential for creating an enabling environment for digital research activities.
- 2) **Institutionalization of Digital Skills Development:** Tertiary institutions should establish structured and continuous professional development programs aimed at enhancing digital competencies among academic staff. This should include training in data analytics, digital publishing, research collaboration tools, and emerging technologies relevant to research.
- 3) **Development of Coherent Digital Innovation Policies:** There is a need for clear and integrated digital innovation policies at both institutional and national levels. Regulatory bodies and government agencies should ensure policy coherence, effective implementation, and alignment with broader research and development goals.
- 4) **Strengthening Institutional Governance and Leadership:** Institutional leadership should adopt strategic approaches to digital transformation by integrating digital innovation into core research and administrative processes. Strong governance frameworks are required to ensure accountability, coordination, and sustainability of digital initiatives.
- 5) **Promotion of Research Collaboration Networks:** Institutions should actively foster local and international research collaborations through digital platforms. Partnerships with global institutions, industry stakeholders, and research organizations should be encouraged to enhance knowledge exchange and research visibility.



- 6) **Enhancement of Funding Mechanisms for Research and Innovation:** Government and funding agencies such as TETFund should expand financial support for digital research infrastructure, innovation projects, and capacity-building initiatives. Sustainable funding models are critical for long-term development.
- 7) **Adoption of Data-Driven Governance Systems:** Institutions should implement digital research management systems that enable data-driven decision-making, performance monitoring, and efficient resource allocation. This will improve transparency, accountability, and institutional effectiveness.
- 8) **Strengthening the National Innovation Ecosystem:** Efforts should be made to improve linkages among universities, industry, and government to support research commercialization and innovation. Digital platforms can be leveraged to facilitate these interactions and enhance the overall innovation ecosystem.
- 9) **System-Level Coordination and Monitoring:** A coordinated system-level framework should be established to monitor and evaluate digital innovation initiatives across tertiary institutions. This will ensure alignment, reduce duplication, and promote best practices.

Contribution to Knowledge

This study contributes to existing literature by providing a **system-level perspective** on the relationship between digital innovation and institutional research capacity in Nigeria. It integrates multiple theoretical frameworks to offer a holistic understanding of the issue and highlights the importance of coordinated strategies in achieving sustainable transformation.

Conclusion

This study examined how digital innovation can be leveraged to strengthen institutional research capacity in Nigerian public tertiary institutions using a system-level analytical approach. Drawing on Systems Theory, the Technology–Organization–Environment (TOE) framework, and National Innovation Systems (NIS) theory, the study provided a comprehensive understanding of the interactions between digital technologies, institutional structures, human capital, and policy environments.

The findings reveal that digital innovation has the potential to significantly enhance research productivity, collaboration, and global visibility. However, this potential remains largely underutilized due to persistent systemic challenges. These include inadequate ICT infrastructure, limited digital competencies among academic staff, weak institutional governance, fragmented policy implementation, and insufficient funding. The study demonstrates that these challenges are not isolated but deeply interconnected, reinforcing one another and constraining the overall effectiveness of digital innovation efforts.

Furthermore, the study establishes that the impact of digital innovation on research capacity is conditional upon the alignment of technological, organizational, and environmental factors. Institutions that exhibit relative strength across these dimensions tend to perform better in terms



of research output and visibility, while those with systemic weaknesses remain marginalized. This underscores the importance of adopting a holistic, system-level approach rather than fragmented interventions.

Ultimately, the study concludes that strengthening institutional research capacity through digital innovation is not merely a technological issue but a strategic and systemic imperative. For Nigerian public tertiary institutions to compete globally and contribute meaningfully to national development, digital innovation must be embedded within a coordinated framework that integrates infrastructure development, human capital enhancement, effective governance, and supportive policy environments.

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