

Leveraging Cloud Computing and Artificial Intelligence to Enhance E-Government Services in Developing Countries: Insights from Zambia

Millius Liswaniso¹ and Jameson Mbale²

School of Information and Communications Technology, Department of Computer Science,

Copperbelt University, Zambia

¹Milliusn@gmail.com and ²jameson.mbale@gmail.com

Abstract— the rapid advancement of cloud computing offers a pivotal opportunity to transform e-government services, particularly in developing nations where conventional IT infrastructure often falls short. This study focuses on Zambia, aiming to enhance cloud-based e-government services by addressing key issues such as accessibility, security, and cost efficiency. The research thoroughly examines the primary barriers to effective implementation, including inadequate internet connectivity, data security concerns, and low user trust. Notably, integration challenges are significant, as evidenced by difficulties faced by Zambia’s Ministry of Health with the Smart Care application and the lack of cohesive systems across various departments under the Ministry of Home Affairs—such as the Zambia Police Service, Zambia Correctional Service, Drug Enforcement Commission, Immigration Department, Department of National Registration, and Passport and Citizenship. In response, the study proposes targeted cloud-based strategies to improve service delivery, focusing on scalability, robust data protection, and cost efficiency. Cloud computing can address the unique challenges of e-government in resource-constrained settings. Despite existing integration challenges, the proposed solutions hold promise for significantly enhancing public service efficiency, accessibility, and security, thereby strengthening governance and public trust in the digital age. The findings provide actionable recommendations for policymakers in Zambia and similar developing countries, aiming to create a conducive environment for effective cloud-based e-government implementation. Despite existing integration challenges, the proposed solutions hold promise for significantly enhancing public service efficiency, accessibility, and security, thereby strengthening governance and public trust in the digital age.

Keywords— *Cloud Computing, E-Government Services, Data Security, Developing Countries, Internet Connectivity, Service Integration*

I. INTRODUCTION

In the digital era, cloud computing has emerged as a transformative technology with the potential to revolutionize how governments deliver services to their citizens. As developing countries strive to modernize their public sector operations as highlighted by Mbale Jameson [1], the adoption of cloud-based solutions offers a promising pathway to enhance efficiency, transparency, and accessibility. Zambia, a nation with significant development needs, stands to benefit greatly from the integration of cloud computing into its e-government framework. This report examines the potential of cloud computing to address key challenges faced by Zambia in its pursuit of effective e-government services. Van Staden and Mbale [2] explain that by leveraging the scalability, flexibility, and Cost-efficiency of cloud technology, Zambia can overcome barriers such as inadequate IT infrastructure, limited internet connectivity, and data security concerns. The focus of this study is to explore how cloud computing can be harnessed to improve the delivery of government services, enhance public trust, and facilitate a more integrated digital governance framework. The investigation is driven by the need to understand the current limitations of Zambia’s e-government infrastructure and to propose actionable solutions that align with the country’s unique context. Through a comprehensive analysis of existing challenges and opportunities, this report aims to provide insights and recommendations for policymakers and stakeholders involved in the digital transformation of Zambia’s public sector

A. Background Of the study

Zambia, like many developing nations, is striving to modernize its public service delivery through the adoption of e-government initiatives. However, the country faces significant challenges in this endeavor, including inadequate IT infrastructure, limited internet connectivity, and concerns about data security. These obstacles hinder the effective

implementation of digital government services, which are crucial for improving efficiency, transparency, and accessibility in governance. Cloud computing has emerged as a potential solution to these challenges, offering scalable, cost-effective, and flexible IT resources that can support the expansion of e-government services [3]. Despite its promise, the adoption of cloud-based e-government in Zambia has been slow, due to barriers such as low trust in digital systems, integration difficulties across government departments, and the high cost of reliable internet access.

This study aims to explore how cloud computing can be leveraged to overcome these challenges and enhance e-government services in Zambia. By addressing issues related to accessibility, security, and cost-efficiency, the research seeks to provide actionable insights and recommendations that can help policymakers create a more effective and integrated digital governance framework in the country.

B. Problem Statement

The primary problem addressed in this study is the significant gap between the potential benefits of cloud computing for e-government in Zambia and the current level of adoption and integration of these technologies within the public sector. The issues include inadequate IT infrastructure, poor internet connectivity, data security concerns, and a lack of interoperability between different government departments.

C. Research Objectives and Research Questions the research aims to:

- 1) To Examine and Uncover Key Challenges: Delve into and identify the primary barriers impeding the implementation of cloud-based e-government services in Zambia. This includes investigating issues related to internet connectivity, data security, and integration difficulties among government departments.
- 2) To Design and Propose Scalable Solutions: Develop and propose innovative, scalable, and cost-effective cloud-based solutions that effectively address the identified challenges. The focus will be on significantly improving service delivery, security, and accessibility.
- 3) Formulate Actionable Recommendations: Craft and present actionable recommendations for policymakers and stakeholders to drive the successful adoption and integration of cloud computing within Zambia's e-government framework. These recommendations will be grounded in best practices and insights from existing literature.

To achieve these objectives, the research will address the following questions:

- 1) How can the primary barriers to the implementation of cloud-based e-government services in Zambia be effectively addressed, and what impact do these challenges have on digital governance?
- 2) What scalable and cost-effective cloud-based solutions can be developed to tackle issues related to internet

connectivity, data security, and integration among government departments in Zambia?

- 3) What actionable recommendations can be proposed for policymakers to facilitate the successful adoption and integration of cloud computing in Zambia's government services, and how can these recommendations be effectively implemented?

D. Scope of the Study

This study focuses on the potential of cloud computing to enhance e-government services in Zambia, with a specific emphasis on addressing the challenges of accessibility, security, and cost-efficiency. Johnson & Mille (2020) highlight, that exploring how cloud-based solutions can be implemented across various sectors, including the Ministry of Health and the Ministry of Home Affairs, is crucial.

II. LITERATURE REVIEW

The integration of cloud computing into e-government services presents a significant opportunity for enhancing public service delivery, particularly in developing countries like Zambia. This literature review examines the potential of cloud technology to address challenges such as limited infrastructure, data security concerns, and the need for scalable and cost-effective solutions. By analyzing existing research and case studies, the review aims to highlight both the obstacles and the advantages of cloud adoption in eGovernment, providing a foundation for understanding how these technologies can be effectively implemented in resource-constrained environments

A. Introduction to Cloud Computing in E-Government

Cloud computing has become a transformative technology for e-government services, enabling governments to streamline operations, reduce costs, and improve service delivery. By leveraging the cloud, governments can efficiently store, process, and analyze vast amounts of data, offering a scalable, flexible, and cost-effective solution that enhances the delivery of public services and improves governance, especially in resource-constrained settings [2].

B. Challenges in Cloud Adoption for E-Government

Despite its potential benefits, the adoption of cloud computing in e-government faces several challenges, particularly in developing nations like Zambia [4]:

Inadequate Internet Connectivity: Reliable internet access is essential for effective cloud-based e-government services. However, in many developing countries, internet connectivity remains inconsistent and limited, especially in rural areas, which hampers the widespread adoption of cloud technologies.

Data Security and Privacy Concerns: The transition to cloud computing raises critical issues related to data security and privacy. Governments must ensure that sensitive information

is protected from cyber threats and unauthorized access. In Zambia, where cybersecurity infrastructure is still developing, concerns over data breaches and privacy violations pose significant obstacles to cloud adoption.

Low User Trust and Awareness: Trust in e-government services is crucial for their success. In Zambia, there is often a lack of awareness and understanding of cloud computing among both government officials and the public. This lack of familiarity can lead to skepticism about the reliability and security of cloud-based services, further impeding their adoption.

Integration and Interoperability Issues: Effective government services require seamless integration across various government departments. In Zambia, many government agencies operate in silos, with little to no interoperability between their IT systems, making it difficult to implement cloud-based solutions that require unified data sharing and collaboration.

C. Benefits of Cloud Computing for E-Government

Despite these challenges, cloud computing offers numerous advantages for e-government services [4]:

Scalability and Flexibility: Cloud computing allows governments to scale their IT resources up or down based on demand. This flexibility is particularly beneficial for handling peak usage periods, such as during elections or national emergencies.

Cost Efficiency: Cloud computing has the potential to reduce costs significantly by eliminating the need for expensive physical infrastructure and maintenance. The pay-as-you-go model of cloud services means that governments only pay for the resources they use.

Improved Service Delivery and Accessibility: Cloud computing can enhance the efficiency and accessibility of e-government services. Citizens can access government services anytime, anywhere, with an internet connection. Cloud computing also facilitates the integration of services, leading to more streamlined and user-friendly experiences.

Introspect ability: Cloud computing provides governments with valuable data analytics capabilities, allowing for introspection into system performance, user engagement, and service delivery. This insight enables continuous improvement, helping to identify areas for optimization and better alignment with citizens' needs.

D. Case Studies of Cloud Adoption in E-Government

Several developing countries have successfully implemented cloud computing in their e-government initiatives, providing valuable lessons for Zambia:

● **Kenya:** The Huduma Namba initiative in Kenya serves as a successful example of cloud computing in e-government. Mwangi [5] reports that the initiative has leveraged cloud technology to digitize and unify citizen data across government departments. This integration has improved the efficiency, transparency, and accessibility of public services,

providing valuable insights for Zambia's e-government efforts.[6] ● **India:** India's Aadhaar system exemplifies the potential of cloud computing for large-scale e-government projects. The Aadhaar utilizes cloud technology to manage and authenticate data for over a billion citizens [7]. The system's success demonstrates the capacity of cloud computing to support extensive digital governance initiatives and offers lessons for Zambia in implementing similar solutions

E. Related Works

Several studies and projects offer valuable insights into the adoption and impact of cloud computing in e-government:

Cloud Computing for Public Sector Modernization: A study by Gupta et al.[8] explores how cloud computing can modernize public sector operations by improving service delivery and operational efficiency. The research highlights case studies from various countries, showing how cloud solutions have streamlined government processes and enhanced citizen engagement. **Overcoming Barriers to Cloud Adoption in Developing Countries:** Singh and Rathi [7] examine the barriers to cloud adoption in developing nations, focusing on issues such as infrastructure limitations, regulatory challenges, and skill gaps. The study provides recommendations for overcoming these barriers, which are relevant to Zambia's context.

Best Practices for Cloud-Based E-Government Implementation: Lee and Kim [3] discuss best practices for implementing cloud computing in e-government settings. Their research includes strategies for ensuring data security, managing integration challenges, and enhancing user trust. These practices offer actionable insights for Zambia's e-government initiatives.

III. RESEARCH METHODOLOGY

This study utilizes a mixed-methods approach within an agile framework. Both qualitative and quantitative data were collected from key stakeholders, including government officials, IT experts, and citizens. Data was gathered through MMsurveys, interviews, and case studies from other countries that have successfully implemented cloud computing in e-government services.

A. Data Analysis

Quantitative data was analyzed using descriptive statistics to identify common trends, while qualitative data was examined using thematic analysis. The mixed-methods approach allowed for a comprehensive understanding of the challenges and opportunities associated with cloud computing in Zambia's e-government framework.

B. Results and Discussion

The data collected reveals several key challenges that Zambia faces in adopting cloud computing for e-government:

Limited Infrastructure and High Cost of Internet: Limited infrastructure and high costs of Internet access remain significant barriers to cloud adoption, particularly in rural areas. Mr. Simba Tsiga, a Network Engineer at MTN, explains that some rural areas, such as Nselauke Ward in Kasempa District, are located 12 kilometers from the nearest cellular tower. This distance makes it challenging to integrate facilities like the Nselauke Health Post with the Ministry of Health's systems due to the limited infrastructure and lack of reliable connectivity. The absence of robust communication networks in such regions hinders the effective adoption of cloud-based government services.

Furthermore, the financial burden of securing internet access complicates this scenario. In many rural regions, limited competition among service providers leads to inflated internet service prices [1]. Residents often find it economically challenging to afford even basic connectivity, which exacerbates their exclusion from cloud technologies. This high cost, combined with the lack of robust communication networks, severely restricts the adoption of e-government services, leaving rural populations at a disadvantage in accessing essential resources.

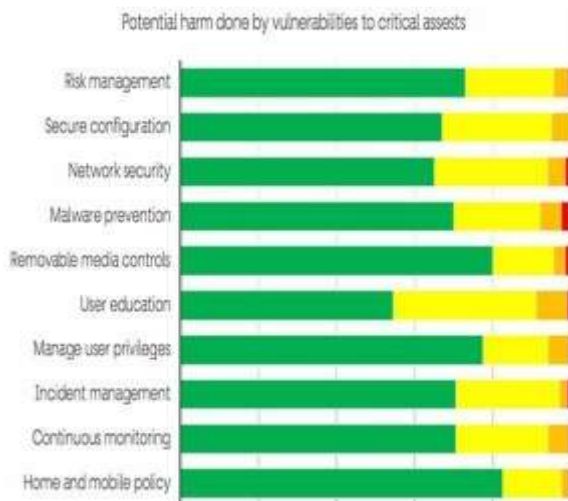
Data Security Concerns: Public sector officials in Zambia are increasingly concerned about data security due to the country's limited cybersecurity infrastructure. With the growing digitization of government services, the potential for cyber threats like data breaches, hacking, and ransomware attacks has escalated. Zambia's cybersecurity framework is still developing, and many public institutions lack advanced security protocols, leaving them vulnerable to attacks.

According to the National Cyber Risk Assessment report for Zambia [9], there are critical concerns about cybersecurity, particularly in essential sectors such as government, healthcare, banking, and energy. These sectors are highly susceptible to malware and phishing attacks, with cyber criminals identified as the primary threat actors. The report highlights several key vulnerabilities, including weak user education, poor malware prevention, inadequate network security, and Figure 22 National Vulnerabilities ZICTA REPORT

Figure 2: National Vulnerabilities ZICTA REPORT

This raises concerns, particularly since it is possible that respondents will not fully acknowledge their vulnerabilities. Analyzing areas outside of the green zones shows that user education, malware prevention, and network security represent the most pressing concerns. Without proper mitigation, these vulnerabilities could lead to severe consequences, such as data breaches, service disruptions, and significant financial losses. For instance, a major cyberattack could result in GDP losses of up to 12.17%, potentially destabilizing the economy. Moreover, an attack on one sector could have cascading effects on others, jeopardizing critical infrastructure nationwide. The report underscores the urgent

need to address these cybersecurity weaknesses to prevent



long-term damage to Zambia's economy, national security, and public trust. Sector could trigger cascading impacts on others, affecting critical infrastructure nationwide. The report stresses the urgent need to address these cybersecurity weaknesses to prevent long-term damage to Zambia's economy, national security, and public trust.

Interoperability Issues: The Zambian government faces significant challenges related to interoperability across its departments, as many of them function in isolated silos. This organizational fragmentation hampers the sharing and integration of critical data between agencies, leading to inefficiencies in public service delivery and decision-making processes. Each department typically operates its own system with little compatibility, resulting in duplication of efforts, delays, and fragmented datasets. For example, while one department may collect data that could benefit another, this information remains Framework" developed for the Ministry of Health also highlights the need for collaborative structures, data governance models, and open standards to facilitate interoperability. Ineffective incident management. Furthermore, when examining Zambia's National Critical Infrastructure (CII) through the lens of the UK's National Cyber Security Centre's "10 Steps to Cyber Security," it becomes clear that without effective defenses to address these vulnerabilities, critical assets remain at risk. At first glance, CII-owning organizations appear to see few significant vulnerabilities; however, red and orange indicators reveal notable weaknesses in their security controls as shown in the image below. Inaccessible due to a lack of standardized systems, which ultimately slows down government operations and hinders effective policy planning. The issue is further compounded by the absence of standardized data formats and incompatible software systems, as well as the lack of a centralized platform for real-time communication and data exchange between departments. Decision-makers are often left with incomplete or outdated information, making it

difficult to address urgent national needs and coordinate nationwide

Furthermore, fostering a culture of collaboration among government departments and prioritizing digital transformation initiatives will be crucial for breaking down these silos and improving governance. By resolving these challenges, the government can enhance its ability to respond swiftly to national crises, streamline administrative processes, and offer better services to its citizens.

Interoperability Architectural Framework for the Zambian Ministry of Health

To appreciate how far Zambia has come in resolving issues, I took the time to look at and appreciate the Interoperability Architectural Framework for the Zambian Ministry of Health.

Interoperability Architectural Framework for the Zambian Ministry of Health offers a comprehensive blueprint for addressing the interoperability challenges specific to the health sector. As represented in the visual model, the framework integrates various components of the healthcare system—ranging from hospitals and clinics to laboratories, pharmaceutical services, and emergency medical services—into a single, interoperable ecosystem according to the Ministry Of Health Report [10] .

The framework emphasizes the importance of seamless data exchange and real-time communication across all levels of the healthcare system. Key icons in the visual representation include hospitals, doctors, emergency services (represented by ambulances), and medical research institutions (symbolized by microscopes). These components illustrate the critical need for healthcare providers to access comprehensive patient records, diagnostic information, and treatment histories in a timely manner. Through such integration, doctors and healthcare workers can deliver more accurate diagnoses and offer more effective treatment plans, reducing redundancies and errors in patient care.

A critical feature of this architectural framework is centralized data storage, depicted by a database/server icon. Centralized storage enables secure data exchange between healthcare institutions, which helps reduce data fragmentation, ensures data consistency, and enables the retrieval of essential patient records when needed. This element is especially important for national health initiatives, such as monitoring disease outbreaks or implementing nationwide vaccination programs, which require the Coordination of various stakeholders. Strategies for overcoming challenges to overcome these challenges, several strategies are recommended:

Enhancing Internet Infrastructure: To address Zambia's challenges in expanding Internet infrastructure, particularly in rural areas, public-private partnerships (PPPs) have emerged as a vital strategy. These collaborations enable the government to leverage the expertise, technology, and resources of the private sector, accelerating the deployment of

mobile towers, fiber-optic networks, and satellite-based solutions. By fostering such partnerships, Zambia aims to enhance connectivity, ultimately bridging the digital divide and promoting economic growth (Presidential Delivery Unit Zambia).

Significant strides have already been made through initiatives like MTN's partnership with Huawei, which successfully launched Zambia's first 5G network in 2022. This groundbreaking development not only boosts internet accessibility in urban and peri-urban regions but also catalyzes further technological advancements (Open Zambia). Moreover, the introduction of Starlink's satellite-based internet service in October 2022 has proven particularly effective in extending connectivity to rural and underserved areas, where traditional infrastructure often falls short (Presidential Delivery Unit Zambia). These initiatives illustrate how innovative solutions can overcome geographic and logistical barriers to access.

Liquid Telecom also plays a crucial role in Zambia's efforts to improve digital infrastructure. By providing free internet connectivity to 450 technical schools and planning to expand this initiative to over 1,200 secondary schools nationwide, Liquid Telecom is actively contributing to the government's broader agenda of enhancing digital inclusion (Open Zambia). Such initiatives not only support educational development but also empower future generations with the skills needed to thrive in an increasingly digital world [11]. Furthermore, the recent agreement between Zambia and Malawi to establish the Diplomatic Data Corridor aims to reduce data costs and improve regional connectivity, highlighting the importance of cross-border collaboration in enhancing internet access (Presidential Delivery Unit Zambia).

These public-private partnerships are instrumental in helping Zambia Bridge the digital divide. By expanding internet infrastructure, reducing costs, and ensuring more inclusive access, they contribute to the country's overall socioeconomic development. Continued investment in these areas will be critical for achieving the government's ambitious target of 80% internet access by 2026. The successful implementation of these strategies will not only improve connectivity but also foster innovation, create job opportunities, and enhance the quality of life for all Zambians (Open Zambia). Utilizing Cheaper Internet Options: The Role of Star Link. In the pursuit of expanding internet access in Zambia, particularly in rural and underserved areas, exploring cheaper internet options is essential. One such innovative solution is Starlink, a satellite-based internet service developed by SpaceX. Launched in October 2022, Starlink aims to provide high-speed internet access in regions where traditional infrastructure is lacking or economically unfeasible [12].

Starlink's technology allows it to deliver internet connectivity via a constellation of low Earth orbit (LEO) satellites. This enables it to reach remote areas that are often bypassed by conventional broadband providers. By offering competitive pricing and reliable service, Starlink can significantly reduce

the cost barriers associated with internet access for many Zambians. The introduction of this service has the potential to transform the landscape of connectivity, providing students, businesses, and communities with essential online resources and opportunities.

Moreover, as the Zambian government aims for 80% internet access by 2026, leveraging affordable options like Starlink is crucial. Partnerships with satellite providers can help the government meet its connectivity goals while ensuring that internet services are accessible to all, regardless of geographical location. By incorporating these cheaper internet solutions into its broader strategy, Zambia can enhance digital inclusion and drive socio-economic development across the nation.

As Zambia continues to explore innovative approaches to connectivity, it is essential to prioritize cost-effectively Solutions that empower individuals and communities. Starlink represents one such opportunity, promising to bridge the digital divide and foster a more connected society.

Strengthening Cybersecurity in Zambia: Implementing strong cybersecurity measures is critical for the successful adoption of cloud-based systems, particularly within the public sector. As digital transformation accelerates, the Zambian government must prioritize data protection through encryption technologies that secure sensitive information, such as personal records and national databases, both in storage and transmission. Multi-factor authentication (MFA) is also essential in securing access to these systems, especially given the increasing cyber threats that target government institutions. By enforcing these measures, Zambia can build public trust in its e-government platforms, such as the Zambia Integrated Land Management and Information System (ZILMIS) and other initiatives aimed at improving service delivery.

Furthermore, Zambia must continuously update its cybersecurity frameworks and policies to address emerging risks. Initiatives like the Zambia Cybersecurity and Cyber Crimes Act of 2021 provide a legal foundation for prosecuting cybercrime and setting up regulatory guidelines, but the country also needs to invest in capacity-building for government IT personnel. Training them to respond to cyber threats and deploying advanced threat detection systems are steps toward protecting Zambia's critical infrastructure and data integrity.

Improving Interoperability in Zambia: Interoperability is vital for enhancing the effectiveness of Zambia's e-government services, such as the Smart Zambia initiative. By developing standardized data exchange protocols and platforms, the government can enable different ministries and departments to share and integrate data more efficiently. For instance, interoperability could allow systems from the Ministry of Health to seamlessly share patient data with the National

Registration, Passport, and Citizenship Department, improving the delivery of public health services. This type of integration could accelerate initiatives such as the electronic health records system (EHR), making healthcare more responsive to the needs of citizens.

For Zambia to realize the full potential of cloud-based systems, it needs to adopt open standards, enabling different technologies and platforms to work together. Collaborative efforts between the Zambian Information and Communications Technology Authority (ZICTA) and the private sector will also be crucial. Additionally, Zambia must focus on building a strong digital infrastructure by ensuring that all government systems follow a unified architecture. This will eliminate data silos, improve coordination across departments, and ultimately lead to more transparent, efficient, and accessible public services.

IV. CONCLUSION

Cloud computing offers Zambia a powerful tool to modernize its public service delivery system. However, addressing key challenges like internet connectivity, data security, and integration will be critical to its success. By adopting the recommended strategies, Zambia can leverage cloud computing to improve the efficiency, transparency, and accessibility of e-government services, ultimately enhancing the quality of life for its citizens.

References

- [1]. Jameson, Mbale, Van, and Staden, "Interoperability governance model (IGM): Envisages areas of activities and relationships to establish information interoperability within Government," vol. 9, pp. 1252–1257, 2012.
- [2]. S. Van Staden and J. Mbale, "The information systems interoperability maturity model (ISIMM): Towards standardizing technical interoperability and government," *Int. J. Inf.*
- [3]. *Eng. Electron. Bus.*, vol. 4, no. 5, pp. 36–41, Oct. 2012.
- [4]. T. Almarabeh, Y. K. Majdalawi, and H. Mohammad, "Cloud computing of eGovernment" *Commun. Netw.*, vol. 08, no. 01, pp. 1–8, 2016. [4] V. Weerakkody, Y. Dwivedi, L. Brooks, M. Williams, and A. Mwangi, "E-government implementation in Zambia: Contributing factors," *E-Gnos.*, vol. 4, pp. 484–508, Jan. 2007.
- [5]. "HUDUMAKENYADIGITALIZATIONPLAN- V1.5.1."
- [6]. "Implementing-Huduma-Namba-Report- 22.10.2020."
- [7]. Nilekani, "India's aadhaar system: Bringing Egovernment to life." Available:<https://www.chandlerinstitute.org/governancematters/indias-aadhaar-system-bringing-egovernmentto-life>. [Accessed: Sep. 23, 2024] [8] cloud computing-in-the-public-sector-final-25052017_V03."
- [9] W. Z. Zm, "National Cyber Risk Assessment Report."