



Economic Influences on Digital Migration and the Adoption of the Internet of Things (IoT) in Zambia

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Abstract – This study examines the influence of economic factors on digital migration and IoT adoption in Zambia, using a mixed- methods approach based on secondary quantitative data and qualitative policy analysis. While national initiatives such as the Smart Zambia Programme have advanced foundational digital migration in areas like e-government and broadcasting, persistent economic constraints—including limited public investment, high infrastructure and device costs, unreliable electricity, and pronounced economic inequality—severely restrict the scale, equity, and sustainability of IoT deployment. The findings reveal a strong correlation between economic stability and digital progress, with budgetary fluctuations directly affecting ICT project implementation. IoT adoption remains predominantly at the pilot stage, hindered by high total cost of ownership and inadequate rural connectivity. The analysis further demonstrates how pre-existing socio-economic disparities exacerbate the digital divide, limiting access for low-income and rural populations. The paper concludes that realizing the transformative potential of digital migration and IoT in Zambia requires an integrated policy framework focused on sustained economic investment, targeted affordability measures, rural connectivity treated as public good and concurrent investments in human capital and digital literacy to ensure inclusive development.

Keywords – Digital Migration; Internet of Things (IoT); Digital Economy; Economic Development; Zambia; ICT Infrastructure

I. INTRODUCTION

Digital migration refers to the systematic shift from analog systems to digital platforms for communication, data processing, and service delivery. In developing economies, digital migration is often driven by the need to improve efficiency, transparency, and access to services. The Internet of Things (IoT), involving interconnected devices embedded with sensors and software that collect and exchange data over the internet, has the potential to enhance productivity, reduce costs, and improve decision-making in sectors such as agriculture, health, energy, and transportation. In Zambia, digital transformation efforts are evident in areas such as broadcasting, public service delivery, education management systems, and mobile financial services. Despite these advances, economic limitations continue to affect the depth and sustainability of digital transformation. This study examines how specific economic conditions influence the trajectory of digital migration and IoT deployment in Zambia.

II. LITERATURE REVIEW

Digital Migration in Developing Economies

Digital migration in developing economies is closely tied to economic capacity, particularly the availability of financial resources to invest in infrastructure and skills development. The transition often requires significant upfront capital for network upgrades, consumer education, and the creation of supportive legal ecosystems, posing a substantial challenge for resource- constrained nations. In the Zambian context, digital migration has been evident in areas such as broadcasting, public service delivery, education management systems, and mobile financial services. The mandatory migration from analog to digital terrestrial television (DTT) and the rise of mobile money

platforms exemplify this shift. Despite these advances, economic limitations continue to affect the depth and sustainability of digital transformation, especially in rural areas. The pace of migration has been uneven, often advancing faster in institutional and urban settings while leaving behind community-based and rural applications.

The Internet of Things (IoT) and Economic Development

The Internet of Things (IoT) is a critical component of the digital economy and a catalyst for the Fourth Industrial Revolution, but its adoption is uneven across countries due to differences in economic capacity, technological readiness, and human capital. The full economic value of IoT is realized not just in device connectivity but in the ecosystem it creates—integrating data analytics, cloud computing, and cyber security to generate actionable intelligence. For developing economies, IoT presents a dual challenge: an opportunity for technological leapfrogging and a risk of deepening dependency if core technologies and platforms are externally controlled. In Zambia, IoT applications are emerging in precision agriculture, smart metering for water and electricity, logistics tracking, and remote health monitoring. However, large-scale, commercially sustainable implementation remains limited due to high initial costs, limited and unreliable connectivity, inadequate technical expertise, and a lack of standardized protocols.

Economic Factors Influencing Digital Migration

Economic factors such as GDP growth, government revenue, fiscal stability, and private sector investment strongly influence the scope and speed of digital migration. Countries with stronger and more stable economies are better positioned to finance large-scale broadband infrastructure, data centers, and cybersecurity



systems. Macroeconomic stability is crucial, as it affects a government's ability to secure loans or public-private partnerships (PPPs) for long-term digital projects. Conversely, economic downturns force governments to prioritize immediate social needs over strategic digital investments. In Zambia, fluctuations in economic performance, driven by volatile commodity prices and elevated public debt levels, have directly affected government spending on ICT infrastructure, slowing progress in some digital initiatives outlined in national plans.

Infrastructure Costs and Affordability

Infrastructure development is one of the most expensive components of digital migration, encompassing not only physical hardware but also the soft infrastructure of legal, regulatory, and market systems. The high cost of internet access, digital devices, and electricity remains a major barrier in low- and middle-income countries, creating a "material access" problem. The affordability challenge is typically measured by the ratio of the cost of a basic broadband subscription to average monthly income. In Zambia, while urban centers have seen improvements in network coverage and competition among service providers, internet penetration remains markedly lower in rural areas. This disparity is due to the high capital and operational expenditure for operators to build and maintain networks in low-density, remote regions, coupled with the low purchasing power of the population there.

Economic Inequality and the Digital Divide in Zambia

Economic inequality plays a significant and compounding role in shaping access to and effective use of digital technologies, a concept known as the digital divide. This divide operates on multiple levels: access (first-level), skills and usage (second-level), and outcomes (third-level). Households with higher incomes are not only more likely to afford smartphones, computers, and consistent internet subscriptions but are also better positioned to develop the digital literacy necessary to leverage IoT-enabled devices for economic or social benefit. In Zambia, high poverty levels, particularly in rural provinces, fundamentally limit access to digital services. For populations struggling to meet basic needs, expenditure on data or smart devices is a low priority. This economic reality directly reduces the potential impact and scalability of IoT-driven solutions in critical sectors like agriculture and health.

III. METHODOLOGY

Research Design

The study adopted a pragmatic, mixed-methods research design, combining quantitative analysis of economic and ICT indicators with qualitative policy and document analysis. This convergent parallel design was selected to triangulate findings, thereby providing both breadth and depth of understanding.

Quantitative Component

Secondary quantitative data were collected from international and national sources for the period 2010–2023. Key datasets were sourced from the World Bank's World Development Indicators, the International Telecommunication Union (ITU) ICT Indicators database, and the Zambia Information and Communications Technology Authority (ZICTA) annual sector reports. Indicators analyzed included GDP per capita growth, public and private ICT expenditure as a percentage of GDP, fixed and mobile broadband penetration rates, mobile cellular subscriptions, and the cost of a 1GB data basket as a percentage of gross national income (GNI) per capita. Descriptive and inferential statistical analysis was used to identify significant relationships between economic capacity indicators and levels of digital adoption.

Qualitative Component

The qualitative component employed a systematic document analysis of strategic national policy frameworks and related scholarly and grey literature. A purposive sample of documents included the Seventh National Development Plan (7NDP), the National ICT Policy (2023), the Smart Zambia E-Government Master Plan, the Smart Zambia Strategic Plan, and budgetary speeches from the Ministry of Finance. Published reports from institutions such as the World Bank, UNCTAD, and local think tanks were also reviewed. This analysis followed a thematic coding process to identify recurring themes, gaps, and discursive priorities concerning economic constraints, funding mechanisms, and envisioned pathways for digital transformation.

Integration of Methods

Integration of the quantitative and qualitative strands occurred at the analysis and interpretation stages. Quantitative findings were directly interpreted and explained using qualitative evidence. This explanatory sequential logic strengthened the validity of the conclusions by ensuring that statistical patterns were grounded in the specific economic, institutional, and policy realities of the Zambian context.

Study Area and Sample

The study is a focused, in-depth national case study of the Republic of Zambia. Zambia serves as a critical case due to its status as a lower-middle-income country with clear digital ambitions yet facing pronounced economic volatility. While the primary focus is national, the research includes selective comparative references to peer Sub-Saharan African countries to contextualize Zambia's performance.

Data Collection

Data were collected exclusively through rigorous, desk-based secondary research. A structured protocol was developed to guide the sourcing and selection of materials. Priority was given to recent and authoritative publications



from official government bodies, reputable international organizations, and peer-reviewed academic journals.

Ethical Considerations

As the study relied exclusively on publicly available secondary data and published documents, it did not require ethics review involving human subjects. However, stringent academic ethical principles were upheld. This included the rigorous and systematic citation of all sources to maintain academic integrity. Data were presented objectively, with careful attention to accurately representing the findings and limitations of the original sources.

IV. RESULTS

Economic Capacity and Digital Migration in Zambia

The results indicate a clear, positive correlation between phases of relative economic stability and measurable progress in Zambia's digital migration. Government-led initiatives, particularly under the Smart Zambia Programme, have successfully established foundational e-government platforms. However, this progress is highly dependent on two primary economic factors: the level of annual public investment in ICT infrastructure and the availability of targeted donor or development partner support. Budgetary constraints have resulted in uneven and often delayed funding for critical digital projects. Consequently, while urban centers and government ministries demonstrate improved digital service delivery, nationwide coverage remains inconsistent. Public ICT expenditure as a percentage of GDP has fluctuated between 0.5% and 1.2% over the past decade, falling short of national targets.

IoT Adoption and Economic Constraints

IoT adoption in Zambia is confirmed to be at a nascent, pilot- dominant stage. The findings categorize IoT deployment into three tiers: (1) donor-funded pilot projects, (2) commercial applications within large-scale private enterprises, and (3) isolated, small-scale initiatives. The primary economic constraint identified is the high total cost of ownership, which encompasses not only the initial procurement of sensors and gateways but also recurring expenses for cellular data subscriptions, cloud-based data storage, and specialized technical maintenance. These costs restrict widespread adoption, confining most IoT applications to projects with external funding or clear, short-term return on investment. Scalability is severely constrained by limited access to affordable, long-term financing for SMEs and farmers.

Infrastructure and Cost Barriers

The study identifies a critical dual infrastructure barrier: prohibitively high internet costs and unreliable electricity supply. Quantitative analysis places Zambia's cost for a 1GB mobile data basket above the UN-affordable threshold, with costs significantly higher in rural areas. This directly limits data- intensive IoT applications.

Furthermore, inconsistent grid electricity in peri-urban and rural areas undermines the functionality of always-on IoT devices, necessitating costly solar or battery backups. These barriers are most acute in rural areas, thereby directly contradicting and limiting the potential of IoT solutions specifically designed to address rural challenges.

The Interplay of Inequality and Access

The results further highlight how economic inequality directly maps onto the digital landscape. Disaggregated data on internet penetration and device ownership reveals a pronounced disparity along urban-rural and income lines. High-income urban households demonstrate access patterns and usage similar to global trends, while low-income rural households face a compounded exclusion: they cannot afford devices or data plans, and even if they could, the necessary network quality and reliability are often absent. This socioeconomic filtering effect means that the benefits of digital migration and IoT accrue disproportionately to those already in more advantaged positions.

V. DISCUSSION

The Primacy of Economic Enablers

The analysis confirms that digital migration is not a purely technological shift but a capital-intensive developmental undertaking. Zambia's progress in establishing core e-government platforms during periods of stable investment, contrasted with the stagnation of nationwide broadband rollout during fiscal tightening, underscores this vulnerability. Without sustained and predictable investment in both physical infrastructure and human capital, digital initiatives risk remaining fragmented "islands of automation." The IoT domain magnifies this challenge, as its value proposition hinges on ubiquitous connectivity and data affordability—conditions that are currently unmet for a majority of the population.

Inequality as a Digital Multiplier

A central and concerning insight from this research is the role of pre-existing economic inequality as a multiplier of the digital divide. The findings strongly support the model of the "third- level digital divide," where unequal access translates into unequal outcomes. In the Zambian context, the inability of low- income and rural households to afford devices and data plans, coupled with the market failure in providing infrastructure to low-density areas, systematically excludes them from the benefits of digitalization. This exclusion actively reinforces socioeconomic disadvantages. Therefore, the digital migration process, if not deliberately designed for equity, risks cementing a two-tier society.

Towards an Integrated Policy Framework

Addressing these intertwined challenges necessitates a move from standalone digital strategies to an integrated policy framework that synchronizes economic, industrial, and digital planning. This discussion posits three critical pillars for such a framework:



Affordability by Design: Policy must actively lower the cost of participation through innovative fiscal measures and incentives for locally relevant, low-bandwidth IoT solutions.

Targeted Investment in Rural Connectivity: Treating rural connectivity as a public good is essential, requiring dedicated universal service funds and complementary investments in reliable renewable energy.

Human Capital and Ecosystem Development: Investment must shift to a balanced emphasis on skills and innovation, integrating digital skills into education and supporting local tech entrepreneurship.

VI. CONCLUSIONS

This study concludes that economic factors play a decisive role in shaping digital migration and IoT adoption in Zambia. While notable progress has been made through national digital initiatives, economic constraints continue to limit the scale and impact of these technologies. Sustainable digital migration in Zambia requires increased investment, improved affordability of digital services, and inclusive economic strategies that ensure equitable access to IoT-enabled solutions. Strengthening the digital economy is therefore not only a technological challenge but also an economic imperative.

Author Contributions

Chilufya Alex: Conceptualization, Investigation, Formal Analysis, Writing – Original Draft, Visualization. Dr. Adam Banda: Supervision, Methodology, Validation, Writing – Review & Editing.

Conflicts of Interest

There are no conflicts to declare.

Data Availability

The data that support the findings of this study are derived from publicly available sources. All relevant data and sources are cited within the article and its reference list.

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