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Designing, Implementing and Scaling National Digital Talent Pipelines: Lessons from a Multi-Stakeholder Innovation Program in Nigeria

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Abstract*—Skills deficits remain a key constraint to inclusive digital skill development in many emerging economies, with enduring mismatches between supply and demand in national labor markets. How can digital talent pipelines be designed, implemented, and scaled to sustainably meet employer demand, opportunity gaps and fuel digital innovation? Through a mixed-method explanatory case study of Nigeria's largest digital talent program, this paper answers this question empirically by analyzing the design, implementation, and scale-up of a national digital talent pipeline delivered via a multi-stakeholder collaboration (public-private) sector mass training program—the 3 Million Technical Talent Program (3MTT) connecting government entities, private sector actors, training providers, and community networks across Nigeria. Specifically, we study how national digital talent pipelines are designed, implemented, and scaled through cross-sectoral governance arrangements in developing countries. Combining multiple sources of evidence (program documents, stakeholder interviews, administrative datasets, and platform records) across multiple years of implementation (2023-2025), we employ process-tracing logic to identify how combinations of institutional, governance, and coordination mechanisms support an operating model capable of training digital talent at scale and driving innovation within ecosystems. Case study research is an underutilized methodology in digital government research, but is useful for generating rich insights about technology-enabled policy instruments. Rather than asking "does" X work, case studies can be used to explain how (or why) given instruments operate based on evidence from "real world" implementations. Based on these insights, we argue that scalable digital talent pipelines require five mechanisms: adaptive program governance, community-led talent mobilization (peer-to-peer learning model), modular curriculum design aligned to industry needs, project based knowledge application and feedback-driven iteration enabled by digital platforms. Research in this area has important implications for government agencies and development actors working to understand, design, and implement technology-enabled talent pipeline initiatives/workforce development programs in emerging and developing economies. The lessons derived from this research also contribute to theory on national innovation ecosystems by illustrating how cross-sector collaborations between public and private stakeholders can organize and deliver solutions to meet employer demand and skill-based opportunity gaps.

***Keywords*—Digital talent pipeline; Innovation ecosystems; Skills development; Multi-stakeholder collaboration; Digital Transformation; Public–private partnerships; Emerging Technologies.**

I. INTRODUCTION

1.1 The Global Digital Talent Imperative and the Digital Transformation Agenda

The world we live in today in the 21st century has been characterised by a rapid digital transformation affecting economies, governments, and society at large (World Economic Forum, 2025). UNDP in their 2022–2025 Digital Strategy report emphasizes that digital technology has become a fundamental force reshaping economies, governance, and societies in the 21st century, driving a growing global need for digitally skilled workers and inclusive digital ecosystems. This increase in demand for digital talent has transformed workforce development into a national priority. UNESCO's Skills for the Future Platform emphasizes the urgent need to modernize education systems and build digital and future skills that match labour market transformation — underscoring why investing in digital talent development is critical for national competitiveness.

However, there remains a longstanding and growing shortage of digitally skilled workers relative to increasing demand across both public and private sectors. Research from the World Economic Forum (2023) highlights that structural skills shortages reduce productivity, slow the adoption of emerging technologies (such as AI and cloud computing), and hamper national innovation systems. While ET skill shortages threaten industrialized countries' ability to remain competitive; they severely undercut developing and transitioning countries' abilities to innovate for inclusive growth.

1.2 The African Paradox and the Need for Systemic Skills Development

Africa's population trends – also commonly known in the development community as the "youth bulge" or demographic dividend – are characterised by a fast growing youth population. With close to 60 % of Africans below the age of 25 years, Africa has both an opportunity and development challenges ahead (African Development Bank, 2024). In theory, this should have positioned Africa to lead the digital revolution given its population growth but on the flip side, there is a widening gap in youth unemployment while facing an acute shortage of high-end technical skills sought by today's workplace (ILO, 2021). This has led to calls for a broader view on skills development beyond academia and across the entire talent lifecycle including literacy.

Hence the need to think less about siloed training programmes and more towards developing sustainable Innovation ecosystems. There needs to be a strong correlation between skills development and access to jobs/entrepreneurship which can then power a nation's national digital economic engine, also skill development policies need to be scalable and sustainable and part of the national digital strategy. According to Jobtech Alliance's (2025) workforce research, continuous investment in people, especially digital skills development, upskilling and adaptable career pathways — is critical to building resilient workforces and unlocking economic opportunities through technology-led platforms.

1.3 The Policy Response: National Digital Talent Pipelines and Multi-Stakeholder Governance

In developing economies, national efforts to address the digital skills gap have historically been fragmented, lacking continuity as short-term bootcamps or donor-supported pilots that struggle to build institutional legitimacy required for national scale. A global review of digital skills programmes in the Global South found that despite widespread proliferation, evidence of long-term effectiveness in enhancing digital competencies or labour market outcomes is limited, reflecting fragmented efforts that struggle to deliver sustained national impact (Fietz & Lay, 2023). Mergel et al., (2019) research found that existing programmes often lack clear career pathways or don't keep curriculum up to date with industry needs, resulting in little carry-multiplier effect on countries' digital skills capabilities.

This paper posits that national digital talent pipelines can serve as an antidote to fragmentation. Building and maintaining a pipeline requires coordinated policy action across several functions – from talent scouting, to curriculum standardization, certification, recruitment and acceleration. This claim is supported by (OECD, 2019), which argues that responding to digital transformation effectively requires *co-ordinated, cross-sectoral strategy and policy action across education, labour markets, and other functions*. Furthermore, the complex nature of this work requires multi-stakeholder governance and well-resourced public–private partnerships (Ansell & Gash, 2008).

Research findings on collaboration in complex policy spaces has shown that government, business, and civil society must work together to develop policy that is relevant to the needs of each, balance ambiguity, and ensure large enough interventions can be actioned (Klievink et al. 2017). To date, however, there are no on-the-ground examples or quantitative data to show us what successful institutional design elements and working mechanisms look like for continent-wide multi-stakeholder programs.

1.4 The Nigerian Case Study: The 3 Million Technical Talent (3MTT) Programme

Existing literature has mostly remained empirical or theoretical about the subject. To this end, this paper aims to bridge this gap by focusing on arguably Nigeria's most significant digital skills intervention initiative to date—the newly launched 3 Million Technical Talent (3MTT) programme.

Formally commenced in October 2023 by Nigeria's Federal Ministry of Communications, Innovation & Digital Economy. The Ministry set an audacious target of digitally-skilling three million Nigerians in high-demand tech skills such as AI/Machine Learning, Cybersecurity and Software Development. The initiative plans to achieve this through an innovation-driven approach with an overarching aim of making Nigeria a net exporter of digital skills while creating two million digital jobs by 2025.

Aligned to Nigeria's policy-driven development vision, 3MTT adopts a three-phase 1%-10%-100% development model working across a consortium of government ministries, digital skills training providers and corporate entities. Thus, making it a sterling example of a systemic approach to building

an ecosystem through intent-driven public–private partnership, as highlighted by World Economic Forum (2024) research showing how coordinated public–private efforts can develop sustainable talent pipelines and shared solutions for complex challenges such as cybersecurity skills development.

Through its innovative model governance and unmatched scale, the program provides valuable insight into realizing the working concept of Multi-stakeholder collaboration, fast-tracking Digital transformation and strengthening innovation ecosystem.

1.5 Research Questions

This study is guided by the following research questions:

1. How are national Digital talent pipelines designed, implemented, and scaled through Multi-stakeholder collaboration and governance mechanisms in developing economies?
2. What are the key institutional, governance, and coordination mechanisms that enable large-scale Skills development programs, such as the 3MTT, to achieve high participation, retention, and employment outcomes?

1.6 Study Contribution

The qualitative explanatory case study design on which this paper is based, coupled with the triangulation of evidence from multiple sources within the Nigerian 3MTT program allowed this paper to make three contributions to existing literature on National Innovation Systems and digital skills policy: It offered empirically derived insights into the design and implementation of a national digital talent pipeline within Africa's largest economy filling an important contextual/geographic gap in extant literature.

Building on prior research into demand-responsive design principles, it conceptually advances thinking around digital talent initiatives as multi-stakeholder collaboration and governance instruments, NOT simple workforce interventions. Specifically, drawing upon process-tracing logic to distill causal relationships from our findings, we offer complimentary interlocking mechanisms with scalability including adaptive governance models as well as community-led mobilization dynamics.

Provided practitioners and policy makers working within development contexts interested in researching, designing, and/or deploying technology-enabled workforce development programs at scale with Emerging Technologies education-focused mandate(s) with lessons learned and institutional design considerations.

II. LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1 Digital Government Capacity, Emerging Technologies, and National Competitiveness

Today's government functions in a digital world intensified by globalization. Deloitte's *Tech Trends (2025)* report indicates that governments are leveraging emerging technologies to transform operations and improve efficiency, underscoring the strategic importance of digital capabilities within public services. Research shows that states with higher levels of digital transformation across government departments achieve better administrative outcomes when supported by institutional capacity for cross-department coordination, which enables integrated implementation and decision-making (OECD, 2019). In short, digital transformation is the ability for public sector organizations to use digital technologies to achieve policy goals, deliver services, and generate public value.

Capability with emerging technologies plays an important role in strengthening digital transformation efforts. These technologies include, but are not limited to, artificial intelligence, cloud computing, blockchain, and other advanced methods of data processing and analysis, which are increasingly shaping public-sector capability and policy effectiveness (Musoni, 2024). Governments around the world are beginning to adopt new technologies to improve their processes; however, digital capabilities are only as good as people who have the knowledge and skills to use them. Or in other words, technology is only useful to an administration if that administration has the right digital talent who understands the technology in use.

Countries with emerging tech in place still face the issue of not having enough skilled people to actually use the technology they have invested in. A recent blog post from the U.S Department of state analyzed this issue through the lens of competitiveness. Digital

skills have been recognized as a crucial resource to a country's innovation ecosystem. Recent research highlights that digital skills gaps remain a major global challenge, with structural barriers such as outdated curricula, limited access to quality learning, and insufficient industry alignment restricting workforce readiness (Pravin et al., 2025).

2.2 Digital Skills Development and Workforce Transformation in Emerging Economies

Skills have become a prominent topic in recent years. Where once basic ICT literacy was sufficient, research shows that labour markets now demand much more advanced technical competencies including software development, programming, cybersecurity, and data science — as part of digital transformation and employment expectations (Jackman et al., 2021) As such today skills development is increasingly fast-paced to keep up with emerging technologies, requiring reskilling efforts and life-long learning in order to mitigate displacement caused by automation and platformization.

The World Bank, in its 2024 report on "Digital Pathways for Education," explicitly states that many countries "take a fragmented and siloed approach when adopting digital" technologies and skills development programs. This is echoed by the ILO (2021) report, which highlights the need for more integrated and comprehensive national strategies to address the changing demands of the digital economy.

Further supporting the assertion that silos, coordination challenges, and lack of long-term institutional support limit scalability of short-term interventions are reports from the World Bank and European Centre for Development Policy Management. While bootcamp-style programmes and short-term digital skills interventions can create localized benefits, research shows that *broader structural and policy barriers — such as fragmented implementation, weak integration into national curriculum frameworks, and limited formal institutional support — often prevent such initiatives from achieving country-wide or systemic impact* (World Bank et al., 2023; ECDPM, 2024). As such, skills gaps can be reframed as failures of public governance rather than simply educational policy or market failures. Public governance assumes the state must play the role of conductor, coordinating public–private collaboration around training to ensure private sector needs are met and skills development supports skills needs in the public sector.

2.3 National Digital Talent Pipelines as a Strategic Policy Instrument

The notion of a digital talent pipeline offers a unified policy mechanism to overcome the fragmentation of siloed skills programmes. Drawing on systems thinking, such an approach encompasses the full skills lifecycle — from early talent identification and education through competency-based training, certification, deployment, and ongoing upskilling — aligning actions across education, labour markets, and socio-economic ecosystems (OECD, 2019). Applied at a national level, talent pipeline works to formalize processes which match supply in education and labour market demand with the national interest of the state and its digital ambitions. However, (Sacavém et al., 2025) warn that digitization is "not a self-executing process" and that leaders must mold skillsets, behaviors, and readiness throughout the organization to capture value from digital systems.

In line with this OECD (2019) work suggests that governments must move from reactive hiring to strategic talent management and this involves building a "pipeline" to attract, develop, and retain skilled individuals, which is critical for institutional learning and adapting to new challenges like digitalization.

Also worthy to note is that by embedding standardized competencies within quality infrastructure frameworks—such as standards, conformity assessment, and evaluation mechanisms—innovation pipelines help reduce inefficiencies in public investment while strengthening the capacity of innovation ecosystems to adapt to ongoing technological change. These innovation pipelines serve as a critical infrastructure for scaling the adoption of Emerging Technologies across government and the economy. However, as noted in the literature, empirical research on the design and scaling of these pipelines remains scarce, particularly in the African context where institutional and resource constraints are pronounced.

2.4 Multi-Stakeholder Collaboration and Governance for Digital Innovation

The current wave of national digital transformation programs have grown large and complex and

therefore require multi-stakeholder participation as their governance standard (UNESCO, 2025).

The United Nations and the World Summit on the Information Society (WSIS) in their “Tunis Agenda for the Information Society" (2005) report says that governments cannot and should not manage the internet and digital economy by themselves. The private sector, civil society, academia and technical community must be actively engaged to bring legitimacy, effectiveness and innovation.

Multi-stakeholder governance is considered the best practice approach to address issues of great complexity spanning multiple sectors and cross-cutting issues, as well as enabling unleashed innovation. This has been observed in Internet governance, among other fields. When applied to digital talent, it means multi-sector cooperation between four main actor groups:

Table 1: Key Stakeholder Groups and their Roles in Digital Talent Pipeline Programs.

Stakeholder Group	Role in Digital Talent Pipeline
Government/Public Sector	Strategizes, standardizes, funds, scales policy, and drives employment as largest recruiter
Private Sector/Industry	Establishes demand for labor, delivers workforce-ready projects, mentors, places into employment
Educational/Training Providers	Deploys plug and play curriculum, certifies, scales training for Emergent Tech
Community/Civil Society	Connects with outreach, inclusion, enables P2P learning, and gives localized learner support and reinforcements.

Well-managed Public–private partnerships have well-defined coordination mechanisms, common metrics, and flexible management approaches (Ansell & Gash, 2008). They allow for both top-down (ensuring comparability, aggregation) and bottom-up (enhancing fit and legitimacy) decision-making to address the power imbalances and capacity shortages often found in developing countries.

2.5 Community-Led Approaches and the Inclusion Imperative

Studies have found that even when learning takes place digitally, social connection, peer support, and community are essential ingredients to successful learning. This supports notions that community-driven initiatives such as peer mentoring are equally if not more important when it comes to digital skills building.

Topping (2005) provides evidence that peer learning leads to cognitive gains for both the "tutor" and the "tutee." He states that the act of teaching reinforces one's own knowledge, while the learner benefits from receiving instruction from someone who has recently mastered the material. This validates the peer-to-peer model as an effective pedagogical strategy. Community-level organisations and grassroots initiatives play an important role in connecting national strategies with local level implementation. They can reach marginalised groups and ensure equal access to opportunities such as the digital talent pipeline.

This community-led or grassroots programs approach allows for better participation from members of the community as well as create contextualized and sustainable opportunities for skills development through strategies such as peer-to-peer learning and community level mentoring. As these community actors get folded into formal governance and steering structures of national programs, the question then becomes: how can we retain the adaptive and participatory nature of community-led programming while meeting the quality and scalability requirements of a national initiative? Ensuring this is done effectively is essential to ensure national level digital transformation programs help bridge, not widen the digital divide.

2.6 Synthesis and Research Gap

Existing scholarship converges around three propositions: 1. Digital talent matters for digital government capacity building and national competitiveness; 2. Digital talent pipelines are a required policy lever to address fragmentation of silo'd skills development programs, and 3. Multi-stakeholder partnerships and public–private partnerships are required governance models for scaling talent pipelines in Innovation ecosystems.

Yet little work has been done to document first-hand how these leverages work and what institutional design factors drive scalability and success for government sponsored digital talent pipelines in African developing economies. More specifically, what are the actionable tactics for balancing centralization and decentralization for scale with inclusion via community-led models?

Through process-tracing methodology applied to Africa's largest digital talent pipeline initiative to date, Nigeria's 3MTT program, this paper aims to fill that gap and contribute to theory building around successful models for multi-stakeholder governance of digital talent pipelines for sustainable digital government capacity building and resilient innovation ecosystems.

III. RESEARCH METHODOLOGY

3.1 Research Design: Explanatory Case Study and Process-Tracing Logic

A qualitative, explanatory case study design was used for this study. Case studies, specifically explanatory case studies, provide powerful insight into complex causal mechanisms underlying phenomena of interest and are suitable for digital government research. Explanatory case studies are particularly relevant to digital government research given their utility for understanding complicated causal relationships at institutional, technological, and organizational levels (Yin, 2018; George & Bennett, 2005). This approach is particularly well-suited for digital government research, as it allows for an in-depth understanding of the *how* and *why* behind policy outcomes, rather than merely measuring *what* outcomes occurred.

They further explain that these case studies allow researchers to ask how or why programs or policies produced certain results instead of what results programs or policies produced. This study adopts an explanatory case study approach because it seeks to provide empirically based explanations, and institutional design, tailored for policymakers and practitioners.

Process-Tracing Logic guided data collection and analysis for this study. Process-tracing is an analytical method for identifying causal mechanisms within a case study. It allowed the researcher to identify how, in particular the intermediate steps, governance arrangements led from the independent variable (national digital talent pipeline) to the outcome variable (scaled, sustained outcomes). Process tracing was used to analyze how Nigeria scaled its talent development program by understanding the causal mechanism between policy design, institutional alignment, and impact on implementation.

3.2 Case Selection and Context: The Nigerian 3MTT Programme

Case choice rationale

The chosen case was 3 Million Technical Talent (3MTT) Programme Nigeria, a nationally coordinated, government-initiated program delivered through a multi-stakeholder model of innovation. Purposeful sampling criteria was based on three strategic filters aligned to addressing gaps in research identified in Chapter Two:

1. Scale and Scope: The program is national in reach affecting individuals and stakeholders from diverse regions or cohorts. This criterion ensures the study explores scaling processes as well as ripple effects that cut across siloes (system vs. pilot case).
2. Governance/Ecosystem: Program is overtly situated within Nigeria's National Digital transition plan requiring high degrees of Multi-stakeholder interaction between State and non-state actors – chief among them are; Public sector agencies, Private sector ecosystem and implementing partners, Skill providers and communities. This provides needed context to evaluate models of Public–private partnership (PPP) governance.
3. Maturity/Evolution: Ideally the program would have reached end of life, however since the focus is on program governance evolution and adaptation practices we needed a case that has matured past year 1 of implementation (2023-2025).

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This allows for the research to observe governance adaptations that may have occurred during implementation. Analytical Generalization will be used to relate findings from Nigeria's case study to larger theoretical conversations around digital government capacity building, governing innovation, and digital skills amongst developing countries.

3.3 Data Sources and Collection

The research included the following sources for triangulation purposes and credibility: Collected across 2023–2025:

Table 2: Shows Data Sources, Evidence Types and their Purpose in Process-Tracing.

Data Source	Type of Evidence	Purpose in Process-Tracing
Program Documentation	National policy documents, roll-out reports, curriculum design, and program dashboards.	Records "what was supposed to happen". Articulates program's intended design, governance, and theory of change.
Stakeholder Interviews	Interviews with government officials, program managers, training partners, private sector contributors, and community workers.	Records "what happened". Includes implementation experience, why decisions were made, how practices were adapted, and how informal coordination occurred.
Administrative Data	Total participation numbers, completion rates, and pathway progress data (i.e. platform data).	Helps explain the qualitative information, substantiate scaling claims, and offer evidence to measure scale outputs.
Observational Insights	Researcher observations of program events, meetings, and platforms.	Helps explain how the Innovation "day-to-dayed" and the environment in which it operates.

Interviewees granted consent before their interview was taken. Confidentiality was upheld through the anonymization of interviewees and organizations when requested and necessary.

3.4 Data Analysis: Thematic Analysis and Causal Inference

We coded and analyzed the data in several stages using Thematic Analysis methodology alongside process-tracing methodology for causal inference.

1. Stage One: Open Coding/Data Reduction: Our team performed open coding of the interview transcripts and documents to distill emergent themes related to interview questions on pipeline design choices, governance tensions, and scaling strategies. This allowed our team to inductively code for empirical themes that appeared in the data outside of pre-set theoretical constructs.
2. Stage Two: Focused Coding/Theoretical Constructs: We then matched emergent themes to theoretical constructs and concepts described in Chapter Two, such as Digital talent pipeline, Multi-stakeholder collaboration, and Adaptive Governance among others. In other words, we used deductive reasoning to organize our data into higher-order themes/concepts that fit within the scope of the research questions.
3. Stage Three: Process-Tracing: Finally, we traced causal mechanisms by comparing elements of program design as expressed by our interview participants (our sequence of evidence) with expectations set by theory and/or literature on what enables digital programs to scale (our hypothesis). Does the sequence of evidence we observe (e.g. addition of a new governance mechanism) align with the sequence of expected behavior that we would theoretically expect

to see (e.g. adoption of adaptive governance strategies in complex, multi-actor programs)? By iteratively reviewing evidence against theoretical expectations, we can strengthen our inference and identify empirically derived explanations of how the program scaled.

3.5 Trustworthiness and Rigor

Several techniques were applied during the study to enhance its credibility and trustworthiness:

- Data Triangulation: Collecting different types of data (documents, interviews, administrative data) helped to eliminate bias that could arise from relying on a single source of information and allowed for a better understanding of the case as a whole.

- Operationalization and Clarification of Constructs: Constructs that are central to understanding the case such as "digital talent pipeline" and "multi-stakeholder governance" were clearly defined and operationalized via the codebook.

- Thorough Description of Methods: Providing as much detail as possible regarding how data was collected and analyzed allows others to replicate the study and make their own judgments regarding the conclusions.

- Analytical generalization: Finally, by connecting the lessons learned from Nigeria to ongoing theoretical conversations about digital government and innovation systems, the conclusions of this case study should hold true for other developing countries across Africa and beyond.

3.6 Ethical Considerations and Limitations

Ethical aspects were taken into consideration. All students voluntarily agreed to participate in this research, providing informed consent prior to their participation. Confidentiality of all respondents was maintained.

The results of this qualitative case study cannot be generalized beyond this unit of analysis in a statistical sense. In addition, case studies that use stakeholder interviews are often limited by respondent biases when performing process-tracing. Stakeholders may perceive programmatic success differently than what was reported. This shortcoming is overcome by leveraging triangulation as well as objective administrative data.

IV. RESULTS AND DISCUSSIONS

In this chapter, we share our findings from analyzing the case of a national digital talent pipeline built using a multi-stakeholder innovation platform in Nigeria. Our analysis surfaced five (5) interconnected themes describing how the pipeline was architected and scaled efficiently and effectively. These themes are listed below.

- Adaptive governance and institutional anchoring.
- Modular Curriculum Design Aligned to Industry Needs and Talent Pipeline Architecture
- Community-Led Talent Mobilization and Retention at Scale
- Feedback-Driven Iteration Enabled by Digital Platforms

These themes highlight how governance structures and operational mechanisms worked together to drive scalability, sustain continuity, and create public value.

4.1 Adaptive Governance and Institutional Anchoring

One lesson learnt here is the need for flexible governance mechanisms that are anchored on formal public sector organisations. The programme was not run as a stand-alone training program. Instead, it was anchored under the larger national agenda on the digital economy, giving it political will, policy coherence and access to public infrastructure. The government served as a convener here by playing the role of setting goals and agenda, determining who can participate and convening stakeholders to work together.

At the same time, flexible governance mechanisms were employed so that learnings from implementation could be used to adjust some of the decisions taken at the outset. As some of my interviewees noted, if it had been a government-run program with strict control from bureaucracy, it would not have been able to adapt quickly to evolving demands of the job market and technology shifts.

The involvement of multi-stakeholders, including 3MTT program partners (such as Airtel Nigeria,

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MTN Nigeria, IHS, Google, Microsoft, Moniepoint, UNDP, AWS, Huawei), ensured the availability of funding, facilitated joint decision-making, and coordinated activities between public agencies, private sector training providers, and community facilitators. For example, private sector partners contributed technical insights, and guidance on curriculum design, public sector agencies ensured availability of funding, equitable access and inclusion, they all played a central role in aligning program activities with national digital skills objectives, providing mentorship, and monitoring implementation to maximize learning outcomes.

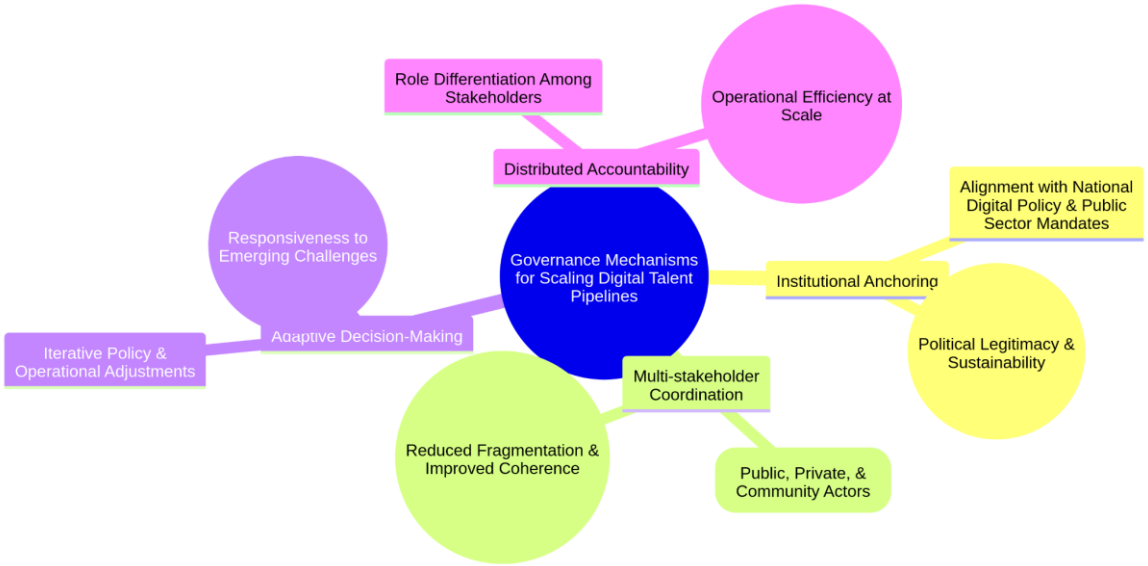

Figure 1. Mapped Governance Mechanisms Supporting Pipeline Scalability

4.2 Modular Curriculum Design Aligned to Industry Needs and Talent Pipeline Architecture.

Modular curriculum design has emerged as a practical approach for addressing evolving needs assessments like digital skills because it enables educational institutions to structure learning into adaptable modules that can integrate emerging digital technologies and competencies efficiently (Arslan et al., 2025). According to the Journal of Curriculum Studies, this type of program structure allows for quicker implementation of new technologies without the need to redesign the entire curriculum. Skills development solutions that are adaptable to evolving industry trends — such as modular curriculum design — align with the World Economic Forum's *Future of Jobs Report 2023*, which highlights the need for responsive reskilling and upskilling strategies to meet rapidly changing labour market demands (World Economic Forum, 2023).

In the case of 3MTT, to solve for scalability and industry fit the team had to make the digital talent pipeline a modular program—not an end-to-end training curriculum. Research on competency-based education indicates that modular and competency-based learning structures enhance workforce readiness and improve outcomes by aligning learning pathways with industry requirements, enabling learners to progress at their own pace and demonstrating competencies that employers value. 3MTT's curriculum was broken up into stand-alone modules focused around each in-demand program—Software Development, Data Analysis & Data Science, Product Design, Product Management, Data Visualization, Animation, Quality Assurance, and AI—allowing possible to move students through the funnel and create "market-ready" talent instead of four year degrees that no longer provide relevancy by the time of graduation.

The pipeline was broken into several logical stages—talent identification & outreach, baseline training, program tracks, assessment & certification, and workforce placement— that could live decentralized across the country but run simultaneously. Literature around vocational education and training has found that modularized curriculum allows providers to pivot more quickly to industry shifts and tailor training content to different regions and circumstances, allowing for a more relevant and transferable curriculum (OECD, 2023). It also allowed for students to enter and exit the pipeline at various stages.

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Table 3 Outlines the Core Pipeline Stages and their Scaling Functions.

Pipeline Stage	Key Activities	Scaling Function
Talent identification	Outreach, screening, onboarding	Broad participation and inclusivity
Foundational training	Core digital skills and literacy	Standardized skill baseline
Specialization tracks	Role-specific technical training	Labor market alignment
Assessment & certification	Competency-based evaluation	Quality assurance
Workforce integration	Internships, placements, projects	Employment and public sector capacity

4.3 Community-Led Talent Mobilization and Retention (Peer-to-Peer Learning)

Fangfang et al., (2024) findings posit that under the digital learning environment, peer interaction among learners is not only playing a crucial role in the construction of their knowledge, but also is a key link to enhance their learning outcome.

Peer interaction within online learning communities has been shown to significantly enhance learner engagement and academic achievement, underscoring the role of collaborative exchange in improving learning outcomes (Lai, Lin, & Tho, 2019). In the field of online learning, specific cognitive activities such as negotiating, arguing, questioning, and providing feedback triggered during interactions have been extensively utilized for a variety of purposes such as improving the quality of students' writing (Noroozi et al., 2018, Latifi et al., 2020).

Empirical studies indicate that strong peer relationships and social support from classmates are linked with higher levels of learning engagement, as students who receive encouragement from peers tend to participate more actively and develop greater confidence in learning activities (Shao & Kang, 2022). A number of empirical studies have shown that online and blended learning programs — which integrate digital tools and adaptive instructional approaches — can enrich educational practice and contribute to improved student achievement outcomes (Getenet et al., 2024; & Uzorka & Odebiyi 2025)

Data backed evidence from these reports suggest P2P learning creates "shared responsibility for growth" that leads to exponentially greater engagement and motivation within digital skills programs. Moreover, other research also found that peer-to-peer (P2P) learning techniques–especially those revolving around technical discussion forums and open-source code sharing–are essential for closing digital skills gaps in emerging markets.

3MTT's fellowship model operates on a similar principle, facilitating grassroots, community-driven expansion through P2P learning. By default, the program groups fellows into home-based learning cohorts which shifts the structure of learning from individual consumption to collective production. Not only does this help overcome the limited number of dedicated instructors in developing markets, it allows more advanced learners to extend the talent pool by elevating others. Within 3MTT, this is achieved by assigning each fellow two roles:

1. Applied Learning Clusters (ALCs)
2. Community Managers.

Within the 3MTT program, ALCs are the nuts and bolts of P2P; they are where peers physically or digitally congregate to work on assignments, troubleshoot code, and learn from each other. This is where the real knowledge reinforcement happens. Community Managers are the birds-eye view support system for these collaborations. They handle the logistics of keeping everything moving along smoothly, keeping morale high, ensuring everyone is following program guidelines, and connecting the distributed fabric of learning cohorts back to program leadership.

4.4 Project-Based Knowledge Application

Education is a dynamic field in which innovative approaches are constantly sought to engage students and foster learning. One such approach is PBL. PBL emphasizes active, hands-on learning experiences that empower students to tackle real-world problems, collaborate with peers, think critically, and develop 21st-century skills (Rehman et al., 2024). PBL learning combines knowledge acquisition with professional development, using real-world problems

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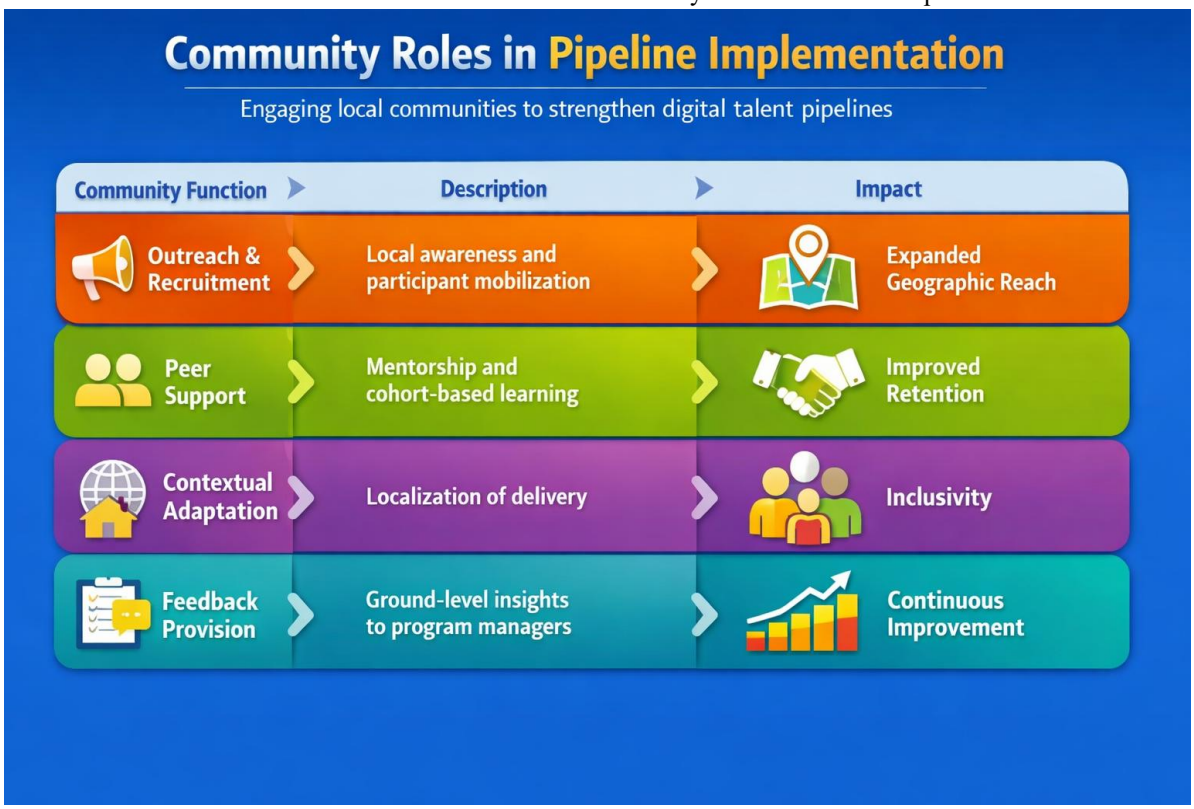
as the foundation for learning. It fosters active, interactive, and collaborative learning (Rehman, *et al.* 2023).

Project-Based Learning (PjBL) is widely recognized as an effective pedagogical approach for developing 21st-century skills, particularly problem-solving, collaboration, and digital competencies required in contemporary technological and economic contexts (Bell, 2010).

Project-based learning environments have been shown to excite students and trigger independent learning. The aim is to have their learning better reflect real life and offer real-world solutions. Studies have shown that PBL helps shape students' cognitive thinking and develop skills needed in today's workforce. Claims have been made that PjBL does a better job at developing student's critical thinking skills and problem-solving abilities than conventional education models across all types of learning institutions. And that by integrating real world case studies and project builds into students' educational journeys, digital talent pipelines can be built in ways that create flexible innovators instead of workers with tunnel vision technical skills.

One of the foundations of the 3MTT model is helping students transition from book knowledge to applying what they know to build. Fellows take the skills they learn and use them to solve real world problems. Many times with a project inside of the 3MTT program itself such as the National Launchpad (also known as Knowledge Showcase) framework which encourages students to practically apply the skills gotten from the program into building solutions to real world problems.

Table 4: Presents the Functions of Community Actors within the Pipeline.



4.5 Feedback-Driven Iteration Enabled by Digital Platforms

The role of digital platforms in enabling adaptive learning and continuous assessment is a major instrument in learning technology trends. AI-powered personalized learning systems, combined with data-driven feedback loops, are increasingly central to managing large-scale talent pipelines, as they enable adaptive learning, continuous monitoring of learner progress, and individualized support across diverse educational contexts (Zawacki-Richter, Marín, Bond, & Gouverneur, 2019). Evidence from curriculum-based studies indicates that formative feedback embedded within learning materials and tools enhances learning outcomes by enabling timely instructional support and promoting learner self-

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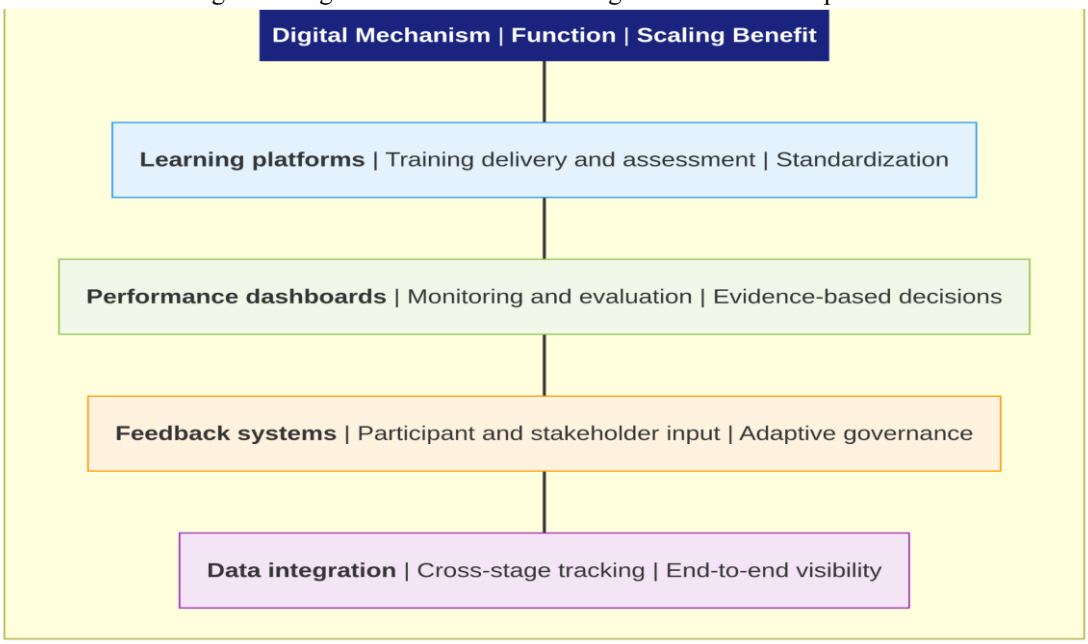
regulation, particularly in digitally mediated learning environments (Putri et al., 2024).

Also within the 3MTT program, robust digital platforms are utilized to facilitate continuous, feedback-driven iteration. This platform serves as a "digital nervous system," collecting real-time data points on fellow progress, engagement, and challenges. This data allows program administrators to make rapid, evidence-based adjustments to the curriculum, delivery methods, and support structures.

Figure 2. Digital Mechanism for Scaling National Talent Pipelines



4.6 Cross-Theme Synthesis

Across the five themes, a key finding is that scaling national digital talent pipelines is less about expanding training volume and more about building governance capacity. Adaptive institutional arrangements, modular design, community engagement, project based application and feedback-driven learning operated as mutually reinforcing mechanisms.

Figure-based conceptualization (presented in the discussion section) illustrates how these mechanisms collectively enabled scale while preserving quality and inclusivity. The findings directly address the research questions by demonstrating how governments can design and scale digital talent pipelines and how multi-stakeholder governance shapes outcomes.

V. DISCUSSION AND POLICY IMPLICATIONS

5.1 Interpreting the Findings through Digital Government Theory

Our research objective was to explore how national digital talent pipelines can be shaped and scaled within multi-stakeholder governance ecosystems. Our research contributes to theory on digital government by evidencing that talent development functions beyond an intervention to "build the workforce." The development of digital talent is intrinsically linked to state capacity and the generation of public value. Consistent with Fountain (2001), these findings underscore that digital transformation is primarily a process of capability building, rather than the simple implementation of technological tools.

Unlike previous literature, we expand on this conclusion by providing empirical examples of how sound governance (vs. fragmented training) informs scale. The four themes of adaptive governance, pipeline modularity, mobilization led by community, and iteration via feedback loops provide a blueprint for governments to act on digital capacity building as an organic system-wide process. This mirrors recent developments in digital-era governance literature which takes precedence over bureaucracy-centered "control" paradigms by emphasizing agility, network governance, and feedback loops to learn and adapt (Dunleavy et al., 2006).

Much of the recent policy and practitioner literature on digital public infrastructure (DPI) aligns with our findings, emphasizing the need to embed governance mechanisms directly into the technical "rails" of digital systems, rather than treating governance as an afterthought (Munga & Sambuli, 2025). In doing so, we begin to shift towards a "techno-legal" mentality at the foundation of DPI to enable trust and long-term viability.

5.2 National Digital Talent Pipelines as Instruments of State Capacity

Society has shifted from an economy based on commodities and manual labor to an economy based on knowledge and highly qualified human capital (Dede, 2010; Jara et al., 2015). Van Laar et al. (2017) examine how digital skills competencies constitute foundational capabilities for workforce readiness and employability in digitally driven economies, with important implications for national economic performance.

Our conclusions also corroborate scholarship on state capacity as well as innovation systems theory by framing the national digital talent pipeline as an institutional capability-building lever. Differentiating our pipeline case from prior narrowly conceived skills programs, our analysis shows how anchoring it within the broader imperative of digital transformation at the national level facilitated alignment across skills development with civil service reform and broader innovation goals. Our insights about pipeline institutionalization also buttress findings in the digital government field about the need to formally align such long-term transformation efforts with public sector missions and reporting lines to ensure durability (Mergel et al., 2019).

Finally, our observations about adaptive program governance call into question prevailing notions of bureaucratic steering. By showing how the central government was able to preserve strategic decision-making authority while distributing implementation across organizations below it, our work provides insight into how governments operating in developing contexts can increase their digital capacity amid uncertainty.

5.3 Multi-Stakeholder Governance and Public Value Creation

These findings also contribute to the theory on collaborative governance. Through an empirical example, this paper contributes to the scholarship on collaborative governance through the lens of public value creation in digital talent formation. Echoing prior work by (Ansell & Gash, 2008), the case demonstrates how bringing together public agencies, private firms, training providers, and community actors behind a shared vision can address fragmentation while increasing relevance and improving prospects for sustainability.

According to Tayanes, Lozarito and Escarlos (2025), education governance is shifting from top-down to stakeholder-oriented models that value multi-actor participation, shared decision-making and co-production processes as means to enhance legitimacy and effectiveness of policies. As we seek to address bottlenecks in the educational pipeline space, we will need to see closer alignment between education and labour-market needs. Such alignment will be particularly critical to managing disruptions from the ongoing digital transformation.

The study goes one step further. It shows that for such collaboration to be sustained at scale, an orchestrating role by the government was required. This mode of governance was neither market-led nor donor-driven. Nor did it fall into the traps of over- or under-inclusiveness. Instead, it struck a balance by bringing stakeholders together and establishing coordinating mechanisms, such as defining clear roles and agreeing to common standards. This finding echoes recent arguments that public value creation through digital government should not be seen as resulting from adopting technology but from effectively governing socio-technical systems.

5.4 Modularity, Adaptation, and Digital-Era Governance

The creation of a standardized yet modular digital talent pipeline speaks to theories of modularization in governance as well as adaptive policymaking. By developing the talent pipeline in modules—or stages that could be individually adjusted without impacting other elements of the program—policy makers were able to scale participant numbers while also retaining quality assurance and adaptability mechanisms. This modular approach speaks to existing literature on digital-era governance, which emphasizes

decoupling and reintegrating services as needed to allow for efficiency and flexibility (Dunleavy et. al., 2006).

Additionally, the employment of digital interfaces for collection of monitoring data and feedback illuminates extant theories on digital government as a learning organization. Real-time performance measurement allowed for adjustments to policy implementation on the fly, embracing learning and iterative change as core components of digital government (Mergel et. al., 2019). Taken together, this supports the proposed characteristics of DPIs as being composed of modular, interoperable components that support digital public services. The emphasis on security and safe exchange of data allow for scalability, inclusion, and longevity (Munga & Sambuli, 2025).

5.5 Community Engagement and Inclusive Digital Government

The emphasis on community-driven mechanisms in our findings underscores that inclusivity is critical for advancing digital government initiatives. Prior research highlights that digital transformation can exacerbate inequalities when marginalized groups are excluded from planning and implementation processes (Heeks, 2018). The case demonstrates how community actors can mitigate these risks by facilitating local engagement, trust-building, and retention.

From a theoretical perspective, this supports arguments that inclusive digital government requires hybrid governance models combining centralized coordination with decentralized participation (Gil-Garcia et al., 2018). Building from this literature, the research highlights how community engagement can be intentionally implemented at a national scale as part of digital talent pipelines instead of being an afterthought. Examples include models for national digital transformation centered around localized solutions, as well as Africa's youth driving digital solutions when given the proper toolkits, resources, and ecosystems to do so (Sang, Munga & Sambuli, 2025).

5.6 Policy Implications

The findings yield several policy-relevant implications for governments and development actors seeking to design and scale national digital talent pipelines.

Table 5: Shows Policy Implications, Strategic Focus and Supporting Theoretical Links

Policy Implication	Rationale and Strategic Focus	Supporting Theoretical Link
Institutionalize as Core Strategy	Digital talent development must be embedded within national digital transformation and state capacity agendas to ensure sustainability, accountability, and strategic alignment.	State Capacity, Institutional Anchoring
Adopt Adaptive Co-Governance Models	Governments must balance strategic oversight with decentralized execution by establishing multi-stakeholder coordination mechanisms that move beyond project-based collaboration to institutionalized co-governance.	Collaborative Governance, Digital-Era Governance
Prioritize Modular and Interoperable Design	A modular pipeline structure enables scalability, standardization of core competencies, and flexibility in delivery, aligning with the principles of Digital Public Infrastructure (DPI).	Modularity, Digital Public Infrastructure
Formally Integrate Community Actors	Community organizations are strategic partners for enhancing inclusion, building local trust, and ensuring	Inclusive Digital Government, Hybrid Governance

Policy Implication	Rationale and Strategic Focus	Supporting Theoretical Link
	retention, particularly in developing localized solutions that leverage youth potential.	
Invest in Data-Driven Feedback Systems	Investments in digital monitoring and evaluation infrastructure are essential for managing complexity at scale, enabling continuous learning, and facilitating evidence-based policy adjustments.	Adaptive Policymaking, Data-Driven Public Management

5.7 Implications for Digital Government Research

This research offers empirical analysis on a topic relatively understudied in the digital government literature: national digital talent pipelines in emerging economies. It shows how qualitative implementation research can also inform theory development on digital capacity-building, governing structures and public value. This research also opens up several possibilities for future research. There is opportunity for quantitative research across countries and mixed-methods research tying governance mechanisms to outcomes over time, especially as new digital government infrastructures (DPIs) are designed.

VI. CONCLUSION AND FUTURE RESEARCH

6.1 Conclusion

The paper investigated how national digital talent pipelines can be architected and scaled through multi-stakeholder innovation programmes in emerging economies, providing empirical evidence from Africa's largest multi-sector government-backed innovation programme. Framed by ongoing crises of digital skills gaps and piecemeal capacity building efforts, this paper proposed digital talent pipelines as governance frameworks that can support state building and the production of public value for the digital age.

Empirical insights showed how four mechanisms interacted to enable at-scale national digital talent pipelines: adaptive institutional governance arrangements, open-ended and industry-aligned pipeline architectures, bottom-up talent elicitation practices and digital-native iteration mechanisms. Instead of approaching digital skills development as siloed training initiatives, we observed how governments orchestrating governance ecosystems can strategically govern demand and supply of digital skills needed to meet national digital innovation and industrialisation goals.

As panelists at the 2025 Trialogue Business in Society Conference stated: Creating an inclusive digital talent pipeline will ensure young people have access to much-needed skills to thrive in Africa's digital economy. Demand-driven digital skills are key to Africa joining the global digital economy.

By grounding these insights in an African context, the study addresses a significant empirical gap in the digital government literature, which remains heavily skewed toward advanced economies. The findings contribute to theory by extending digital-era governance and collaborative governance frameworks to the domain of national digital talent development. For policymakers, the study offers evidence that scalable digital talent pipelines require not only financial investment but also deliberate institutional design and adaptive coordination across public, private, and community actors.

6.2 Theoretical Contributions

This article has three theoretical contributions to the extant literature on digital government. First, it develops our conceptualization of digital talent pipelines as a means of state capacity building. Skills development is thus presented as central, not tangential, to understanding digital government. This is reinforced by the finding that digital leadership and skills are critical mediators for enhancing organizational performance in the public sector (Mergel, Edelmann, & Haug, 2019).

Secondly, this article unpacks, with empirical evidence, how multi-stakeholder governance concretely enables large-scale digital transformation

efforts to endure over time, and the role governments play in 'orchestrating' these arrangements. Bertot, Jaeger, & Grimes (2010) in their reports support this claim by arguing that effective digital transformation requires collaborative governance involving government agencies, NGOs, and citizens, and ties collaboration to legitimacy and improved public policy processes.

Thirdly, it shows how modularity and feedback loops help translate adaptive governance into action. Bodin and Crona (2009) empirically shows how network structures—not just the presence of multiple stakeholders—plays a role in determining whether governance systems can adapt to change. They argue that adaptive governance is strengthened not simply by participation, but by how actors are connected. Well-structured social networks enable information flow, trust, learning, and feedback, which are essential for translating governance intentions into action.

6.3 Policy and Practice Implications

One important lesson from this study for policymakers and development practitioners is on the need for governments and other stakeholders to institutionalize digital talent development as part of the national digital strategy and not treat skill development programs as standalone initiatives. Scaling digital skills development efforts will require national governments to focus on designing effective governance models, coordinating among stakeholders, and building learning systems that are able to provide evidence on what works, in addition to investing in curriculum development and platforms.

Closer collaboration with community-based actors will likely require these informal participants to be given seats at the governance table to promote sustainable, inclusive coordination across geographically fragmented and socio-economically diverse settings. Moreover, national governments might consider viewing digital platforms as more than just service delivery vehicles but governance infrastructures that can be leveraged for monitoring, coordinating, and learning for impact at scale.

6.4 Limitations

The unit of analysis of this study is one national level case–the 3 Million Technical Talent (3MTT) program in Nigeria. There are likely institutional and political differences across African countries (and globally) that may affect the applicability of results. Although this study makes use of analytical generalization by tying findings to theory, future research could employ comparative designs to increase external validity. Furthermore, while this research utilizes qualitative data to better understand implementation dynamics, it does not measure long-term employment or economic outcomes directly.

6.5 Directions for Future Research

Building on these limitations, comparative studies across countries and regions could examine how variations in institutional capacity, political commitment, and labor market structures shape digital talent pipeline outcomes, particularly by integrating quantitative performance metrics with qualitative governance analysis to strengthen understanding of causal relationships between pipeline design and socio-economic impact.

Future research could also explore the long-term effects of national digital talent pipelines on public sector performance, innovation ecosystems, and inclusive growth. Additionally, examining the role of emerging technologies—such as artificial intelligence and data analytics—in enhancing governance and personalization within talent pipelines represents a promising direction for digital government scholarship, especially in the context of Africa's rapidly evolving AI governance landscape (Plantinga et al. 2024).

6.6 Final Remarks

With digital transformation surging across the globe and skills shortages looming large, how countries design and govern national digital talent pipelines will be critical to the public sector's future capability and competitiveness. Based on empirical research, this paper explores how multi-stakeholder adaptive governance can help scale national digital talent pipelines in developing countries. The paper also makes contributions to theory by connecting the dots between practice and debates around how governments can consistently create public value across various institutional environments.

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