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Enhancing Zambia's Health Information System: Opportunities for Digitalization to Achieve Better Health Outcomes

Celia Tusiime
School of Public Health, Texila American University/UCN, Zambia

Abstract

The Ministry of Health (MoH) in Zambia has introduced several strategic initiatives aimed at improving the Health Information System (HIS) by integrating digital technologies. These five-year strategies include the Digital Health Strategy, Health Information Systems Strategy, and Interoperability Architectural Framework, which are aligned with Zambia's e-Government Master Plan (2018-2030). The study investigates how digital technologies can enhance HIS, focusing on improving efficiency, accessibility, and accuracy of health data. A mixed-methods approach was used, involving a secondary review of existing strategies and publications, alongside interviews and focus group discussions with key stakeholders. The research also examined the digital evolution and interoperability of Zambia's HIS, with a particular focus on 10 health information systems. The study reveals that there are more than 14 existing information systems in Zambia. The MoH is transitioning from paper-based systems to electronic health records to allow health facilities to digitally capture and store patient data. The national health management information system uses the District Information System 2 (DHIS2) as its underlying database for collecting, managing, and analysing health data across various levels of the health system. Key elements such as sustainable financing, coordination between the key directorates within the MoH and enhanced capacity in data science, data analytics, and informatics will be key in driving this digital transformation. The study concludes that implementation of these strategies is crucial to achieve a stronger HIS to improve data quality and support evidence-based planning and decision-making, thus promoting efficiency and equity in healthcare delivery to achieve better health outcomes.

Keywords: *Digital Health, Health Information Systems.*

Introduction

A health information system (HIS) refers to a system designed to manage healthcare data [[1]]. The World Health Organization lists the HIS as one of the six building blocks essential for health system strengthening. The HIS collects data from the health sector and other relevant sectors, analyses the data and ensures their overall quality, relevance and timeliness, and converts data into information for health-related decision-making [[2]]. This includes systems that collect, store, manage and transmit a patient's electronic medical record, a hospital's operational management or a system supporting healthcare policy decisions.

In recent years, national governments have faced growing pressure to leverage advancements in technology, internet access, and data management methods to enhance health service delivery. The MoH in Zambia developed key strategies aimed at transforming the HIS. These strategies will enable the HIS to fully capitalize on technological advancements, modernize data collection, ensure equitable data access, and offer appropriate analytical tools for use by local communities and health facilities. The HIS in Zambia is undergoing a

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****Corresponding Author: cktusiime@gmail.com***

significant transition from paper-based and aggregate information systems to a modernized digital HIS, enhancing patient care in a decentralized setting. Health data can guide the development and focus of national and regional health initiatives, promoting health equity and advancing universal health coverage.

Problem Statement

The need to track individual patients has significantly strained traditionally vertical, program-focused information systems, pushing them to share data across isolated systems that were originally designed as standalone systems. At the Zambia MoH technical level, there is inadequate coordination between the Monitoring and Evaluation (M&E) unit and the Information, Communication and Technology (ICT) Directorate. The M&E technical working group which is supposed to be the coordination mechanism for HIS development in Zambia has not been fully functional [[3]]. This has led to inefficient donor and partner coordination, resulting in duplicated efforts and ineffective use of available resources. In addition, the unclear distinction between the roles of the ICT Directorate and M&E functions has led to parallel system development and inadequate coordination of efforts. Consequently, the MoH did not implement the HIS Strategy for 2009-2015, leading to the emergence of parallel systems. However, with partner support, the MoH developed the HIS Strategy (2022-2026) in 2024, though delayed, as the previous strategy only covered the period until 2015. There remains uncertainty about whether the MoH will fully implement the new HIS strategy, particularly if donor support is inconsistent or fails to materialize.

Purpose and Objectives

The purpose of this study was to explore how digital technologies can enhance the HIS, including data collection, processing, and management, to improve the efficiency, accessibility, and accuracy of health data. The aim is to improve the efficiency of healthcare delivery and support better health outcomes across the country.

Objectives

1. Assess the existing health information systems in Zambia, focusing on digitization, interoperability, and data management practices.
2. Investigate how digital technologies can be leveraged to modernize data collection, management, and reporting processes within the health sector.

Achievements

Over the years, the MoH has consistently utilised the DHIS2 as part of the health management information system. DHIS2 is a tool/database for the collection, validation, analysis, and presentation of aggregate and patient-based statistical data, tailored to integrated health information management activities [[4]]. DHIS2 is utilized at the facility, district, provincial, and national levels. While overall data quality has improved due to better completeness and enhanced management of the DHIS2 database, there remains room for further improvement.

In 2024, the MoH launched a comprehensive Digital Health Strategy designed to revolutionize the integration of key technologies in Zambia's healthcare system. The strategy aims to enhance data quality for decision-making and planning, while also strengthening various functions such as health supply chains, logistics, management, and research capabilities [[5]]. The MoH acknowledges that digitalization is a crucial driver for enhancing various aspects of the health system, including improving patient care, disease surveillance, and program monitoring as well as offering e-learning for healthcare workers, ultimately boosting the efficiency of health service delivery.

The MoH in Zambia recently developed a comprehensive HIS Strategy, aimed at ensuring

the efficient and cost-effective generation of quality data by leveraging ongoing digitization efforts within the MoH and across other government departments [[6]]. The MoH has reaffirmed its commitment to high-quality data by prioritizing health information in the National Health Strategic Plan (2022-2026). The HIS Strategy reinforces this priority, providing a roadmap for the continued advancement of information systems in the health sector.

With the establishment of the national data warehouse as a central repository for health data from various sources and systems, a more robust approach to data accuracy is essential. This approach requires all technologies in the health sector to communicate effectively, ensuring more accurate information to support decision-making at all levels. For the first time, the Zambia MoH has developed a comprehensive Interoperability Architectural Framework (IAF), outlining principles and guidelines to help design and implement systems and processes that enable seamless information exchange [[7]]. Implementation of components of the IAF commenced in 2024 with support from MoH partners.

In 2024, the MoH developed integrated guidelines to enhance health system performance across health facilities, management units, and training institutions. These guidelines for supportive supervision highlight the MoH's strong emphasis on the crucial role that implementing units, and their supervisors play in selecting the most effective interventions to address health challenges [[8]]. The guidelines are designed to streamline processes for accessing, analysing, and planning for health services by replacing paper-based tools with web-based solutions. The digitization of the web-based performance assessment was implemented to provide a simpler and more informative method for conducting assessments and enabling easy performance comparisons across different periods. Transitioning from electronic to web-based systems has also reduced the costs of conducting assessments by eliminating the need for printing paper-based tools used in the previous system. The guidelines are currently being implemented across all 10 provinces of Zambia.

Limitations

This study highlighted system interoperability as a key issue, however, it may not fully capture the complex technical, political, and institutional barriers involved, especially without in-depth technical evaluations. During the secondary review, the types of documents available were mainly government reports and publications, this may present a more optimistic view of the existing health information system, while independent studies may reveal different shortcomings or areas for improvement. However, some of the strategies were developed by MoH with significant input from partners and focus group discussions were conducted with independent digital partners, hence mitigating this limitation.

Materials and Methods

The study employed a combination of secondary review, key informant interviews, and focus group discussions. It involved analysing strategies, articles, and publications related to Zambia's HIS, as well as the evolution of digitalization, system interoperability, and data utilization systems. Twelve (12) key informant interviews were conducted with MoH ICT and Monitoring & Evaluation staff at the national level, along with Senior Information Officers at the provincial level. Additionally, two focus group discussions of 6 people each were conducted with independent stakeholders from Zambia's digital health sector. The data collection process excluded outdated sources, including articles or publications that are irrelevant to current digital health developments in Zambia, as they may not reflect the latest advancements in

technology, policy, or system interoperability. Additionally, focus group participants with limited expertise in digital health were excluded, as they were unlikely to provide valuable insights into technical challenges.

Results

Current Health Information Systems in Zambia with a Focus on Digitalization

The HIS in Zambia has evolved to effectively utilize data from patient-based information systems, enabling a diverse range of users to make evidence-based decisions that improve health services. With the development and launch of the Digital Health Strategy and the HIS Strategy, the integration of essential technologies in Zambia's healthcare system has revolutionised to improve data quality for informed decision-making and planning. Implementation of the HIS strategy will result in efficient and effective systems for data collection, analysis, and management while promoting interoperability and data utilization to enhance health outcomes nationwide.

There are more than ten existing information systems in Zambia, including various platforms for financial management, logistics, and program-specific systems, particularly for malaria and HIV. However, this study assessed 10 health information systems, out of which 4 are using DHIS2 as the underlying database. DHIS2 is a comprehensive free, open-source platform for collecting, visualizing and sharing health data [[9]]. It functions across various device types, including desktops, laptops, tablets, smartphones, and feature phones. DHIS2 also supports system integration and interoperability. All the assessed systems presented in table 1 below are digitalized, although not all of them have the potential for interoperability.

Table 1. Selected Health Information Systems in Zambia

SN	Existing Systems	Definition and Use
1.	Integrated National Health Management Information System (iNHMIS)	Digital platform designed to streamline and integrate various health information systems. It supports the collection, management and analysis of health data. Facilitates interoperability. Uses DHIS2 as the underlying database.
2.	Data for Accountability, Transparency, and Impact Monitoring (DATIM)	Online platform used for monitoring and reporting on HIV/AIDS programs, particularly those funded by the U.S. President's Emergency Plan for AIDS Relief (PEPFAR). Facilitates interoperability. Uses DHIS2 as the underlying database.
3.	Malaria Rapid Reporting System (MRRS)	A digital system that enables health facilities to report malaria cases and related data quickly and efficiently through mobile and web-based platforms. Uses DHIS2 as the underlying database.
4.	National Health Surveillance System	An electronic system that leverages digital technologies to collect, analyse, and share real-time data on disease outbreaks, monitoring disease trends and prompt response. It facilitates interoperability. Uses DHIS2 as the underlying database.
5.	SmartCare	Electronic health record systems are designed to manage patient health information across various healthcare facilities. Supports PEPFAR reporting. Allows data exchange between healthcare facilities and is interoperable with the National Data Warehouse.
6.	Electronic Logistics Management System (eLMIS)	Web-based platform designed to manage and streamline the supply chain for health commodities. It facilitates real-time tracking of

		inventory, orders, and shipments across various levels of the health system, from the national warehouse to local health facilities.
7.	DISA Labaratory System	Digital platform used to manage laboratory operations, data, and workflows across various health facilities. LIMS supports the management of laboratory samples, patient information, test results, and laboratory resources.
8.	Logistimo	Cloud-based supply chain management platform designed to enhance the efficiency and visibility of supply chains. It is used for managing inventory, tracking shipments, and facilitating the distribution of vaccines, and essential commodities.
9.	Human Resource Information Management System (HRIS)	Digital platform used to manage and streamline various human resource (HR) functions. Supports MoH in managing its workforce effectively and efficiently.
10.	National Data Warehouse (NDW)	Centralized digital platform designed to aggregate and store health-related data from various health information systems. It is designed to be interoperable with various digital health systems, ensuring that data from different platforms can be standardized and consolidated for comprehensive analysis.

Leveraging Digital Technologies to Modernize Data Collection, Management, and Reporting Processes within the Health Sector in Zambia

Digitization can enhance health programs in several aspects, including:

1. Providing complete and detailed client records that contribute to higher-quality patient care.
2. Increasing accountability and improving decision-making and service delivery efficiency through high-quality data.
3. Enhancing patient management, service delivery, and overall program performance

A growing global movement involves integrating Electronic Health Records (EHRs) in existing health information infrastructures, often at a national level, through health information exchanges. While EHRs have traditionally been designed as organization-specific systems, new integration methods are emerging that challenge this model. The WHO supports a platform-based approach to health systems, promoting integration by establishing a national infrastructure that consolidates health and social care information in a unified system [[10]]. To fully harness the potential of digital health applications and services, the MoH should strengthen its leadership and coordination efforts to ensure that all applications comply with a standardized set of requirements before deployment.

Integrated digital platforms such as the iNHMIS have modernized data collection, management, and reporting processes within Zambia's health sector in several ways: centralized data management; automated data collection: real-time reporting; enhanced analytics, reporting, improved communication and interoperability. Zambia utilizes DHIS2 as part of the national HMIS for collecting, managing, and analysing health data across various levels of the health system. Health Information Aggregate (HIA) tools are integrated into the DHIS2 platform to facilitate the collection and reporting of aggregate data at both district and national levels. The Zambia MoH is transitioning from paper-based systems to EHRs to allow health facilities to digitally capture and store patient data using the DHIS2 platform. In some of the health facilities, data entry is done at the facility level using the DHIS2 system and it is aggregated at the

district, provincial and national level. The HMIS monitors timely reporting, with a national target of 95%. Some of the provinces conducting facility-level data entry have on average successfully met this target, as illustrated in Table 2 [[11]].

Table 2. Percentage of Districts in Central, Luapula, Northern and Copperbelt Provinces Reporting Timely Using HIA Tools in DHIS2 During the Last Twelve Months (September 2023 to August 2024)

Report Type	Fiscal Year 2024 (FY24) Quarter 1	FY24 Quarter 2	FY24 Quarter 3	FY24 Quarter 4
Health Information Aggregation Form – Disease Health Centre (HIA1A)	92.6%	94.5%	97.1%	98.0%
Health Information Aggregation Form – Disease Hospital (HIA1B)	72.8%	83.2%	87.4%	87.9%
Health Information Aggregation Form – Service Delivery Health Centre (HIA2)	91.7%	93.5%	94.9%	95.4%
Health Information Aggregation Form – Service Delivery Hospital (HIA3)	78.5%	86.1%	88.0%	93.0%

The SmartCare system initiated by Centre for Disease Control and Prevention also serves as a comprehensive EHR system for multiple programs such as antenatal care, delivery, postnatal, antiretroviral therapy (ART) and paediatric ART, in support of continuity of care. SmartCare Pro is an electronic EHR system used in Zambia's healthcare facilities implemented by the MoH, Smart Zambia Institute and other stakeholders [[12]]. The system improves data accuracy, accessibility, and reporting timeliness availing data for planning and decision-making in real time. "*The SmartCare Pro electronic system has revolutionized healthcare services, enhancing service delivery and offering significant improvements over the paper-based system. It enables patients to receive timely and efficient care," Ms Siachiwena, Public Relations Officer, Levy Mwanawasa University Teaching Hospital, Lusaka.*

The National Health Surveillance System has modernized Zambia's health sector by enabling real-time, accurate, and comprehensive data collection, management, and reporting of public health emergencies. This system is used by the Zambia Public Health Institute and has supported digitization of data collection; real-time data reporting; comprehensive disease surveillance; centralized data management; data standardization and enhanced data analysis and reporting [[13]]. It has strengthened disease surveillance, improved health service delivery, and supported data-driven decision-making, which ultimately contributes to better public health outcomes across the country.

The COVID-19 pandemic demonstrated the importance of real-time data for informing public health policy decisions and interventions. In response to COVID-19, DHIS2 released a digital data package (tracker) to accelerate case detection, situation reporting, active surveillance and response for COVID-19. The tracker applications support surveillance workflows for active surveillance. To address COVID-19 data needs in Zambia, the MoH customized the COVID-19 laboratory request form using the DHIS2 Tracker Capture App. The customization included all other data

requirements as follows: linking the COVID-19 DHIS2 system to MoH HMIS; strengthening DHIS2 linkages with lab systems such as DISA; harmonization of COVID-19 data by pulling all historical data existing in KOBO Collect and Excel into the DHIS2 System; providing tablets for data entry and training of health workers to use DHIS2 tracker for data reporting. The routine analysis of data helped to understand the disease burden and inform the timely deployment of targeted interventions. Through the implementation of this system, the MoH ensured that stakeholders could track the status towards the required 70 percent head immunity [[14]].

Mobile applications and SMS-based platforms are being used for real-time data collection in Zambia's malaria programs. These tools are helping to track healthcare workers to gather data efficiently in the field. An example of this is the malaria rapid reporting system where health facility workers submit basic information on malaria burden by mobile phones that are enabled with a JAVA-based data entry form. Once data is entered into a phone, it is sent through a data-enabled mobile telephone network to a centralized data server. Health staff can then access this data on the internet, viewing the local malaria situation in real-time and monitoring facility-level progress in reducing malaria transmission. Importantly, this system links a community's malaria burden with its malaria commodities, thereby streamlining the supply chain. A process that used to take three or four months to complete now takes only one week, allowing critical time to respond to any changes in parasitemia rates [[15]].

Leveraging cloud-based platforms allows for secure, centralized data storage, which ensures that health data is accessible in real-time across different facilities. This supports streamlined reporting, faster decision-making, and collaboration among healthcare professionals. In Zambia, the cloud-based platform Logistimo has played a significant role in enhancing the health sector, particularly in the management of health supply chains including vaccines.

The MoH in Zambia utilizes DISA as its laboratory management system, which has significantly modernized the processes of data collection, management, and reporting in the health sector. DISA plays a vital role in handling laboratory results, particularly for critical diagnostics such as HIV, tuberculosis (TB), and other infectious diseases [[16]]. By automating data collection and entry, centralizing data management, and improving reporting and analytics, DISA is transforming Zambia's health system. It enhances communication and interoperability, streamlines workflows and turnaround times, ensures data security and confidentiality, and enables real-time monitoring to support informed decision-making.

The eLMIS has significantly modernized data collection, management, and reporting processes within Zambia's health sector, particularly in the management of medical supplies and health commodities through digitization of supply chain data; real-time data collection and tracking; enhanced reporting capabilities; improved data accuracy and consistency; forecasting and demand planning; centralized inventory management; optimized supply chain operations, improved accountability and supporting national health programs.

Interoperability standards are critical for any health information system. Digital tools that ensure interoperability between different health systems can facilitate seamless data exchange across various healthcare providers and regions, ensuring that health data is accurate and up to date. Zambia's e-Government Master Plan 2018-2030 outlines a vision where, during the Integration Phase (2022-2026), ICT infrastructure and system integration will be expanded [[17]]. This phase aims to create unified policies backed by interconnected, interoperable networks and systems. The plan's goal is to improve public health by providing

citizens with access to efficient, integrated electronic systems. By implementing the Digital Health Strategy complemented by the IAF, the MoH will enable seamless communication and data sharing between various systems, applications, and devices, even when developed by different stakeholders leading to more integrated and effective healthcare services.

Discussion

Technology and data play a crucial role in daily life worldwide, particularly in the health sector. As health systems face growing pressure to deliver more efficient, innovative, and accessible services to all, the importance of data and technology continues to rise. Digital technologies can enhance health systems, optimize public health and financing, and extend care to underserved populations. With emerging innovations such as artificial intelligence, the future of healthcare is expected to be deeply integrated with technology and driven by data [[18]].

The Zambia MoH has developed a series of strategies to advance digitalization in the health sector. Together, these strategies provide comprehensive guidelines for strengthening the health information system. The strategies were developed through a consultative process involving all key stakeholders, fostering collaboration, ownership, and sustainability. However, previous strategies were not implemented for various reasons, including insufficient budget allocation for the MoH. As a result, the MoH has had to depend on external partners for financial support, each bringing their expectations and agendas, which has compromised the MoH's ability to effectively coordinate efforts. Zambia has made considerable strides in digital health, yet the implementation of health systems interoperability remains unfulfilled, despite consensus among key stakeholders that it is a crucial step forward. Recently, the MoH identified five key areas of support essential for achieving interoperability: standards, services, and applications (technical components); leadership and governance; human resource capacity development; legislative and regulatory frameworks; and infrastructure requirements as illustrated in Table 3 [[19]].

Table 3. Components and Description of Key Areas to Support Interoperability

Component	Description
Leadership, governance and multi-sector engagement	• Direct and coordinate eHealth at the national level; ensure alignment with health goals and political support; promote awareness and engage stakeholders. • Use mechanisms, expertise, coordination and partnerships to develop or adopt eHealth components. • Support and empower required change, implementation of recommendations and monitoring results for delivery of expected benefits.
Strategy and investment	• Ensure a responsive strategy and plan for the national eHealth environment. Lead planning, with the involvement of major stakeholders and sectors. • Align financing with priorities; donor, government and private sector funding identified for the medium term.
Legislation, policy and compliance	• Adopt national policies and legislation in priority areas; review sectoral policies for alignment and comprehensiveness; establish regular policy reviews.

	• Create a legal and enforcement environment to establish trust and protection for consumers and industry in eHealth practice and systems.
Workforce	• Make eHealth knowledge and skills available through internal expertise, technical cooperation or the private sector. • Build national, regional and specialized networks for eHealth implementation. • Establish eHealth education and training programs for health workforce capacity building.
Standards and interoperability	• Introduce standards that enable consistent and accurate collection and exchange of health information across health systems and services.
Infrastructure	• Form the foundations for electronic information exchange across geographical and health-sector boundaries. This includes the physical infrastructure, core services and applications that underpin a national eHealth environment.
Services and applications	• Provide tangible means for enabling services and systems, access to, and exchange and management of information and content. Users include the public, patients, providers, insurance, and others. The means may be supplied by the government or commercially.

Efficient coordination of the MoH's ICT department is crucial for the success of the Digital Health Technical Working Group (DHTWG), which plays a key role in achieving health systems interoperability. A major challenge, however, is that the DHTWG and its technical subcommittees do not meet regularly, resulting in partners developing siloed systems due to weak coordination. Strong collaboration between the M&E unit and the ICT Directorate is essential to maintaining a functional health information system. As a primary user of the integrated data produced by the digital health system, the M&E unit manages key systems like DHIS2. The ICT Directorate, on the other hand, oversees the technical aspects of the digital health strategy, including software development and deployment. In the past, poor coordination between these two major players has led to delays and incomplete implementation of health information and digital health strategies.

Change management is a key component outlined in Zambia's Digital Health Strategy, essential for supporting the implementation of the developed strategies. As digitization can introduce significant changes, some of which may not yet be fully anticipated, the change management strategy must focus on engaging policymakers and leaders [[20]]. This will help them grasp the scale and potential of digitization and encourage them to embrace innovative and unfamiliar initiatives.

Important to note is that the MoH has not fully explored the potential of other useful technologies such as blockchain technology for securely managing patient records, ensuring data integrity, and promoting interoperability between healthcare providers, while also protecting sensitive information [[21]]. A significant risk exists concerning the management of confidential patient information in Zambia.

Sustainable financing is essential for the successful implementation of health information systems, as it is a complex process that progresses through various stages, including piloting, scaling up, and maintenance [[22]]. Implementation costs are influenced by the stage and scale of deployment and infrastructure needs. In most cases, these costs are borne by projects funded by various donors

and funding is of a limited duration. It is crucial to assess the anticipated costs before adopting any technology. In addition, other areas such as telemedicine and artificial intelligence in healthcare remain largely untapped within Zambia's health sector.

Human resources play a vital role in implementing digital health solutions. While Zambia has several academic and professional institutions that produce ICT professionals, the development of health informatics as a specialized field is still in its early stages [[23]]. Donors and implementing partners provide capacity-building opportunities for both in-service and pre-service professionals, but these tend to be limited in scope, focusing primarily on specific systems rather than broader health informatics concepts. Additionally, these initiatives are often aligned with individual programs rather than the MoH's overall vision for the healthcare workforce. Therefore, a comprehensive strategy for developing digital healthcare skills is needed to improve the adoption, use, and integration of digital health technologies and their outputs as indicated in the Digital Health Strategy.

Conclusion

In conclusion, Zambia has established robust five-year strategic plans for digital health and health information systems, along with an interoperability architectural framework that outlines key priorities for advancing HIS into the digital era. Aligned with the 8th national development plan and the "Smart Zambia" vision, a strengthened HIS will enable the MoH to provide timely, high-quality, policy-relevant data. These strategies provide a clear structure for the MoH to guide implementation and resource allocation, to achieve universal health coverage. However, sustained financing is a key issue in ensuring the full implementation of these robust strategies. Enhanced capacity across all levels from data collection and analysis to economic evaluations will support evidence-based decision-making, promoting greater efficiency and equity in healthcare. With Zambia's focus on digital transformation, the MoH has a unique opportunity to lead the development of interoperable national information systems. This could serve as a model for other ministries and set best practices for developing nations.

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Conflict of Interest

The author declares no conflict of interest.

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