

Digital Health to Support HIV Care

A landscape assessment of KwaZulu-Natal and
Gauteng Provinces in South Africa (2022)



Table of Contents

EXECUTIVE SUMMARY	i
OVERVIEW	1
BACKGROUND	2
GOVERNANCE	4
<i>Leadership and Governance</i>	4
<i>Legislation, Policy, and Compliance</i>	6
<i>Strategy and Investment</i>	6
<i>Summary and Recommended Actions</i>	9
WORKFORCE	10
<i>Summary and Recommended Actions</i>	12
SYSTEMS	13
<i>Infrastructure</i>	13
<i>Standards and Interoperability</i>	15
<i>Services and Applications</i>	18
<i>Summary and Recommended Actions</i>	24
CONCLUSION	25
APPENDIX A: INVENTORY OF SYSTEMS, APPLICATIONS AND TOOLS	26
APPENDIX B: ADDITIONAL INFORMATION FOR SYSTEMS, APPLICATIONS, AND TOOLS FROM ONLINE QUESTIONNAIRE	36
REFERENCES	39

Contributors and Acknowledgments

Digital Square at PATH thanks the many individuals who contributed to this report. This report would not have been possible without the input from stakeholders who work in Gauteng Province, KwaZulu-Natal Province, and in some cases, across multiple provinces in South Africa. These stakeholders contributed their time and insights by responding to the online questionnaire, engaging in interviews, and participating in focus groups and other discussions.

Stakeholders who provided consent to be listed as contributors during the key informant interviews (alphabetically by first name) are: *Department of Health Gauteng* (Chris Horne, Dikeledi Poole, Kgosi Madikwane, Mathlodi Mogorosi, Mbhekiseni Khumalo, Modipadi Mugivhi, and Tembi Sedibe); *Department of Health KwaZulu-Natal* (Andile Ngcobo, Elizabeth Lutge, Ismail Subhan, Jaqueline Ngozo, Shane Naidoo, Sizwe Coka, Vuma Magaqa, and Xolani Phakathi); *Africa Health Research Institute* (Kobus Herbst); *Aurum Institute* (Trisha Crawford); *Health Systems Trust* (Felicity Basson); *Health Information Systems Program* (Ronelle Niit); *John Snow, Inc.* (Sarie Podges); *TB/HIV DREAMS* (Jenny Mcloughlin); *University of KwaZulu-Natal* (Sifiso Mtshali, part time); *Vital Wave* (Pierre Dane); and *54asONE Africa* (Nomvelo Pungula).

This report was authored by the Digital Square project team: Lead authors Christa van den Bergh and Crizelle Nel (consultant) with significant content contributions by Emily Carnahan and contributions by (alphabetically by first name) Anzél Schönfeldt, Auson Kasinga, Riley Willis, Skye Gilbert, and Zahra Lutfeali. The project team recognizes and thanks several consultants who supported various aspects of the assessment: Annie Neo, Kristina Celentano, Margaret Ramukumba, Sifiso Mtshali and Trish Heimann. The team also extends thanks to the editing and graphics team for their support: David Simpson, Ingela Emblen, Mara Lavery, Meredith Hastings and Thom Heileson.

This assessment was strengthened by insights generated from previous digital health landscapes. The team at Vital Wave is acknowledged for sharing the list of digital solutions in use in South Africa that they had compiled as part of their digital health strategy work for the Bill & Melinda Gates Foundation. The [Map & Match project](#) team is acknowledged for their work, which is available on the Digital Square website.

The assessment collected primary data using REDCap (Research Electronic Data Capture), a tool hosted at the University of Washington Institute of Translational Health Sciences. This project benefited from the Institute of Translational Health Science grant support (UL1 TR002319, KL2 TR002317, and TL1 TR002318 from NCATS/NIH) for the usage of REDCap only. *No direct or indirect funding other than that of the Gates Foundation was received for the actual landscaping exercise.*

Abbreviations

AIDS	acquired immunodeficiency syndrome
ART	antiretroviral therapy
CHW	community health worker
COVID-19	coronavirus disease 2019
DHEA	digital health enterprise architecture
DHIS2	District Health Information Software 2
DOH	Department of Health
EHR	electronic health record
EMR	electronic medical record
HIS	health information system
HIE	health information exchange
HIV	human immunodeficiency virus
HNSF	Health Normative Standards Framework
HPRN	health patient registration number
HPRS	Health Patient Registration System
ICT	information and communications technology
IT	information technology
MPI	master patient index
NDHS	National Digital Health Strategy
NDOH	National Department of Health
NGO	nongovernmental organization
NHI	National Health Insurance
NHISSA	National Health Information System of South Africa
NIDS	National Indicator Data Set
PHC	primary health care
SA	South Africa
SDG	Sustainable Development Goal
SITA	State Information Technology Agency
STI	sexually transmitted infection
TB	tuberculosis
UNAIDS	Joint United Nations Programme on HIV/AIDS
WHO	World Health Organization

Executive Summary

South Africa, home to more than 60 million individuals, has the highest number of people living with HIV in the world and the highest number of people enrolled in antiretroviral therapy.

Achievement of the Joint United Nations Programme on HIV/AIDS 90-90-90 targets and other health goals depend on optimal functioning of the health system, which can be strengthened by digital health interventions. The success of digital health interventions relies on an effective digital health ecosystem, including governance mechanisms, a trained workforce, and integrated systems. Working together, this enables efficient and effective data collection, sharing, access, and use to enhance health care coordination and service delivery.


South Africa has numerous policies, strategies, and guidelines governing the public health system, health programs (including HIV), the workforce, and digital health systems. The National Digital Health Strategy provides the overall strategic direction to strengthen digital health, while the National Health Normative Standards Framework for Interoperability in eHealth 2014 provides the baseline for creating interoperable applications and systems. However, progress with implementation and policy compliance is hampered by leadership and governance coordination challenges, lack of sufficient financial and human resources, and inadequate information and communications technology infrastructure.

There are also still many needs to be met to establish interoperability between siloed registries, duplicate and fragmented systems, applications, and tools ([191 systems, applications, and tools](#) were identified in South Africa during recent assessments).

As a step toward supporting development of appropriate, locally relevant solutions to strengthen digital health, Digital Square conducted an HIV digital health landscape assessment in South Africa's two most populous provinces: Gauteng and KwaZulu-Natal.

The content, findings, and recommended actions to strengthen the digital health ecosystems in Gauteng and KwaZulu-Natal Provinces are reported across a foundational layer commonly referred to as the [seven eHealth building blocks](#) and are further organized into three overarching categories: governance, workforce, and systems. The table below provides a high-level overview of the assessment results, with details provided under each category and eHealth building block. The recommendations are framed around South Africa's approach to integrated health services and will benefit the health system broadly while supporting achievement of the country's HIV goals.

It should be noted that some of the challenges identified during the assessment are in the process of being addressed by the national and provincial departments of health and that the list of recommendations is by no means exhaustive. Any organization acting on the recommendations should engage directly with the province and other relevant stakeholders to ensure that they are acting on the highest priority needs in line with existing efforts.

	eHealth Building Block	High-Level Findings and Recommended Actions
 <p>Governance</p>	<p>Leadership & Governance</p>	<p>Gaps in coordination, alignment, and collaboration exist between national and provincial governance structures.</p> <ul style="list-style-type: none"> • Strengthen and/or develop a province-specific digital health leadership and governance strategy with accountability mechanisms. • Strengthen and/or develop province-specific digital health leadership training. <p>Although a draft national policy streamlines government digital infrastructures, documentation is lacking on overall data governance.</p> <ul style="list-style-type: none"> • Customize and adopt the Provincial Health Data Governance Framework for each province to reduce overlap between planning, execution, and delivery functions.
	<p>Legislation, Policy & Compliance</p>	<p>Numerous digital health policies exist, but compliance is low.</p> <ul style="list-style-type: none"> • Develop a change management plan to support understanding of and compliance with relevant digital health policies at subnational level. • Provide technical support to provinces to develop implementation plans that align with national policies.
	<p>Strategy & Investment</p>	<p>Data and digital health strategies to accelerate attainment of HIV program goals lack transparency and coordination.</p> <ul style="list-style-type: none"> • Make the Gauteng and KwaZulu-Natal Department of Health (DOH) Information and Communications Technology (ICT) Strategic Plans available in the public domain and easily accessible. • Develop a costed investment plan for the Gauteng and KwaZulu-Natal DOH ICT Strategic Plans. • Develop a donor coordination strategy.



Workforce

eHealth Building Block	High-Level Findings and Recommended Actions
Workforce	<p>Challenges and shortages persist in data quality, retention of sufficient ICT/digital health staff, health care workers' digital literacy and ICT skills.</p> <p>Short-term actions:</p> <ul style="list-style-type: none"> • Deploy partner-funded roaming technical support staff and/or ICT specialists. • Link individuals to and strengthen existing eLearning platforms and courses. • Support in-service training. • Provide one point of access to main cost driver data in the District Health Information Software 2 (DHIS2). <p>Medium-to-long-term actions:</p> <ul style="list-style-type: none"> • Customize and/or develop and implement a province-specific budgeted ICT competency framework and workforce plan. • Partner with local academic institutions to align their curricula to the provincial ICT competency framework. • Develop and implement a three-year costed data quality and use roadmap and support implementation. • Offer internship opportunities and job placement with provincial departments of health.



Systems

eHealth Building Block	High-Level Findings and Recommended Actions
Infrastructure	<p>Fragmentation of digital infrastructure, insufficient resources and funding, electricity outages, and hardware shortages impact access to and use of digital health systems.</p> <ul style="list-style-type: none"> • Strengthen and/or develop an online ICT infrastructure inventory and a costed procurement and infrastructure maintenance roadmap. • Prioritize computers and other equipment for health facilities, information officers, and ICT staff. • Strengthen connectivity via network boosters and/or topping up of mobile data.
Standards & Interoperability	<p>The proposed national digital health enterprise architecture (DHEA) is outdated and not specific enough to inform implementation; provinces need a framework with which to align and coordinate their systems investments.</p> <ul style="list-style-type: none"> • Strengthen and/or develop a generic, open standards-based DHEA framework that provinces can easily customize. • Strengthen and/or develop a digital health platform for KwaZulu-Natal. • Strengthen and/or develop a health information exchange (HIE).
Services & Applications	<p>An abundance of applications and systems with no central inventory contributes to duplicative efforts; persistence of paper tools and digital systems precludes interoperability; opportunities abound to scale proven, high-impact solutions to provide reusable data across systems.</p> <ul style="list-style-type: none"> • Improve alignment of investments and initiatives: <ul style="list-style-type: none"> » Strengthen and/or develop an online inventory of existing and planned digital health systems/technologies and initiatives in the public domain. » Announce a call to action for donors, partners, and the private sector to contribute to the public inventory. » Include a requirement in grants, contracts, and donor agreements to share information on digital health investments in the online inventory. » Strengthen and/or develop a roadmap for standardized and digitized business processes for KwaZulu-Natal. • Scale proven, existing low-cost, high-impact applications, such as CommCare for community health workers (CHWs) and DHIS2 Tracker for CHWs (both mobile applications), and the eTick Register. • Expand use of mobile applications: <ul style="list-style-type: none"> » Fund maintenance of the existing National Indicator Data Set mobile application (called the "NIDS app"). » Develop a mobile application to support standardized implementation of the health patient registration number (HPRN) as a unique identifier. » Digitize existing paper-based data collection tools for HIV.

Assessment Overview

With funding from the Bill & Melinda Gates Foundation, Digital Square conducted an HIV digital health landscape assessment in South Africa's two most populous provinces: Gauteng, with 15.81 million people, and KwaZulu-Natal, with 11.5 million people¹. The goal was to understand the prevalence of and barriers to treatment for HIV, the state of the digital health ecosystem, and ways the ecosystem is affecting progress toward local HIV targets and the United Nations Sustainable Development Goals (SDGs) in the public health sector.

Specific objectives were to:

- Identify health system strategies, priorities, plans, strengths, and challenges, with emphasis on HIV prevention, testing, and treatment.
- Provide an overview of the digital health ecosystem, including an inventory of the digital health tools and systems in Gauteng and KwaZulu-Natal Provinces.
- Develop recommendations to strengthen the adoption and use of digital health aimed at accelerating achievement of HIV goals in Gauteng and KwaZulu-Natal Provinces.

The Digital Square team used a mixed-method, iterative approach across three phases:

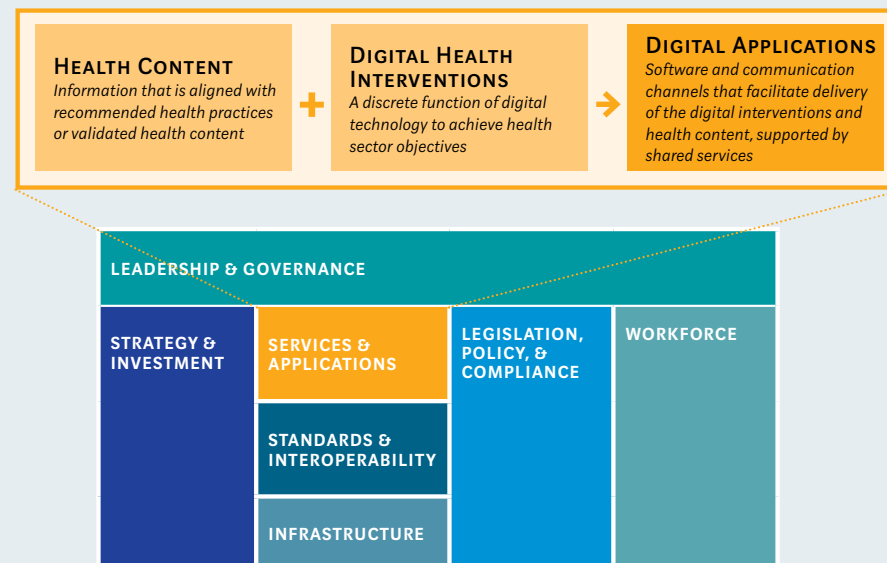
- **Phase I: Data collection.** After obtaining written permission from the heads of provincial departments of health (DOHs), data were collected by means of document reviews, virtual meetings with provincial DOHs and district health management teams, an online questionnaire with 58 respondents, and key informant interviews with 15 health representatives and 13 digital health and information and communications technology (ICT) representatives.
- **Phase II: Synthesis and analysis.** The findings were synthesized and analyzed, and recommendations were developed. The team then verified the findings and proposed recommendations to each province for prioritization through two stakeholder focus group discussions; one with health representatives and one with digital health and ICT representatives. Overall, 30 health and 9 digital health and ICT representatives participated.
- **Phase III: Finalization.** The findings and recommendations were finalized and disseminated.

A **digital health ecosystem** “comprises public and private stakeholders, systems, and an enabling environment that, together, empower people and communities to use digital technology to access services, engage with each other, and pursue economic opportunities.” *Source:* US Agency for International Development (USAID). [Digital Ecosystem Framework](#). Washington, DC: USAID; 2021: 2.

An **enabling environment** is the sum of the “attitudes, actions, policies, and practices that support effective and efficient functioning of organizations, individuals and programmes.” *Source:* World Health Organization (2020): [127](#).³

The project team used two frameworks to guide data collection, synthesis, and reporting: (i) the foundational layer for the ICT and enabling environment,² commonly referred to as the seven eHealth building blocks (Figure 1),³ and (ii) the World Health Organization (WHO) classification for digital health interventions (see [Appendix B](#)).⁴ This report organizes the seven building blocks into three overarching categories: governance, workforce, and systems.

Figure 1: The seven eHealth building blocks for the foundational layer of the ICT and enabling environment.



Source: World Health Organization (2020): 66, [Fig. 5.1](#).³

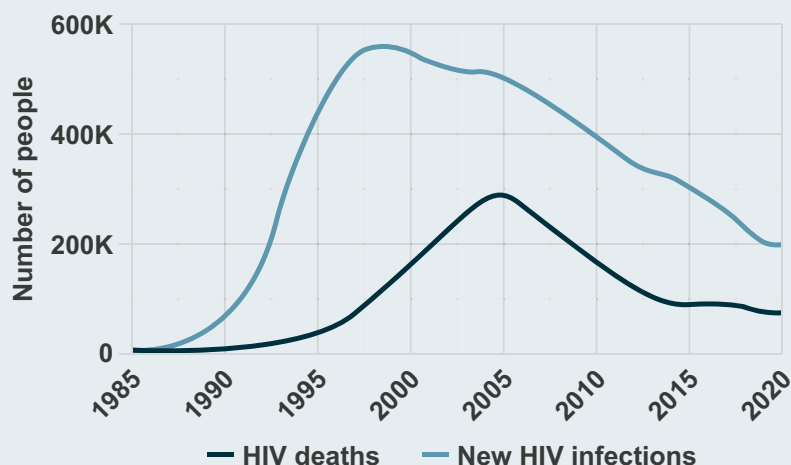
Abbreviations: ICT, information and communications technology.

The assessment was not intended to be exhaustive. A key limitation was that the national and provincial digital health strategies were only developed in 2020, and there was limited information available in the public domain to verify implementation. Moreover, resources redirected to COVID-19 response activities impacted health services and the progression in digital health implementation planning. Limited availability of stakeholders to support the landscape data collection (due in part to the COVID-19 pandemic) and lower-than-expected participation in focus group discussions to verify and prioritize results and recommendations (due in part to digital health not being viewed and/or understood as a priority) may have affected the findings.

Background

South Africa is an upper-middle-income country with a 2021 population of 60.14 million and a 2021 life expectancy at birth of 59.3 years for males and 64.6 years for females.¹ The country has a quadruple burden of disease, with most deaths related to (i) maternal, newborn and child health; (ii) communicable diseases, namely HIV/AIDS, tuberculosis (TB), and since 2020, COVID-19; (iii) noncommunicable diseases; and (iv) violence and injury.⁵ The health system consists of two tiers: the public sector, providing services to around 84 percent of the population (Gauteng 75 percent and KwaZulu-Natal 87 percent),⁶ and the private sector. The public health sector is decentralized to the districts. Each district has a District Management Team whose core function is to organize and manage health services, collaborate with local government and nongovernmental organizations (NGOs), liaise with community representatives and organizations, and practice intersectoral coordination. Several health systems challenges - such as staff shortages, inadequate funding, and fragmented information systems - impact HIV and other health programs.

Figure 2: HIV infections and deaths in South Africa, 1985–2020.



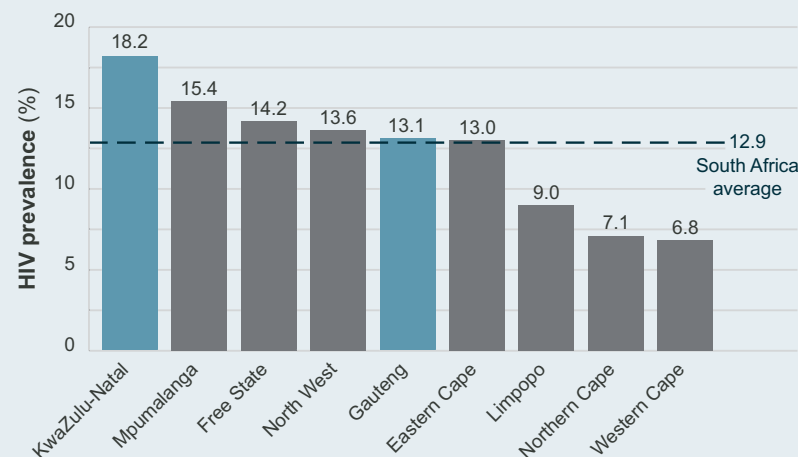
Source: MacDonnell S, Low M. [HIV in SA \[South Africa\]: Seven graphs that tell a story](#) [blog]. *Spotlight*. July 18, 2019.

Globally, South Africa has the highest number of people living with HIV⁷ (8.2 million in 2021¹) and people enrolled in antiretroviral therapy, or ART¹ (4.9 million in 2019⁵). While significant progress has been made since ART was introduced in 2004 (Figure 2), there is a need to further reduce new infections and to increase ART initiation and retention. HIV prevalence varies between provinces (Figure 3), age groups, and genders, with girls aged 17 years around 8.7 times more likely to acquire HIV than their male counterparts.⁸ Though new HIV infections decreased 17 percent between 2016 and 2018, the numbers are still high.

South Africa experienced 222,000 new HIV infections in 2018 (the 2022 target is <100,000) with the highest number in Gauteng Province (58,000) and the second highest in KwaZulu-Natal Province (50,000).⁸

Priority actions to combat HIV are to accelerate prevention; provide treatment, care, and adherence support; address social and structural drivers of infection; and promote leadership and shared accountability. The focus of the latter is to mobilize resources for sustainable response and to strengthen strategic information to drive progress.⁹

Figure 3: HIV prevalence in South Africa by province 2018.



Source: South African National AIDS Council (SANAC) Trust (2019): [113](#).⁸

Prevention initiatives in South Africa include awareness-raising campaigns through mass media, social media, and websites; workplace and community campaigns; and activities such as community screening, with risk-reduction counseling for people who test negative. Specific key prevention activities include interventions aimed at adolescent girls and young women, pre-exposure prophylaxis (PrEP), post-exposure prophylaxis, voluntary medical male circumcision, and prevention of mother-to-child transmission of HIV.⁹

Factors for making adolescent girls and young women the target population for HIV prevention include “multiple partners, drugs and substance abuse, non-consistent use of condoms, poverty and transactional sex, ... disparities in age between them and their partners [sugar daddies], as well as gender-based violence.” (KwaZulu-Natal DOH, health care interview)

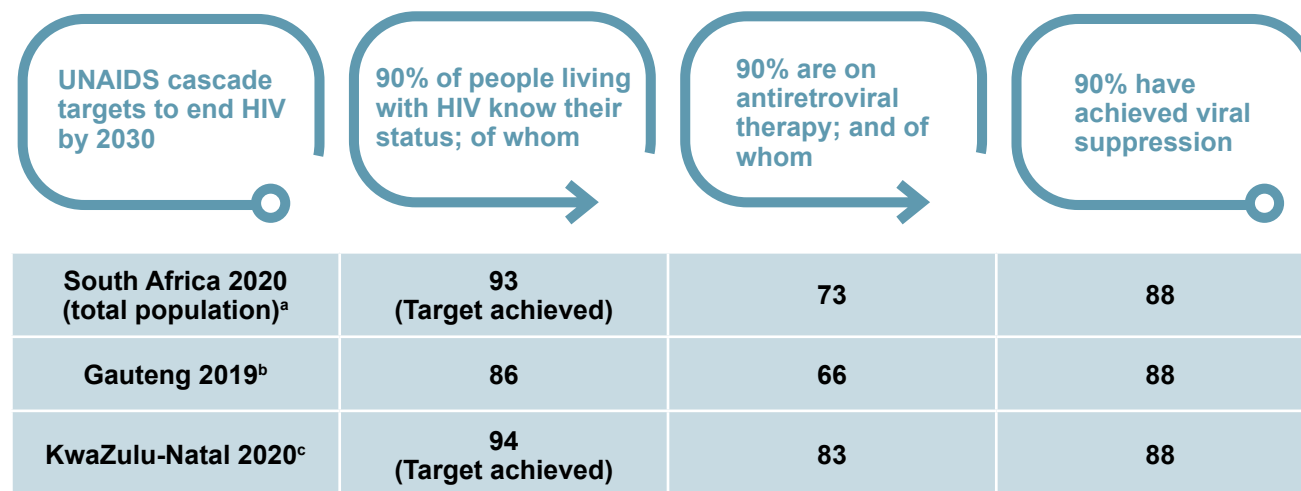
The Universal Test and Treat strategy, with any person testing positive for HIV started on ART irrespective of CD4 count, was implemented in September 2016.⁹ However, only 73 percent of HIV-positive people were initiated on ART in 2020,⁵ and overall retention in care remains poor. In 2018, 30 percent of patients were lost to follow-up in the first six months of treatment.¹⁰

Achievement of the Joint United Nations Programme on HIV/AIDS (UNAIDS) 90-90-90 targets¹¹ and other health goals relies on optimal functioning of the health system, which can be strengthened by digital health interventions. The success of digital health interventions, in turn, relies on an effective digital health ecosystem, including governance mechanisms to coordinate across stakeholders and establish strategic priorities, a trained workforce to support and use digital health, and integrated systems that enable data collection, sharing, access, and use to enhance care coordination, service delivery, and efficiency.

Table 1 depicts 2019/20 progress in South Africa toward the 2020 UNAIDS 90-90-90 targets. The country plans to increase each of these targets to 95 percent by 2024/25.⁵ Nationally and in both provinces, ART initiation and retention gaps are particularly pronounced for men and children. Women are generally initiated during pregnancy and managed through maternal services. There are no equivalent structures for men and children. Other HIV program challenges include low initiation on ART and retention among sex workers and men who have sex with men; poor HIV prevention in youth, with higher prevalence in women than in men; HIV and TB co-infection; inadequate referrals and defaulter tracing; and poor data quality and use,⁸ mainly due to numerous paper systems and vertical electronic systems resulting in duplication and fragmentation.

Optimizing digital health can assist in addressing many of the HIV and other health care challenges to the benefit of all patients, health care workers, and health system managers.¹² In Gauteng and KwaZulu-Natal specifically, the promising practices, gaps, challenges, and recommendations identified through the assessment can assist provincial health leaders, donors, and other partners with strengthening the digital health ecosystem in the public health sector and accelerating progress toward health goals.

Table 1: Progress toward 90-90-90 targets in South Africa overall and in the assessed provinces.



Sources:

- a. National Department of Health (2021): 28, [Fig. 12](#).⁵
- b. Gauteng Department of Health (2021): 33.¹⁴
- c. KwaZulu-Natal Department of Health (2021): [51](#).¹⁵

Abbreviations: UNAIDS, Joint United Nations Programme on HIV/AIDS.



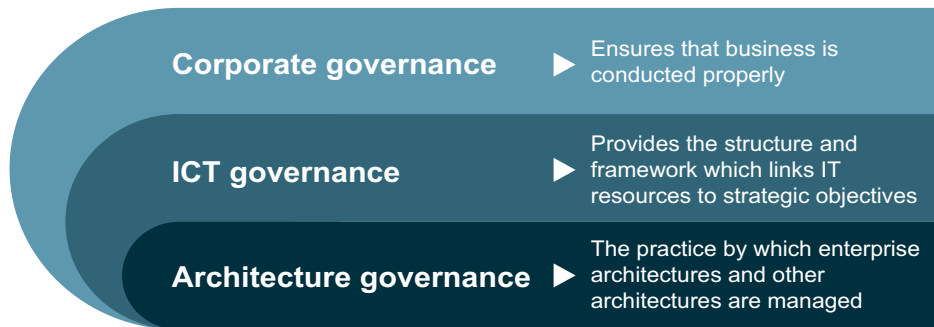
Governance

Governance is a crosscutting component of the digital health enabling environment that underpins all [seven eHealth building blocks](#).^{2,3} Different levels of governance (Figure 4) involve robust processes and structures that coordinate, collaborate, and enable strategic planning and decision-making across government agencies, private-sector entities, donors, and other stakeholders. Of critical importance is that these governance structures are country led to define processes, priorities, and strategies and enact supportive policies.

South Africa has numerous policies, strategies, and guidelines governing the health system, health programs (including HIV), the workforce, and health information. Extensive lists of policies and strategies are provided in the Library Guide on South African Government Policy on ICT,¹³ as well as the National,⁵ Gauteng,¹⁴ and KwaZulu-Natal¹⁵ Annual Performance Plans. In addition, there are policies, strategies, and guidelines for creating a supportive and enabling digital health environment. These are discussed in several documents, including the National Digital Health Strategy (NDHS) for South Africa 2019-2024,¹² the Gauteng DOH ICT Strategic Plan 2019/20 - 2023/24,¹⁶ and the Draft National Data and Cloud Policy 2021.¹⁷

Key health care and digital health policies and guidelines are discussed throughout relevant sections of this report.

Figure 4: Levels of governance.



Adapted from: KwaZulu-Natal Office of the Premier (2020): 19, [Fig. 1](#).³⁷

Abbreviations: ICT, information and communications technology; IT, information technology.

Leadership and Governance

Institutional governance and leadership

The National Department of Health (NDOH) develops and oversees the implementation of legislation, policies, systems, norms, and standards, while health services are rendered through the District Health System, which is managed by provincial DOHs.¹⁸ Numerous state-, health service-, and citizen stakeholders are involved in governance. NGOs make an essential contribution to HIV/AIDS, TB, and other health priorities at the national and provincial levels, as well as local organizations rooted in individual communities.¹⁹

National and provincial digital health governance structures enable stakeholders to determine priority data and systems investments. The National Health Act (No. 61 of 2003) states that the NDOH shall create a comprehensive national health information system (HIS) by facilitating and coordinating (at all levels of the health system) the establishment, implementation, and maintenance of the HISs of provincial departments, district health councils, municipalities, and the private health sector. Provinces are responsible for establishing, maintaining, facilitating, and implementing HISs at provincial and local levels, and district health councils to establish and maintain HISs as part of the national HIS.¹⁸

In line with the National Health Act, the NDOH has instituted several governance bodies engaging a diverse set of representatives. In 1995, the National Health Information System of South Africa (NHISSA) Committee was established as a subcommittee of the Technical Advisory Committee of the National Health Council. The NHISSA Committee convenes quarterly. Its membership consists of officials responsible for health information, monitoring and evaluation (M&E), research, epidemiology, district health systems, primary health care (PHC), and health sector planning in the national and provincial health departments, as well as representatives from NGOs and development partners. The NHISSA Committee drives the country's health data governance and manages operational issues regarding implementation of the NDHS by serving as a link between the national and provincial departments to ensure uniform coordination and implementation of policy. Provincial Health Information Systems Committees (represented in the NHISSA) ensure that all HISs adhere to national guidelines and specifications, and where required, they guide the development of provincial policies and regulations to govern information at provincial and lower levels.²⁰

To advise the Minister of Health on implementation, M&E, and investments in HISs, the Ministerial Advisory Committee on eHealth was established in 2015.¹² In 2019, the Presidential Commission on the Fourth Industrial Revolution was established to assist the government with tasks such as leveraging digital technologies to advance the SDGs, enhancing the effectiveness and efficiency of health services, and reducing the burden on health systems.²¹ The Presidential Health Summit Compact 2018 articulates focus areas related to development and implementation of information systems that will guide health system policies, strategies, and investments.²² The legislative mandate of both the Gauteng DOH and the KwaZulu-Natal DOH are grounded in the national legislative framework.

In Gauteng, the Department of e-Government coordinates, governs, and supports ICT infrastructure, services, and applications for cross-sector public service delivery.²³ Additional governance bodies for the use of ICT in the health sector include the Executive Management Council; the Provincial eHealth Steering Committee, which provides strategic oversight; and the ICT Facility Committee, which operationalizes ICT policies, strategies, and implementation plans.¹⁶ The Gauteng DOH ICT Strategic Plan acknowledges that there are challenges, such as duplicative efforts, within the existing organizational and governance structures. Thus, plans have been outlined to improve oversight, accountability, and coordination.¹⁴

The KwaZulu-Natal Health Act of 2009 mandates the Provincial Health Information Systems Committee with managing HISs at the provincial and local levels.²⁴ The Draft KwaZulu-Natal DOH ICT Strategic Plan proposes ways to strengthen governance structures, develop leadership capacity, and improve accountability for digital health resources at the provincial, district, and facility levels to better support digital health adoption and use and ensure mitigation of pertinent issues. The Provincial ICT Steering Committee meets quarterly to identify department needs, prioritize support services, and identify risks for mitigation. Governance is also a standing agenda item for discussion.²⁵

“Leadership and governance challenges remain prevalent in the various levels of the public sector. Despite efforts by government to inculcate a culture of good leadership and governance, the knowledge and skills amongst managers [are] still ... inadequate. Furthermore, weak accountability mechanisms are linked to inadequate, disparate measures and standards for managing performance (good or poor).”
– National Health Insurance (NHI) Policy^{26(p12)}

While several national and provincial governance structures with digital health mandates are in place, there are still challenges with digital health ownership, coordination, and governance through the NHISSA and provincial bodies. Alignment with and collaboration between the NDOH and provinces need to be improved, and autonomy (limited at the provincial level and lacking at the district level) needs to be addressed to support implementation of the NDHS and the provincial DOH ICT Strategic Plans. Enhancing digital health leadership, political support, and accountability at all levels are key to strengthening digital health.

The 2030 Human Resource Strategy also notes that leadership competency gaps remain at all levels of the health system and that there are shortfalls in strategic, technical, and managerial competence, capability, and accountability.²⁷ As a starting point in addressing this, the NDHS prioritizes strategic interventions to develop leadership structures and capacity for digital health innovation and adaptive management at all levels. The NDOH is committed to strengthening governance structures and oversight mechanisms to ensure high-level accountability on digital health.¹²

Data governance

A significant portion of the non-sensitive data generated by South Africa’s government (using public funds) remains inaccessible to citizens, which limits opportunities to inform scientific, developmental, and economic efforts. The Draft National Data and Cloud Policy 2021 promotes connectivity, access, and governance of data and cloud services and outlines issues related to digital infrastructure and interventions to accelerate digital transformation.¹⁷

The NDOH plans to conduct a review of the existing digital health regulatory landscape and to strengthen regulations on data protection, data sharing between private and public sectors, and cybersecurity.¹² KwaZulu-Natal DOH plans to follow suit, and to also formulate departmental policy and procedures for digital health.²⁵ The Gauteng DOH proposes to develop a provincial health data governance framework to define guidelines and policy around data creation, dissemination, storage, security, and disposal.¹⁶

As part of this project, Digital Square developed a [Provincial Health Data Governance Framework](#) (available on the Digital Square website). It is aligned with international best data practices and the Draft National Data and Cloud Policy of 2021, and can support provinces with implementation and, ultimately, compliance with this policy. The goal of the Draft Provincial Data Governance Framework is to coordinate, support, and improve service delivery outcomes through digital transformation, resulting in improved data quality and use at all levels. Effective digital and data governance will enhance provincial digital health initiatives and ensure that health information is well managed, used, and protected in line with national digital health strategies and community expectations. Building on the National District Health Management Information Systems Policy of 2011,²⁰ relevant roles and responsibilities are defined to assist with effective and consistent digital health management across districts and health facilities.²⁸

Legislation, Policy, and Compliance

Numerous national policies providing rules and guidance for ICT in public services, as well as those specific to the health sector, provide the parameters for the environment in which digital health solutions operate. Policies should drive the change in strategies. However, findings indicate that awareness and understanding of these policies are limited at subnational levels and that leadership's promotion of adherence to policies needs to be strengthened. Implementation is often inadequately supported with clear, up-to-date documentation, funding, and resources, which further impacts compliance.¹ This indicates a need to better communicate and educate stakeholders (including leaders, managers, health care providers, and ICT staff) on these policies and their implementation.

“As a country, in public health we are good at preparing documents, policies, and strategies. The execution of it falls short...Policies are not socialized as well as they should be...The Data Cloud Policy took a lot of people by surprise even within the provinces...You should have some kind of campaign...You take a national Data Cloud Policy and you expect people to now be compliant to a whole set of new Governance and ICT compliance stuff...Where will the resources come from?...Who is going to do this?...There are already not a lot of ICT guys on the ground...You need specialized people to drive it.”
(Consultant, digital health interview)

The NDOH plans to formulate national legislative policy and regulatory frameworks for digital health by establishing a body whose tasks will include the development of mechanisms for enforcing compliance.¹² Efforts to include donor coordination in governance structures should also be made to ensure that donors align with national and provincial priorities and needs.

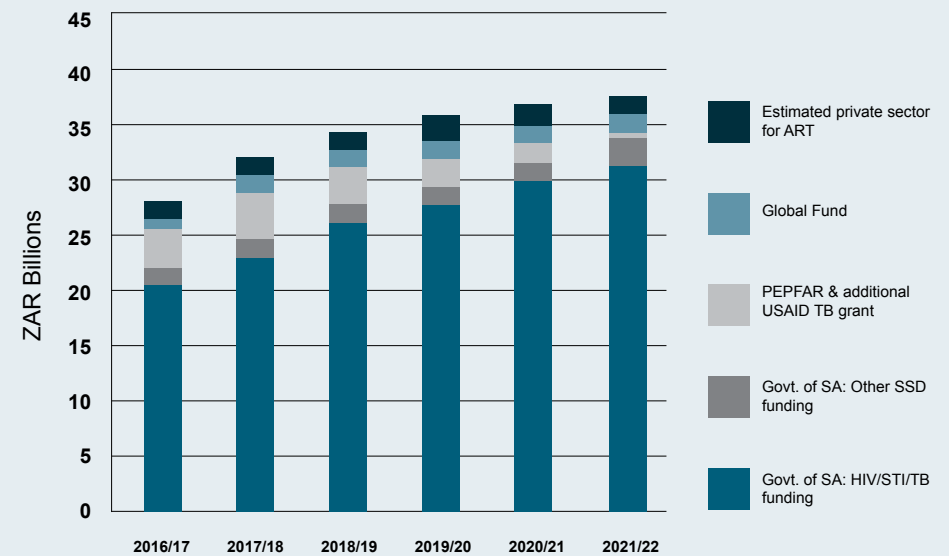
Strategy and Investment

The South African National Development Plan 2030²⁹ outlines the national goals and roles of the different sectors of society and government to eliminate poverty and reduce inequity. The development plan illustrates commitments to evidence-based preventive and therapeutic health care through implementation of National Health Insurance (NHI) to achieve universal health coverage and the SDG to end HIV by 2030.²⁹ The NDOH Strategic Plan 2020/21–2024/25³⁰ depicts health goals, targets, and progress for health system planning and monitoring purposes. South Africa's fourth National Strategic Plan for HIV, TB, and sexually transmitted infections (STIs) 2017–2022 sets priorities and guidelines for integrated HIV, TB,

and STI care in the country.⁹ It emphasizes multisector, people-centered, and evidence-based approaches to end HIV by 2030 and places a high priority on the collection, timely use, and sharing of data to inform programs and policies. Likewise, the Gauteng AIDS Council Strategic Provincial Implementation Plan for HIV, TB, and STIs 2017–2022 guides integrated HIV, TB, and STI interventions in Gauteng,³¹ while the Multi-Sectoral Response Plan for HIV, TB, and STIs 2017–2022 guides HIV care in KwaZulu-Natal.³² Both indicate the importance of strategic information to inform planning and decision-making.

The national consolidated spending on health was South African rand (ZAR) 248.8 billion for 2021/22.³³ The 2018 total national health expenditure was 8.8 percent of the gross domestic product, which is below the Organisation for Economic Co-operation and Development average of 9.3 percent.²² The NHI (designed to fund health services for all South Africans, irrespective of their socioeconomic status) is being implemented,²⁶ with a target date of 2026.³⁴

Figure 5: HIV, TB, and STI funding in South Africa from all sources.



Source: South African National AIDS Council (SANAC) Trust (2017): 39, [Fig. 11](#).⁹

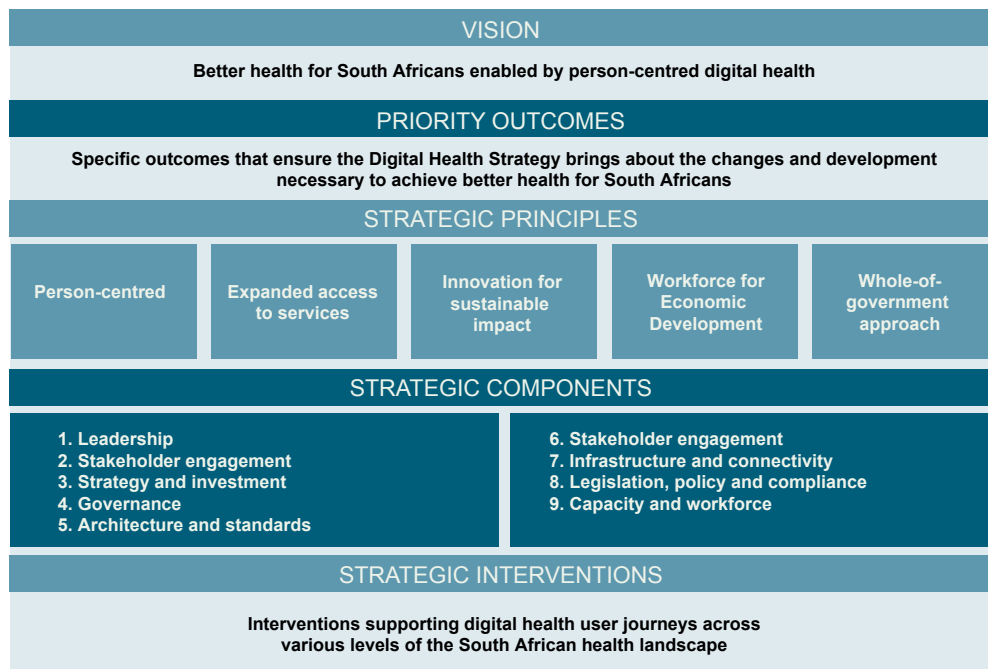
Abbreviations: ART, antiretroviral therapy; PEPFAR, US President's Emergency Plan for AIDS Relief; SA, South Africa; SSD, social and structural drivers; STI, sexually transmitted infection; TB, tuberculosis; USAID, US Agency for International Development; ZAR, South African rand.

¹ Feedback from key informant interviews with 15 health care representatives and 13 digital health and ICT representatives.

Figure 5 shows the trends in HIV, TB, and STI funding from government revenue and other sources from 2016/17 to 2021/22. The Government of South Africa is the primary funder, and the country receives additional funding from The Global Fund to Fight AIDS, TB and Malaria; the US President’s Emergency Plan for AIDS Relief (PEPFAR); the Gates Foundation; and the private sector. Based on actual budgetary data from 2018/19, 23 to 25 percent of the South African rand (ZAR) 28.8 billion budget for HIV, TB, and STIs was from sources other than the government.⁸ Donor funds are largely focused on providing technical assistance and piloting new innovations and nonclinical health interventions; government funds are used to finance routine health care service provision, such as clinical staffing and medication.ⁱⁱ

The National eGovernment Strategy and Roadmap outlines the National eGovernment model for all public sectors and services.³⁵ To establish a national vision and set of key priorities for the desired future of digital health in South Africa, the Ministerial Advisory Committee, in collaboration with NHISSA and stakeholders, developed the NDHS for South Africa 2019–2024 (Figure 6).

Figure 6: Components of the National Digital Health Strategy for South Africa 2019–2024.



Source: National Department of Health (2019): 17, [Fig. 2](#).¹²

ⁱⁱ Feedback from key informant interviews with 15 health care representatives and 13 digital health and ICT representatives.

The NDHS, published in 2020, builds on the eHealth Strategy 2012–2017³⁶ and envisions an integrated approach to better health for South Africans, enabled by person-centered digital health. The strategic components addressed in the NDHS align with WHO guidelines and the seven eHealth building blocks, with the addition of stakeholder engagement.^{2, 3}

Key objectives, as outlined in the NDHS, include the following:¹²

- Support leadership structures and capacity for digital health at all government levels.
- Use digital health to address pressing issues faced by patients and health workers.
- Establish a network of digital health leaders and champions.
- Develop a cross-sector internet infrastructure to reduce costs.
- Optimize multistakeholder engagement for shared opportunities and successful implementations.
- Establish effective collaboration mechanisms between the public and private sectors for cost-effective investments and better infrastructure.
- Establish a data governance framework and systems governance policy to make decisions on new and existing systems.

The NDHS is comprehensive and provides the overall strategic direction of South Africa’s digital health priorities.¹² The Draft KwaZulu-Natal DOH ICT Strategic Plan 2020/21–2024/25 mirrors the priorities of the NDHS and the priorities of the Gauteng DOH ICT Strategic Plan 2019/20–2023/24 are aligned with those of the NDHS (Table 2).

In addition, the Gauteng Department of e-Government developed several provincial strategies, norms and standards, and frameworks in its aim “to modernize government services and foster the implementation of a citizen centric innovation ecosystem that stimulates sustainable economic growth through transformative 4IR technologies”.^{23(p16)}

The KwaZulu-Natal 2020–2025 Provincial ICT Integration Plan for Digital Transformation Strategy aims to create (across all government departments) a digitally enabled province “where technology uplifts human dignity, health, harmony, skills and safety” through provincial ICT goals.^{37(p14)} Additional insight on strategic digital health priorities and implementation plans in KwaZulu-Natal are outlined in the Draft KwaZulu-Natal eHealth Rollout Project Charter,³⁸ and the KwaZulu-Natal Data Warehouse Project Charter.³⁹

Including digital health in the KwaZulu-Natal Annual Performance Plan 2021/22–2023/24¹⁵ and the Gauteng Annual Performance Plan 2021/22,¹⁴ ensures that all managers and service providers are aware of the importance of digital health and of the high-level commitment to use digital health for strengthening the health system.

Table 2: Gauteng and KwaZulu-Natal provincial DOH ICT Strategic Plan priorities.

Gauteng DOH ICT Strategic Plan ^a	Draft KwaZulu-Natal DOH ICT Strategic Plan ^b
<p>Priorities outlined include:</p> <ul style="list-style-type: none"> • Implement an integrated, interoperable health information ecosystem. • Digitize health business processes. • Strengthen use of mHealth solutions to improve service access and delivery. • Strengthen ICT governance structures and oversight. • Develop technical capacity and a skilled workforce to support digitization of the health sector. • Develop and support a health observatory to track population health outcomes, health workforce, and financial investments. 	<p>Priorities outlined include:</p> <ul style="list-style-type: none"> • Develop a complete electronic health record to improve patient management. • Digitize health system business processes. • Establish an integrated, interoperable platform and architecture for health sector information systems. • Scale up mHealth for community-based interventions. • Develop digital health knowledge, skills, and capacity.

Sources:

a. Gauteng Department of Health (2020): 22–25.¹⁶

b. KwaZulu-Natal Department of Health (2021): 19.²⁵

Abbreviations: DOH, Department of Health; ICT, information and communications technology.

The NDHS does not include a costed investment roadmap, which would assist partners in understanding financial plans, limitations, and considerations, but it specifies that the country intends to “develop sustainable interventions and appropriate investment and funding mechanisms for digital health implementation.” The NDHS further states plans to “establish a national grant for digital health implementation in conjunction with National Treasury, to align and coordinate investments, targeting a proportionate allocation of three to five percent of expenditure on health.”^{12(p21)} National-level funding is available for digital health through the NHI, but at the provincial level, funding is a key challenge, often including a mix of government and donor sources. While donor funding is highly valuable, it often lacks alignment with DOH-established priorities; comes with limited engagement from the government on decisions and oversight; lacks long-term sustainability and integration with existing infrastructure and systems; and can lead to duplicate investments between donors.ⁱⁱⁱ

Neither Gauteng’s DOH ICT Strategic Plan for 2019/20 to 2023/24 nor KwaZulu-Natal’s Draft DOH ICT Strategic Plan 2020/21–2024/25 are available in the public domain. This may

contribute to issues with governance activities, stakeholders’ understanding of priorities, and alignment of funding and investments. Another challenge is limited transparency regarding current investments in digital health and data systems leading to a lack of coordination, fragmentation, and expensive duplication of systems and funding in certain areas, with gaps in others.ⁱⁱⁱ


The Gauteng DOH ICT Strategic Plan for 2019/20-2023/24 includes an annual budget, implementation plan, and timelines.¹⁶ The Draft KwaZulu-Natal DOH ICT Strategic Plan 2020/21–2024/25 lacks a companion investment roadmap or budget.²⁵ Neither of the provincial DOH ICT Strategic Plans are available in the public domain. This may contribute to issues with governance activities, stakeholders’ understanding of priorities, and alignment of funding and investments. Another challenge is limited transparency regarding current investments in digital health and data systems leading to a lack of coordination, fragmentation, and expensive duplication of systems and funding in certain areas, with gaps in others.ⁱⁱⁱ

ⁱⁱⁱ Feedback from key informant interviews with 15 health care representatives and 13 digital health and ICT representatives.

Summary and Recommended Actions

Table 3 provides a summary of the digital health governance landscape and recommended actions to address priority gaps within Gauteng and KwaZulu-Natal Provinces. *Any organization acting on the recommendations should engage directly with the province and other relevant stakeholders to ensure they are acting on the highest-priority needs in line with existing efforts.*

Table 3: Findings and recommended actions related to governance of digital health systems in Gauteng and KwaZulu-Natal Provinces.

	eHealth Building Block	Findings and Recommended Actions
 <p>Governance</p>	<p>Leadership & Governance</p>	<p><u>Institutional governance and leadership:</u> Governance bodies have been established at the national and provincial levels, and both Gauteng and KwaZulu-Natal Provinces are acting to strengthen governance functions. However, there are current gaps in coordination, alignment, and collaboration between the National Department of Health and provincial governance structures and authorities, with a need to strengthen political support, digital health leadership capacity, and accountability mechanisms at all levels.</p> <ul style="list-style-type: none"> • Strengthen and/or develop a province-specific digital health leadership and governance strategy with accountability mechanisms that identifies points of coordination across existing authorities and mandates, and that clarifies roles and responsibilities between the national and provincial levels. • Strengthen and/or develop province-specific digital health leadership training through linkage to existing programs, such as the Digital Health Applied Leadership Program and initiatives from universities and other learning institutions, and/or develop and implement customized leadership training contents for specific target groups. <p><u>Data governance and leadership:</u> The Draft National Data and Cloud Policy 2021 streamlines government digital infrastructures. However, there is a lack of documentation on overall data governance, including roles and responsibilities at local levels. Digital Square developed a Provincial Health Data Governance Framework (aligned with international best data practices and the Draft National Data and Cloud Policy 2021) as part of this project, to support provinces with implementation and compliance.</p> <ul style="list-style-type: none"> • In anticipation of South African Auditor General audit requirements, customize and adopt the Provincial Health Data Governance Framework for each province to reduce overlap between planning, execution, and delivery functions.
	<p>Legislation, Policy & Compliance</p>	<p>Although numerous digital health policies exist, they are not being implemented as designed, and compliance is low. Challenges include limited awareness and understanding of policies at subnational levels, insufficient leadership promotion of adherence to policy, inadequate funding and resources for implementation coupled with the lack of costed implementation plans, and inadequate monitoring.</p> <ul style="list-style-type: none"> • Develop a change management plan to support understanding of and compliance with relevant digital health policies at subnational level. • Provide technical support (e.g., workshops, in-service training) to Gauteng and KwaZulu-Natal Provinces to develop implementation plans and ensure alignment with national policies and legislation.
	<p>Strategy & Investment</p>	<p>National and provincial digital health and HIV strategies articulate a clear vision and priorities and explain how investments in data and digital health support acceleration of HIV program goals. The strategies are well aligned to World Health Organization guidelines and are comprehensive and complementary in providing guidance for use of information and communications technology (ICT). However, there are challenges with not all strategies being available in the public domain, not all including costed investment plans to support implementation, and donor funding and investments not being coordinated.</p> <ul style="list-style-type: none"> • Make the Gauteng and KwaZulu-Natal Department of Health (DOH) ICT Strategic Plans available in the public domain and accessible so donors, private-sector partners, and other stakeholders can access the information and identify opportunities to align. • Develop a costed investment plan for the Gauteng and KwaZulu-Natal DOH ICT Strategic Plans to support implementation and coordination of resources. • Develop a donor coordination strategy outlining an approach for engagement with donors on digital health investments at all levels to ensure they are aligned with government priorities, and support training and implementation.



Workforce

Digital tools can strengthen health systems provided enough skilled, high-performing health care and ICT staff are available where needed. Literature and interviewees emphasized that lack of knowledge and skills, increased workload, and staff shortages affect data capturers, health care staff (including health care providers in communities and health facilities, health system managers, academics, and health policymakers) and digital staff (such as ICT technicians, database administrators, software developers, engineers, digital academics, and policymakers). These challenges impact efficiency, achievement of targets, and data quality.

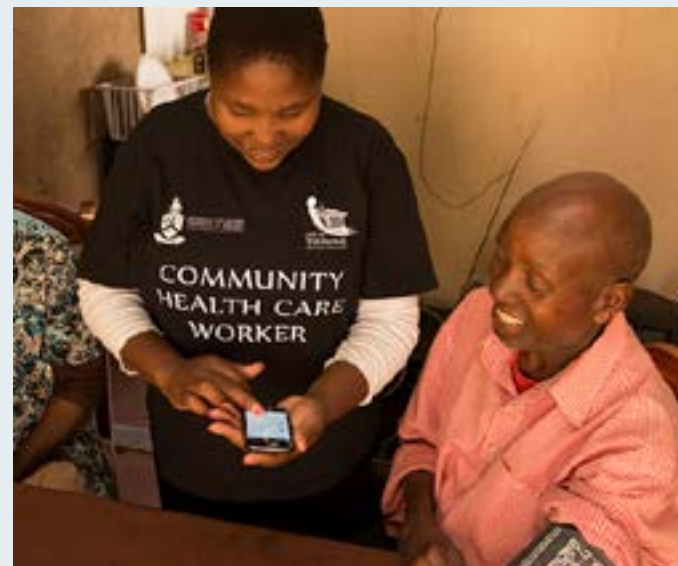
ICT staff shortages result in inadequate ICT support, lengthy support turnover times, provision of ICT support by staff who do not have sufficient skills, and dependence on external service providers. The inability to retain skilled ICT staff due to lack of funding, short-term contracts, low government salary packages, and a lack of career progression hinders digital transformation. It was indicated that donors provide technical support in the form of consultants and secondments but that a huge gap persists locally, especially when donor funding ends.^{iv}

“We have a lot of district support partners...Services would run well while they are there, but once they leave, all those positions fall away. Our DOH human resource structure does not have such posts...There is no skill transfer, and services tend to suffer.” (KwaZulu-Natal DOH, health care interview)

In 2019 there were 243,684 health care workers in the public health sector in South Africa. The sector is predominantly nurse-driven, with nurses making up 56 percent of the health care workforce. Community health workers (CHWs) were 22 percent, and doctors were slightly less than 9 percent.²⁷

CHWs offer HIV and other health education, screening, and adherence support services, trace HIV and TB treatment defaulters, and refer patients to PHC facilities, using mobile tools in a few districts. PHC clinics and community health centers provide nurse-driven PHC services and make referrals to doctors and hospitals, as necessary. Mobile clinics from some PHC facilities provide outreach services to sparsely populated areas. Most public health facility data are collected by means of paper tools standardized throughout the country.

^{iv} Feedback from key informant interviews with 15 health care representatives and 13 digital health and ICT representatives.



Community health worker using mobile application in Gauteng Province, South Africa. Photo: Mezzanine. <https://mezzanineaware.com/aitahealth-4-years-and-1-million-individuals-registered/>. Accessed Oct 25, 2022.

A multitude of systems and applications (see [Inventory](#)) and intermixing of paper and electronic systems have led to duplicate and manual data entry, which is an administrative burden for health workers. Challenges hampering quality of care and efficiency, that can be mitigated by strengthening digital health, include high staff turnover, high patient loads, and staff shortages of CHWs, clinicians, and data capturers.

Use of digital systems

The health workforce utilizes digital health systems and the data they collect to perform job functions. Examples of use by health care providers include utilization of clinical decision support in guiding care delivery, communication between patients and providers (e.g., through telemedicine, which can help resolve staff shortages, especially in rural areas), resource management, and monitoring and reporting from patient care to policy implementation levels.

Health care providers and managers use two main countrywide HIV reporting systems: (i) TIER.Net - a non-web-based electronic register to track ART treatment and care, and (ii) District Health Information Software 2 (DHIS2) - an open source, web-based platform used as a health management information system (HMIS).

While human resources (e.g., PERSAL, or Personnel and Salary System), financial (e.g., BAS, or Basic Accounting System), and pharmaceutical systems (e.g., RxSolutions) are in use, there are insufficient National Indicator Data Set (NIDS) indicators (i.e., vacancy, absenteeism, turnover rates, and cost for medicine per patient), together with health data, to optimize efficiency.

Inadequate information systems lead to administrative burdens, duplicative data collection efforts, and inadequate data-driven decision-making.

Skills development

Barriers to the use of digital systems and tools include a lack of understanding of the importance and benefits of health data; poor data quality; limited capacity to analyze and interpret data for decision-making; lack of computer literacy; gaps in education and training; and gaps in curricula. This results in inadequate pipelines of trained health professionals; inadequate in-service skills development options, especially in rural areas; and insufficient use of ICT for skills development.^v

The NDHS and both provincial DOH ICT Strategic Plans emphasize the need for digital skills development. The NDHS prioritizes the development of a digital health workforce plan, career paths, and several digital health workforce capacity-building initiatives.¹² In 2020, the South African Department of Communications and Digital Technologies published the National Digital and Future Skills Strategy for South Africa⁴⁰ to provide roadmaps for digital skills action points and stakeholder collaboration, and the NDOH published the 2030 Human Resources for Health Strategy.²⁷

The NDOH has a Knowledge Hub and eLibrary⁴¹ to promote easy access to relevant professional digital health development opportunities. A few eLearning modules focus on data quality, the DHIS2, and the NIDS. Although South African universities have started to develop short courses in digital health and are supervising masters and PhD students in digital health topics, educational opportunities remain largely underdeveloped, except for bioinformatics.¹²

While donors provide some support, more assistance is needed to increase skills development opportunities and to train different cadres of the health and ICT staff at subnational levels.^v


“Our systems are not linked - we don’t have a unique identifier...Our loss of patients is really high, it might not be a true defaulter rate because we don’t have a central system to monitor at a national or provincial level. We cannot pick up a person who attends treatment at a different clinic...It is important to look at integration of electronic platforms and be able to monitor clinic hopping and trace patients better. If we had a system like that, the HIV numbers might drop as some people may be recorded in the system three times throughout the country. I’d rather have a system that is patient focused than programme focused. The same individual who needs HIV treatment needs other services...We can have a better idea who this patient is and what they really need if we look at this patient comprehensively. To better serve the patient, a proper integration of all these systems would be better.” (Consultant, health care interview)

^vFeedback from key informant interviews with 15 health care representatives and 13 digital health and ICT representatives.

Summary and Recommended Actions

Table 4 provides a summary of the digital health workforce landscape and recommended actions to address priority gaps within Gauteng and KwaZulu-Natal Provinces. *Any organization acting on the recommendations should engage directly with the province and other relevant stakeholders to ensure they are acting on the highest-priority needs in line with existing efforts.*

Table 4: Findings and recommended actions related to the digital health system workforce in Gauteng and KwaZulu-Natal Provinces.

	eHealth Building Block	Findings and Recommended Actions
 <p>Workforce</p>	<p>Workforce</p>	<p>The National Department of Health and both provinces prioritize the need to address staff shortages, develop digital skills, retain skilled workers, and improve the use of information. Several actions are planned, and many interventions are being implemented. While these efforts are underway, challenges persist, including health care worker digital literacy, data quality issues, information and communications technology (ICT) skill shortages, and retention of sufficient ICT / digital health staff. Knowledge and skills of the digital health and ICT workforce can be strengthened and/or developed through the following short- and medium-to-long-term actions:</p> <p><u>Short-term</u></p> <ul style="list-style-type: none"> • Deploy partner-funded roaming technical support staff and/or ICT specialists to transfer skills to the health department (within focused time frames and predetermined competency transfer targets); implement backfill and handover plans for seconded staff, consultants, and departmental staff leaving posts. • Link individuals to and strengthen existing eLearning platforms and courses offered through partner and government networks. • Support in-service training to improve ICT support, data quality, and data use. • Enable managers to make data-driven decisions by providing one point of access to main cost driver data in the DHIS2 [District Health Information Software 2]. This would require adding basic indicators for (i) human resources (e.g., vacancy, absenteeism, and turnover rates), (ii) finances (e.g., cost per primary health care head count and medication cost per head count), (iii) supply chain (e.g., stock and pharmaceutical), and (iv) diagnostic services (e.g., laboratory and X-rays costs). <p><u>Medium-to-long-term</u></p> <ul style="list-style-type: none"> • Customize and/or develop and implement a province-specific budgeted ICT competency framework and workforce plan that includes in-service skills development plans for each cadre and a supportive supervision strategy. • Partner with local academic institutions to align their curricula to the provincial ICT competency framework. • Strengthen routine health information system data quality and use by developing a three-year costed data quality and use roadmap and supporting implementation. • Offer internship opportunities and job placement with provincial departments of health.



Systems

Optimizing digital health systems can help address many health systems challenges effectively and efficiently to the benefit of patients and health care workers, as well as managers who must plan, manage, and monitor health systems to secure health benefits for all citizens.¹² Successful operation of digital systems and applications rely on a backbone of national and local infrastructure components, including electricity, networks, servers, hardware, and software. They also require standards to enable data collection, exchange, and use/reuse of data within the parameters of an architecture that promotes interoperability.

A **digital health system** “comprises all of the digital technology used to support the operations of the overall health system ... [and includes] software applications and systems, devices and hardware, technologies, and the underlying information infrastructure.”

Source: World Health Organization (2020): [127](#).³

Infrastructure

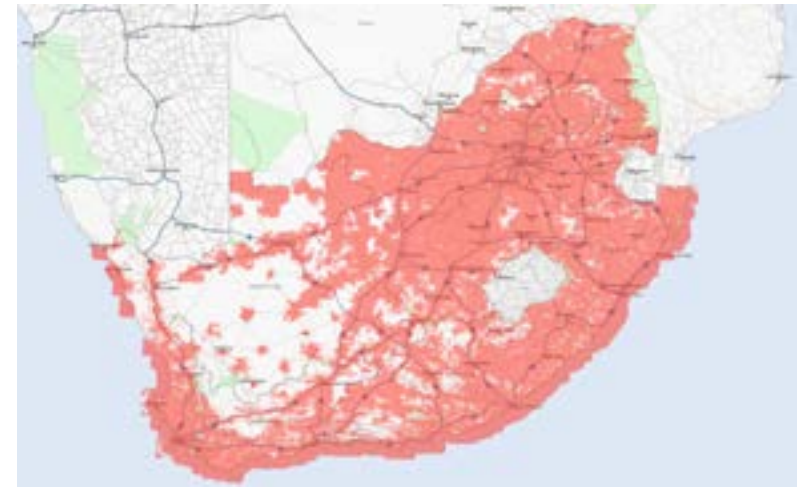
Nationally in South Africa, a high percentage of households are connected to the main electricity grid (90 percent in 2020).⁴² However, access is inconsistent due to rolling electricity outages, which create serious challenges. Despite good mobile network coverage, except in mountainous, rural areas in KwaZulu-Natal (Figure 7), the high cost of data and reported vandalism of the cell phone infrastructure create major hinderances in the uptake and use of digital health solutions.

The State Information Technology Agency (SITA) is the lead national information technology (IT) agency responsible for consolidating and coordinating the government’s IT resources, such as increasing delivery capabilities, enhancing interoperability, and managing the IT procurement, delivery, and maintenance processes to ensure the South African government gets value for money.⁴³

The SA Connect project, first announced in 2013, is a national broadband project designed to meet the government’s goal of creating an inclusive information society. In February 2022, it was announced that the project will connect 44,600 government sites, including schools and health facilities, and will roll out more than 33,000 community WiFi locations and broadband connections to households in the next three years.⁴⁴ Furthermore, the NDHS indicates that the NDOH plans to establish a robust physical and network infrastructure and broadband connectivity in conjunction with relevant government departments, including SITA. Some data are stored in privately owned databases, but the NDOH targets establishment of a cloud service for the health sector by 2024.¹⁷

A summary of key infrastructure findings in Gauteng and KwaZulu-Natal Provinces are provided in the diagram on the right and in Table 5.

Figure 7: 3G mobile coverage in South Africa.



Source: [Vodacom coverage map](#). Accessed Oct 25, 2022.

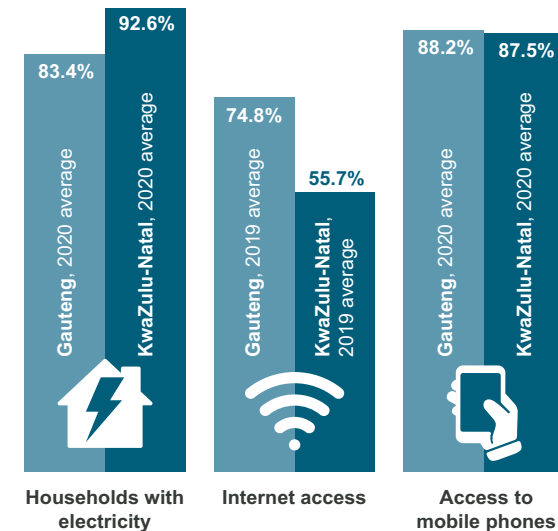


Table 5: Gauteng and KwaZulu-Natal provincial infrastructure components relevant to digital health.

Infrastructure Component	Summary of Findings in Gauteng	Summary of Findings in KwaZulu-Natal
Electricity	In Gauteng, the percentage of households connected to the main electricity supply was 83.4% in 2020. ^a Power outages sometimes exceed the battery time of uninterruptible power supply devices, but backup generators are being installed at health facilities. ^b	In KwaZulu-Natal, the percentage of households connected to the main electricity supply was 92.6% in 2020. ^a Nearly all KwaZulu-Natal health facilities have backup generators which are tested weekly, with a budget to keep a diesel supply. ^b
Connectivity	<p>Among South Africa's provinces in 2019, Gauteng had the highest percentage of households with at least one member having any internet access (74.8%), while internet access at home averaged 14.9% and was higher in metro areas (15.7%) compared to urban (9.4%) and rural (9.0%) areas.^c</p> <p>All hospitals and the majority of health facilities have access to the Gauteng Broadband Network. However, several health facilities have obsolete or unsupported local area network infrastructure, which overrides the potential benefits the Department of Health could gain from high-speed broadband connectivity.^f</p> <p>Challenges such as shortages of network switches, network boosters, ICT staff, and finances, as well as slow infrastructure strengthening processes, hinder connectivity and service delivery.^b</p>	<p>In KwaZulu-Natal in 2019, over half (55.7%) of households had at least one member who could access the internet, while an average of 5.8% of households had access to the internet at home: 9.9% in metro, 6.5% in urban, and 1.1% in rural areas.^c</p> <p>During the 2019/20 financial year, broadband connectivity increased from 66.7% to 80.3% in hospitals and 36.5% to 95.3% in clinics,^d but challenges such as shortages of network points, network boosters, ICT staff, and finances, hinder connectivity.^b</p>
Mobile Phones	In 2020, 88.2% of households in Gauteng had access to a mobile phone. ^e	In 2020, 87.5% of households in KwaZulu-Natal had access to a mobile phone. ^e
Hardware	Challenges include shortages of or outdated hardware and equipment, budget restrictions, and shortages of ICT staff to maintain equipment at facility level. A primary constraint remains the inability to procure products and services speedily through the mandated SITA procurement channel. ^b	Shortages of computers and laptops are experienced, with some devices being more than ten years old. Procurement processes that are managed at provincial level were identified as inadequate and slow and SITA was noted as a bottleneck. Additionally, there is a shortage of ICT staff to maintain equipment at the facility level. ^b
Data Storage & Cloud Computing	The infrastructure platform (VBlock) lacks some of the intended capability envisaged with initial acquisition and is unsupported. In addition, the adoption and implementation of closed-circuit television technologies have resulted in multiple stand-alone infrastructure platforms. ^f	The KwaZulu-Natal Department of Health is developing a Provincial Health Data Centre (PHDC) to expand data science capacity. ^g An interviewee indicated that the project is unable to set up the multiple virtual servers needed to effectively operate, and it was emphasized that server infrastructure needs an urgent upgrade. ^b

Sources:

- a. Statistics South Africa (2020): 43, [Fig. 12.1](#).⁴²
- b. Feedback from key informant interviews with 15 health care representatives and 13 digital health and ICT representatives.
- c. Statistics South Africa (2019): 51-52, [Fig. 13.3 and Table 13.1](#).⁶
- d. KwaZulu-Natal Department of Health (2021): [7](#).¹⁵
- e. Statistics South Africa (2020): 46, [Fig. 13.1](#).⁴²
- f. Gauteng Department of Health (2020).¹⁶
- g. KwaZulu-Natal Department of Health (2021).³⁹

Abbreviations: ICT, information and communications technology; SITA, State Information Technology Agency.

Standards and Interoperability

Standards and interoperability are critical to the success of digital health technologies because they enable consistent and accurate collection and exchange of health information across digital health systems and services. This can drive cost efficiencies, reduce fragmentation of information, and support data-driven continuity of patient-centered care across disparate facilities and providers.³

Standards provide a common language and a common set of expectations (e.g., vocabulary, format, transport, process) that enable data collection and exchange between systems, platforms, and organizations to reuse data and reduce fragmentation. *Source:* World Health Organization (2020): [79](#).³

Interoperability is “the ability of different applications to access, exchange, integrate, and use data in a coordinated manner through the use of shared application interfaces and standards.” *Source:* World Health Organization (2020): [12](#).³

Digital health platform

To effectively support integrated service delivery, a digital health platform is required. The NDHS contains a conceptual overview of a digital health platform and states that it will establish “resources such as cloud infrastructure and an environment for supporting sophisticated data science activities.” It will also “provide a common, shared platform for collaboration, and an enabling environment for innovation,” while strengthening stakeholder participation.^{12(p21)}

A **digital health platform** is a collection of common generalized components, including data sources and information flows, that can be reused to ensure that digital health applications conform to common data standards and are able to exchange information. *Source:* World Health Organization (2020):[11,127](#).³

Digital health enterprise architecture (DHEA)

Standards are normally articulated as part of a DHEA which outlines the business processes, data, systems, and technologies used to support operation of the health system (including the digital health platform) to function in a purposeful and unified manner. A DHEA can have varying degrees of maturity and institutionalization within the broader ecosystem (Figure 8) that range from **siload**, disconnected applications to **integrated** applications that enable system-to-system exchange up to, ultimately, **exchanged** architecture that is modular and uses standards to connect multiple applications through an intermediary in a coordinated manner.³

A national DHEA can lower the financial and management burden of competing digital systems; strengthen national health institutions and the provision of health care overall; and promote the effectiveness, reach, and cost-efficiencies of digital investments.⁴⁵

The National Health Normative Standards Framework (HNSF) for Interoperability in eHealth 2014⁴⁶ provides the baseline for creating a standards-based, interoperable HIS in South Africa. It provides a high-level, ideal HIS framework and informed a proposed national DHEA (Figure 9).⁴⁷ A desired future state consists of the national DHEA and a health information exchange (HIE) that provides core data exchange functions that are periodically reviewed and updated to meet the needs of the changing DHEA. This future state also includes health information standards for data exchange, transmission, messaging, security, privacy, and hardware that are used to ensure the availability of high-quality data, as well as an interoperability framework and guidelines that are consistently used and regularly updated based on lessons learned.⁴⁸

Currently, a lack of national or provincial HIE platforms (in both provinces) is a limiting factor and leads to many point-to-point connections, which increases costs and levels of effort for staff. In addition, the HNSF’s vision for interoperability is outdated and not well defined or specific enough for implementation, making it challenging for provinces and local health system leaders to comply.⁴¹ The NDHS prioritizes the updating and expansion of the HNSF, extending it into an open standards-based health enterprise architecture and implementing HNSF conformance testing as a minimum for all HISs.¹² Work on this has been started and will provide future guidance.

Both provincial DOH ICT Strategic Plans indicate intentions to develop local DHEAs and KwaZulu-Natal specifically indicates plans to align their DHEA with the HNSF. KwaZulu-Natal also plans to implement an integrated digital health platform, while Gauteng prioritizes the implementation of a provincial HIE for linking existing clinical and non-clinical systems within public and third-party information systems.^{16, 25}

A **digital health enterprise architecture** provides a holistic vision or framework for how various systems should capture, store, standardize, manage, or share information across the health sector. *Source:* World Health Organization (2020): [83](#).³

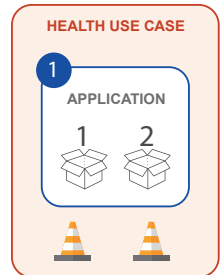
A **health information exchange** provides core data exchange functions. It “enables sharing of electronic health-related information among compliant health information systems used in health facilities... by controlling and mediating standard-based messages between compliant consumer applications and shared registers and repositories.” *Source:* Wolmarans M, Tanna G, Dombo M, et al. (2015): [37](#).⁴⁷

³Feedback from key informant interviews with 15 health care representatives and 13 digital health and ICT representatives.

Figure 8: Digital health enterprise architecture: Degrees of maturity and institutionalization.

SILOED

A digital health enterprise system architecture composed of standalone application(s). A digital health project is a time-bound implementation of a siloed digital health enterprise, usually to demonstrate proof of concept.



PROJECT GOALS

Ineffective

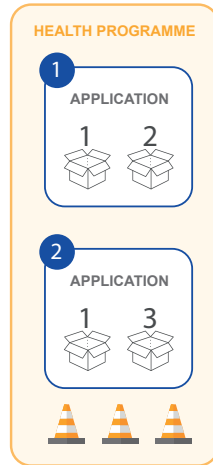


MUD

Monolithic Un-architected software Distribution. Applications characterized by an evolving agglomeration of functions, originating without a predetermined scope or design pattern, which accumulate technical debt

INTEGRATED

A digital health enterprise system architecture in which two or more digital applications are directly connected to each other (i.e., without an intermediary data exchange) intended to address one or more health system challenges and fulfil health programme goals.



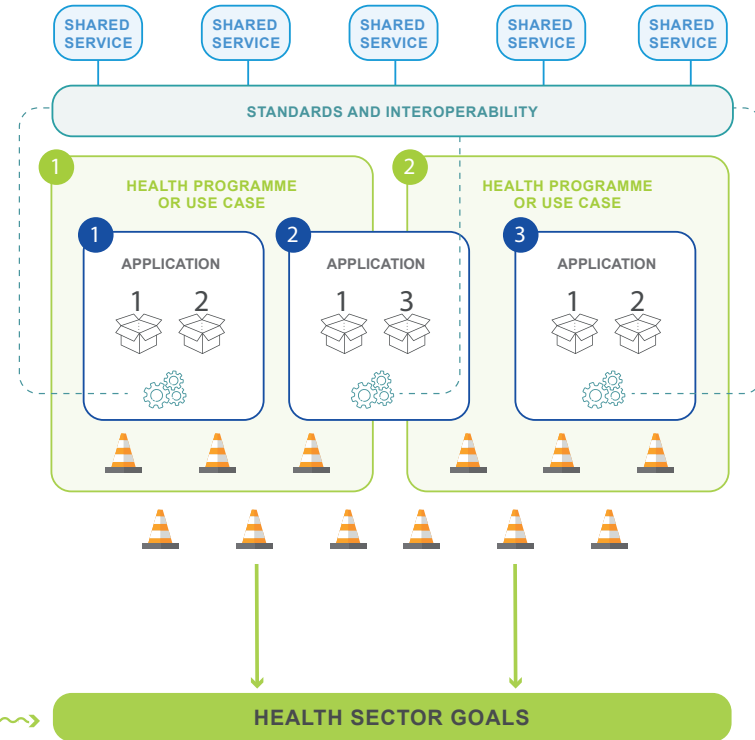
HEALTH PROGRAMME GOALS

Ineffective

Ineffective

EXCHANGED

A digital health enterprise system architecture consisting of multiple applications using standards to connect through a health information exchange to address collective needs across the health sector, operating in a coordinated manner within a digital health architecture.



TECHNICAL DEBT

ECONOMIES OF SCALE ALIGNMENT WITH DIGITAL HEALTH STRATEGY



Digital Health Intervention



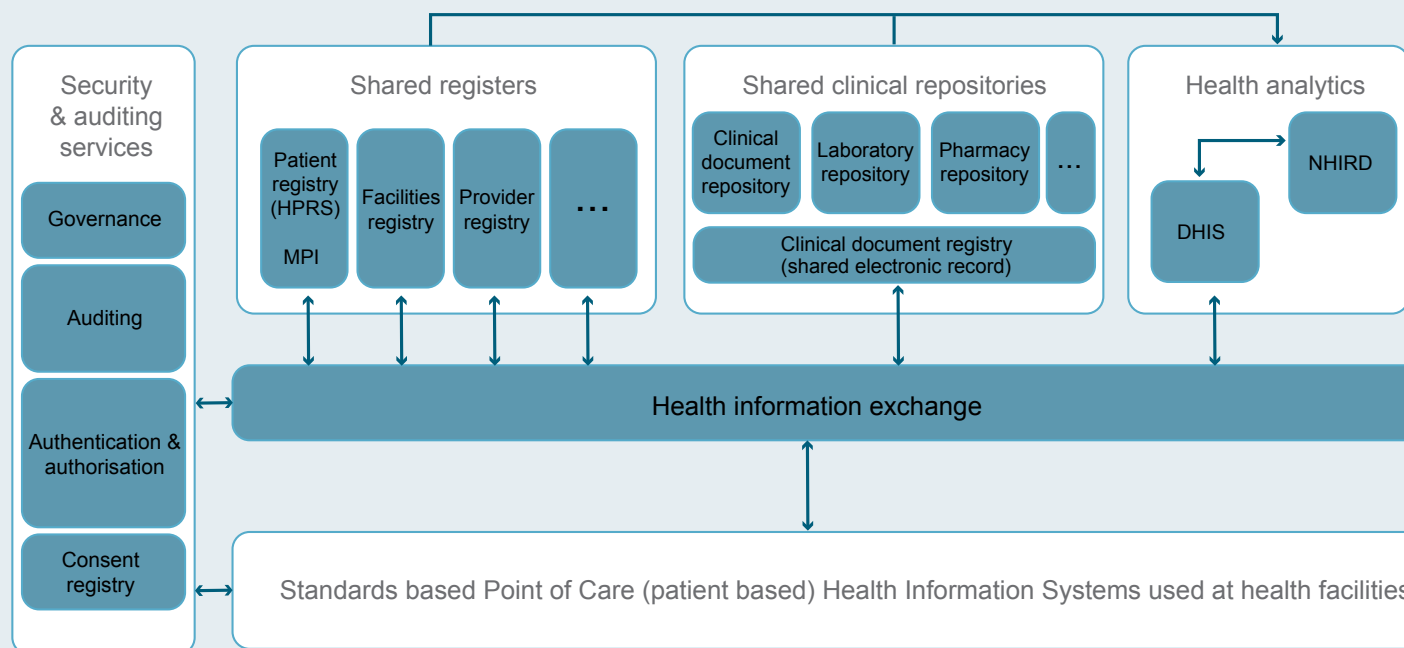
Health System Challenge



Reusable functionalities

Source: World Health Organization (2020): 13.³

Figure 9: Proposed national enterprise architecture adopted from the National Health Normative Standards Framework (2014).



Source: Wolmarans M, Tanna G, Dombo M, et al. (2015): 37, [Fig.1](#).⁴⁷

Abbreviations: DHIS, District Health Information Software; HPRS, Health Patient Registration System; MPI, master patient index; NHIRD, National Health Information Repository and Data Warehouse.

Master patient index (MPI)

One unique identifier per patient across all health facilities throughout the country is essential for high-quality, patient-centered care. The NDHS prioritizes using an MPI as a unique identifier within and across provinces when establishing a DHEA. In support of developing an MPI, some public health facilities have implemented a health patient registration number (HPRN) through the Health Patient Registration System (HPRS),¹² but challenges with unique identification occur both within facilities and when patients move between facilities.^{vii} Duplicate HPRNs caused by lack of or intermittent internet connectivity is a contributing factor.⁴⁹ Stable network and internet connections in all health facilities and implementation of the HPRN in all clinics and hospitals will assist with preventing duplication of patients and tracing of defaulters and will improve continuity, effectiveness, and efficiency of care, as well as data quality around ART initiation, retention in care, and loss to follow up.

^{vii} Feedback from key informant interviews with 15 health care representatives and 13 digital health and ICT representatives.

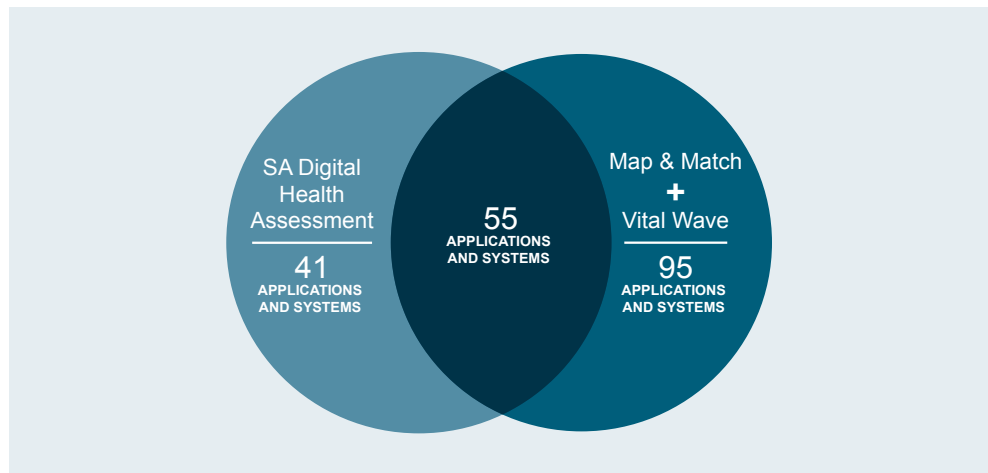
Services and Applications

Inventory

Ideally a country would have regularly updated inventories for hardware and for systems and platforms.⁴⁸ Lack of a centralized inventory of existing digital health systems and applications results in poor coordination, fragmentation, and expensive duplication of systems and funding in certain areas, with gaps in others. The need for a centralized digital inventory was emphasized by both provinces.^{viii} It also became clear that several digital health landscape assessment projects, sometimes by the same funders, collect similar data that are not made available in an inventory format in the public domain. This results in duplication, inadequate use of resources, and poor participation in assessments.

During this assessment 96 systems and applications were identified: 72 by interviewees and through literature and 24 through an online questionnaire. As shown in the diagram, 41 of these were unique systems, while 55 were also identified by digital health assessments conducted in South Africa in 2021 by Vital Wave (funded by the Gates Foundation) and the Map & Match project under Digital Square (funded by the US Agency for International Development [USAID]). Together these two projects listed a total of 150 systems and applications, of which 95 were unique, bringing the total number between the three projects to 191 unique systems and applications. Other sources, for example South African mHealth Start-ups,⁵⁰ indicate that many more digital tools are used in the country.

The registries, systems, applications, and tools identified during this assessment and mentioned in this report are described in [Appendix A](#) and [Appendix B](#), while systems identified by [Map & Match and Vital Wave](#) can be viewed on the Digital Square website.



^{viii} Feedback from key informant interviews with 15 health care representatives and 13 digital health and ICT representatives.

Electronic health record (EHR)

One of the five priorities outlined in the NDHS is the development of a complete EHR to improve patient management,¹² a need emphasized by both provinces^{16, 25} to address the challenges caused by multiple paper tools and electronic systems that are not interoperable.^{viii}

In preparation for an EHR, Gauteng is implementing an integrated, interoperable HIS (including HPRS) across its hospitals and PHC facilities to establish a single, integrated electronic medical record (EMR) and provide a 360-view of the patient across the Gauteng health system.¹⁶ In KwaZulu-Natal, some progress toward an EHR has been made through the HPRS as well as the KwaZulu-Natal eHealth Rollout Project, which aims to establish a single, integrated EMR through implementing an in-house developed hospital information system.³⁸

Effective support of integrated service delivery and an EHR requires standard digitized business processes, the availability of quality clinical patient information, interoperable registries, a common digital health platform, and an HIE.

An **electronic health record** is a digital version of a patient's medical records generated by a patient's health care provider. A health information exchange (HIE) allows health care providers to electronically access and share a patient's medical record on demand, at the point of care. The goal is to have all providers, including hospitals, connect their EHRs to an HIE to help streamline transitions of care and share vital information with other health care organizations in a timely manner. *Source:* Pai D.R, Rajan B, Chakraborty S. [Do EHR and HIE deliver on their promise? Analysis of Pennsylvania acute care hospitals](#). International Journal of Production Economics. 2022; 245:108398.

Business processes

Standardized, automated, facility-based business processes enable the adoption and integration of information systems into provider workflows and inform the development of an EHR. The NDOH¹² and both provinces^{16, 25} have prioritized the digitization of health system business processes to improve efficiency and quality of services, and reduce paper and printing for clinical and non-clinical processes. This can be achieved by conducting business impact assessments; documenting critical business functions, key activities, resources, and partners; and standardizing business processes.

The Draft KwaZulu-Natal eHealth Rollout Project Charter aims to standardize health practices by developing a roadmap to digitize all health-centric business processes,³⁸ while the Gauteng DOH ICT Strategic Plan lists several interventions to achieve business processes digitization.¹⁶

Shared clinical repositories

A complete EHR contains patient clinical information related to health care encounters, including diagnostic services and medicines. Reliable and consistent access to these data is crucial for HIV and other conditions for which treatment should not be interrupted.

Currently in both provinces, individual patient diagnostic results must be recaptured in TIER.Net and other EMRs, while aggregated laboratory and other data must be recaptured in the DHIS2. These duplicative steps result in delays and data quality issues.^{ix} Shared clinical repositories should also include data for monitoring the effectiveness and efficiency of supply chain and diagnostic services, enabling health care providers and managers to make data-driven individual and population-level public health decisions, as well as monitor policy and strategy implementation.

To support the development of shared clinical repositories, the NDOH plans to “establish data sharing agreements ... [with] third-party information systems to bring data into the national platform, prioritizing data from laboratory and pharmacy information systems.”^{ix} Gauteng DOH’s provincial HIE will also link existing clinical and non-clinical systems within public and third-party information systems.¹⁶

The following related systems are currently in use in both Gauteng and KwaZulu-Natal: the Central Chronic Medicines Dispensing and Distribution (CCMDD) program to improve access to essential chronic medication (including ARTs); RxSolution as a pharmaceutical management system; the Stock Visibility System (SVS) mobile application for stock-level management; and TrakCare to enable health care providers to search for the laboratory results of individual patients.

Shared registries/services

To support a complete EHR and integrated service delivery, interoperable registries with authoritative and reusable information across different applications are required. Table 6 describes the key national-level registries that are used by both provinces. Currently there are multiple registries that serve the same function and many siloed registries, which are not interoperable and do not exchange data (no relevant access for third-party software). In addition, registries are centralized at the national level, with provinces often lacking access for maintaining the data to ensure they are timely and relevant.^{ix} Until registries are rationalized and accessible, provincial progress toward digital transformation will be hampered.

“The desire to centralize everything at a national level is sometimes not actually viable. Things sometimes need to run at a provincial level because the province has more interactions with the services and with the workflows that happen within the province...e.g., different drugs get used across different provinces, there are different laboratory tests that are requested, coding is different. It’s difficult to capture all that in a registry, because it takes a lot of people to keep all of that data relevant and live. The data has to be recent. For example, the provider registry, the bank of doctors and nurses becomes useless if it’s not updated regularly.” (Consultant, digital health and ICT interview)

^{ix} Feedback from key informant interviews with 15 health care representatives and 13 digital health and ICT representatives.

Table 6: National registries for health in South Africa.

National Registry	Summary Description	Key Findings and Information
National Population Register	Serves as a birth and death registry.	<ul style="list-style-type: none"> It is maintained by the Department of Home Affairs. It captures a high percentage of deaths and births in the country, for example: <ul style="list-style-type: none"> » 86.9% of births were registered in 2020.^a » Adult deaths during the 2011–2016 intercensal period were estimated at 97% for males and 95% for females.^b Linkage with the Health Patient Registration System (HPRS) is needed in the provinces to avoid patient duplication and to support development of an electronic health record (EHR).^c
Patient Registry / Master Patient Index (MPI): Health Patient Registration System (HPRS)	A networked system to register all patients at public health facilities, allowing for unique identification using a ten-digit health patient registration number (HPRN). Aims to be the authoritative source of patient demographic information, allowing authorized applications and systems to exchange data. ^d	<ul style="list-style-type: none"> The HPRN supports the development of an MPI to facilitate implementation of an EHR.^e Links have been established with the National Health Laboratory Service, or NHLS (to the central HPRS database), and TIER.Net (to a local HPRS database on the same local area network).^d There is a lack of integration with other eHealth interventions such as MomConnect, the Stock Visibility System (SVS), and community health worker systems, which are often the first point of contact with patients.^c Internet connectivity issues affect real-time checking of existing HPRNs, leading to duplicate entries,^f which negatively impacts the system's effectiveness and usefulness.
Facilities Registry and Metadata Repository: National Data Dictionary (NDD) *	Contains all public health care facilities in South Africa that submit data through the DHIS2 [District Health Information Software 2]. Developed to facilitate data exchange. ^g	<ul style="list-style-type: none"> The NDD excludes some private organizations and nongovernment facilities. It is openly available, with registration only required to submit changes for approval. A governance mechanism and accountability exist. However, data are incomplete, fragmented, and in some cases, outdated.^h No information on linkage with third-party systems could be obtained
	Also serves as a metadata repository, containing up-to-date versions of dataset specifications for the National Indicator Data Set, or NIDS) (e.g., data elements, indicators, and data validation rules). ^g	<ul style="list-style-type: none"> The NDD enables standardized monitoring and reporting across all public health facilities and by all public health managers at all levels.
Facilities Registry: Master Facility List (MFL) *	Claims to contain a complete list of all public and private health facilities in South Africa. ⁱ	<ul style="list-style-type: none"> The MFL is not openly available; information is only accessible to registered facilities and approved third-party systems.ⁱ Neither content nor linkage to any other systems could be verified.
Provider Registry / Health Worker Registry: Human Resource Information System (HRIS)	A service provider registration system created in preparation for NHI [National Health Insurance] implementation. ^e	<ul style="list-style-type: none"> The HRIS contains demographic information of health service providers, including doctors, nurses, and CHWs.^e It provides the information necessary to support the health workforce and training.^e It includes a Human Resources for Health (HRH) registry, an HRH data warehouse (DHIS2), and an HR portal.^{c, e} It connects with various other systems at the National Department of Health (NDOH) through an interoperability layer (OpenHIM).^c

Sources:

- a. [Recorded live births 2020](#) [media release]. Pretoria: Statistics South Africa; November 11, 2021.
- b. Statistics South Africa. [Mortality and Causes of Death in South Africa: Findings from Death Notification](#). Pretoria: Government Printers; 2017.
- c. Feedback from key informant interviews with 15 health care representatives and 13 digital health and ICT representatives.
- d. Wolmarans M, Tanna G, Dombo M, et al. (2015).⁴⁷
- e. National Department of Health (2019): [15](#).¹²
- f. PATH (2021).⁴⁹
- g. National Department of Health. National Data Dictionary website. [Home page](#). Accessed Oct 25, 2022.
- h. Mtsweni N, Combrink H, Van der Walt A, Marivate V. [Mapping the South African health facility landscaping in response to COVID-19](#) [blog]. *Data Science for Social Impact*. May 25, 2020.
- i. National Department of Health. Master Facility List website. [About/login page](#). Accessed Oct 25, 2022.

*Two health facility registries were identified, but no evidence of a complete facilities registry for the country was found; therefore, progress on development of a true master facility list⁵¹ could not be established.

Systems, applications, and tools

South Africa has numerous vertical and siloed digital HISs and applications at all levels, with donors creating additional vertical systems and applications for monitoring the priorities they focus on.^x Effectively coordinating digital health applications and making them interoperable will strengthen HISs, transform the way health services are provided and change how people engage with health services. Digital health interventions may alleviate several health care delivery constraints in both provinces, including high numbers of patients and long waiting times; patient referral challenges (especially from hospitals to PHC facilities and with tracking of patients in communities); staff shortages; inefficient use of time; numerous and vertical paper data collection tools; and poor data quality and use.

Digital health applications are the “software, ICT systems, and digital tools used in the health sector... Digital health applications can connect to and exchange data through the digital health platform,” which is a “digital health information infrastructure (‘infostructure’) that digital health applications and systems are built upon in order to deliver digital health services for supporting health care delivery in a consistent and integrated manner.” *Source:* International Telecommunications Union (ITU) and World Health Organization (WHO). [Digital Health Platform Handbook: Building a Digital Information Infrastructure \(Infostructure\) for Health](#). Geneva: ITU/WHO; 2020: 6.

KwaZulu-Natal DOH is implementing an in-house-developed, province-specific hospital information system that interfaces with existing information systems through linking with the HPRS.³⁸ The KwaZulu-Natal eHealth System was piloted in 2 hospitals in March 2020 but has since been deployed to 14 hospitals. It is still at the developmental stage and progress is slow.^x Gauteng DOH is implementing a new Gauteng-specific HIS to replace its legacy information systems. This integrated, interoperable HIS (which includes an HPRN generated through the HPRS for unique patient identification) was piloted in six CHCs between November 2020 and April 2021. Since then, it has been implemented in sixteen CHCs and in five hospitals.⁵²

“There is no such thing as a good tool badly implemented, it’s a bad tool if you haven’t thought about the implementation from when you started it... Digital health tools have hidden resource and capacity constraints we fail to recognize... they [digital tools] are a great opportunity to streamline and optimize processes but we have to think from the [perspective of] process use and not [from] the technology.”
(Consultant, digital health and ICT interview)

^x Feedback from key informant interviews with 15 health care representatives and 13 digital health and ICT representatives.

Stakeholders at both the provincial and district levels identified the need to scale existing systems and applications, develop new tools, and adapt existing tools to meet specific needs, especially those that will have strong interim value until an EHR is finalized:

- » *TIER.Net*: This system is used to track treatment and care for HIV and TB patients at public health facilities. High loss to follow up of ART patients is affected by TIER.Net not being web-based with a countrywide unique identifier per patient. A true defaulter rate cannot be determined because patients attending treatment at different clinics cannot be traced. A countrywide unique identifier will reduce not only data duplication but also costs associated with patients obtaining more medication than they need. It also will enable integrated reporting and analysis of ART data, as well as the possibility for additional relevant patient data. In facilities where the HPRS is implemented, the HPRN is used on paper patient files and captured in TIER.Net.
 - » *DHIS2*: Also known as the webDHIS in South Africa, the DHIS2 is the national data repository for the NIDS²⁰ for routine capturing, monitoring, and reporting of standardized aggregate data across all public health facilities. Some automated and semiautomated data exchange does occur within the DHIS2, but a need for automated data exchange with TIER.Net was indicated.^x
 - » *Mobile health applications*: The NDOH¹² and both provinces^{16, 25} prioritize the scaling of mobile initiatives, with emphasis on community services. This assessment identified two promising mobile applications with scaling potential. Both are global goods,⁵³ interoperable with DHIS2, and received positive feedback from CHWs and managers, but wasn’t scaled due to funding limitations.^x
 - (i) *CommCare for CHWs*: Piloted in Ekurhuleni District in Gauteng Province.
 - (ii) *DHIS2 Tracker for CHWs*: Piloted in Free State Province.
- Several other mHealth initiatives have been implemented (e.g., MomConnect, the Stock Visibility System [SVS], and the NIDS app). The NDOH plans to establish a Health Play Store to host approved mobile health apps.¹²
- » *eTick Register*: This tool was developed by the Public Health Unit in Ekurhuleni District of Gauteng to digitize the paper tick registers used countrywide in all government PHC facilities for collecting NIDS data.

A national telemedicine system for South Africa was planned in 1998 and 28 pilot sites were established in six provinces in 1999. However, low usage of the telemedicine system raised questions about its cost-effectiveness.⁵⁴ Currently telemedicine is not widely used in either of the two provinces,^x but it could connect providers and individuals unable to travel or located in remote areas.

Several targeted client communication interventions implemented by the NDOH and partner organizations were identified, but informal discussions and literature indicated that many more are in use. An in-depth assessment may assist with identifying whether the content addresses key challenges, where alignment is needed, and whether some applications can be scaled.

Data flow and quality

In public health facilities, most HIV and other disease data are captured using nationally standardized paper patient records and NIDS data collection tools:

- **Community level:** CHWs use nationally standardized paper tools to register households and document the care they provide. Aggregated CHW activity data in the NIDS (11 data elements and 3 indicators), published in the National Data Dictionary (NDD),⁵⁵ include the number of TB and HIV defaulters traced. Subtotals for the CHW NIDS data are manually calculated and captured for each Ward-Based Primary Health Care Outreach Team in the DHIS2 per PHC facility. Mobile solutions, like CommCare for CHWs and DHIS2 Tracker for CHWs, will assist in enhancing quality and efficiency of CHW services and data.
- **Health facility level:** Clinicians fill out several paper records for each individual patient, and data capturers capture the TB and HIV data in TIER.Net at the health facility level. Clinicians also capture NIDS data by using a standardized paper-based tick register. Subtotals for the NIDS data are manually calculated and captured in the DHIS2 per facility at the lowest level where computers and connectivity are available (usually at the facility level but sometimes at the subdistrict level when facilities are not connected). The flow of HIV and TB data from and between TIER.Net and the DHIS2 is currently a mix of paper and electronic means (Figure 10).⁵⁶ The eTick Register was noted as a tested solution to addressing challenges not only with various data capturing and paper-based registers but also with patient care, fragmentation in data collection and tools, and data quality.

Challenges with paper tools include the presence of several different records for the same patient; lost records with no backup systems; time required to complete paper forms and do manual aggregation, especially given clinician shortages; printing costs and insufficient storage space; referral and self-referral challenges that result in poor continuity of care; the incidence of HIV patients getting lost to follow up; and patient records duplication.

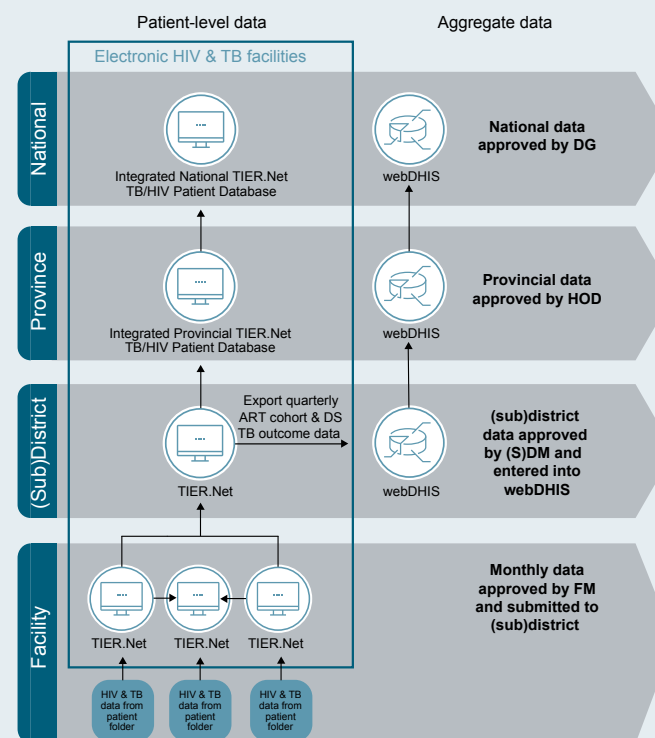
The Draft KwaZulu-Natal eHealth Rollout Project Charter aims to address these challenges by digitizing patient files through backlog capturing of patient profiles, backlog scanning of patient records, and developing and implementing the eHealth System in hospitals.³⁸ In Gauteng, the new HIS and the eight ICT goals with their specified interventions, will address data flow, data quality, and several other health program- and health system challenges.¹⁶

Paper tools identified for digitization (apart from the CHW tools and tick register, for which scalable solutions were recommended) include patient record stationery for data on HIV, voluntary medical male circumcision, pre-exposure prophylaxis (PrEP), post-exposure prophylaxis, and sexual assault.

Digital interventions can improve data quality. However, interviewees across Gauteng and KwaZulu-Natal mentioned several causes of inadequate data flow and poor data quality, including inaccurate data collection and capturing, TIER.Net being a non-web-based solution,

intermittent internet, and lack of interoperability. KwaZulu-Natal indicated the need for support to use the DHIS2 Rapid Internal Performance Data Audit (RIPDA) tool (which mimics the Auditor-General of South Africa's performance data quality audits), and/or other data quality assessment tools.^{xi}

Figure 10: TB/HIV data flow (TIER.Net and DHIS2).



Source: National Department of Health (2019): 16.⁵⁶

Abbreviations: ART, antiretroviral therapy; DHIS, District Health Information Software; DG, director general; DS, drug-sensitive; FM, facility manager; HOD, head of department; (S)DM, (sub)district manager; TB, tuberculosis.

Note: DHIS2 is also known as the webDHIS in South Africa.

^{xi} Feedback from key informant interviews with 15 health care representatives and 13 digital health and ICT representatives.

Data science

Data science can leverage health information and identify new insights to help make progress toward the desired digital health ecosystem. The NDOH prioritizes establishment of “data science capability to source technologies such as big data, artificial intelligence, and predictive analytics,^{112(p30)} as does Gauteng¹⁶ and KwaZulu-Natal.²⁵

The KwaZulu-Natal Data Warehouse Project aims to establish a Provincial Health Data Centre (PHDC) to build capacity in data science and promote timely availability and use of high-quality data and visualizations.³⁹ In South Africa, Western Cape is the only province with a formal data warehouse model.⁵⁷ Efforts to set up a similar model in KwaZulu-Natal are promoting interoperability and paving the way for using individual patient data to more accurately assess health program coverage and impact, starting with HIV and TB.³⁹ However, interviewee feedback indicated that little progress has been made, mainly due to lack of data access.^{xii}

The Gauteng DOH emphasizes the evolution from eHealth to digital health with the focus on 4IR technologies to strengthen the Gauteng health system and facilitate effective use of data to improve health outcomes. The Gauteng DOH plans to develop a provincial health observatory, linked to public and private health data sources (including NGOs, Institutions of Higher Learning, government departments and citizens) with analytics capacity (including predictive analyses) and block chain technology. This will promote data driven decision-making in terms of changing population health needs, population health outcomes, workforce, financial investments, and other aspects of health care.¹⁶

Global goods

This assessment identified several approved global goods used in South Africa (Appendix A).⁵⁸ Before new applications are developed, existing tools and global goods should be considered to prevent duplicative development of single-use applications and their associated costs, especially in low-to-middle-income settings.

Global goods are digital health software tools that can be reused and adapted to different countries and in different contexts to strengthen health systems. Also referred to as digital public goods, there are three types of global goods:

- Software – Tools that are free, open source, and used to manage, analyze, or transmit health-related data, with proven utility in diverse settings.
- Services – Software tools (see above) that can be freely accessed and that adhere to open data principles.
- Content – Resources, toolkits, or data standards that are available under an open license and that are used to improve or analyze health data management processes.

Source: Digital Square (2022): [7](#).⁵³


“It’s more optimization than implementation of new systems...there are enough existing systems like HPRS and Tier.NET that is far from being optimally implemented.” (KwaZulu-Natal Consultant, digital health and ICT interview)

^{xii} Feedback from key informant interviews with 15 health care representatives and 13 digital health and ICT representa-

Summary and Recommended Actions

Table 7 provides a summary of the digital health system technology landscape and recommended actions to address priority gaps within Gauteng and KwaZulu-Natal Provinces. *Any organization acting on the recommendations should engage directly with the province and other relevant stakeholders to ensure they are acting on the highest-priority needs in line with existing efforts.*

Table 7: Findings and recommended actions related to digital health system technologies in Gauteng and KwaZulu-Natal Provinces.

 Systems	eHealth Building Block	Findings and Recommended Actions
	Infrastructure	<p>Nationally and in both provinces, a high percentage of homes are connected to electricity, and there is good mobile network coverage (except in mountainous, rural areas in KwaZulu-Natal). Countrywide electricity outages occur and to mitigate the challenges, the provincial departments of health are installing backup generators in health facilities. The outages, high data costs, and vandalism affect mobile connectivity, impacting access to and use of digital health interventions to support patient care. Other challenges are shortages of hardware, outdated hardware (with some devices being more than ten years old) and slow procurement processes of products and services. Fragmentation of the digital infrastructure and lack of sufficient resources impede improvements and reliability.</p> <ul style="list-style-type: none"> • Strengthen and/or develop an online information and communications technology (ICT) infrastructure inventory and a costed procurement and infrastructure maintenance roadmap to support effective and efficient management of digital health infrastructure. • Prioritize computers and other equipment for health facilities, information officers, and ICT staff to ensure connectivity and prevent gaps in data. • Strengthen connectivity by providing network boosters in facilities with poor signal strength and/or topping up mobile data when the limit is reached to enable capturing and submission of data.
	Standards & Interoperability	<p>A proposed national digital health enterprise architecture (DHEA) was published in 2014^a and is in the process of being updated, but currently it is outdated and not specific enough to inform implementation. Provinces need a framework with detailed plans, including digital health and health information exchange (HIE) platforms, to align their system investments in a coordinated way for data collection, sharing, and use to improve services delivery and outcomes.</p> <ul style="list-style-type: none"> • Strengthen and/or develop a generic, open standards-based DHEA framework that provinces can easily customize. This includes a long-term vision on how various systems should capture, store, standardize, manage, and share information across the health sector and ensures alignment with national plans. • Strengthen and/or develop a digital health platform for KwaZulu-Natal to ensure that digital health applications conform to common data standards and are able to exchange information to effectively support integrated service delivery. • Strengthen and/or develop a health information exchange (HIE) to serve as an intermediary for data exchange between applications and data sources on the digital health platform.
	Services & Applications	<p>A total of 191 unique applications and systems were identified, but there is no central inventory of this information in the public domain to enable coordination across provincial health leaders, donors, and other partners. This contributes to duplicate applications and intermixing of paper tools and digital systems that are not interoperable, causing administrative burdens for providers. Plans have been outlined to move toward a complete electronic health record (EHR) for providers to access patient information in one place including: standardizing and digitizing business processes, linking shared clinical repositories, and rationalizing shared registries/services, which may all hamper efforts, if not addressed. Looking across the landscape of existing systems and applications, opportunities exist to scale proven, high-impact solutions and invest in high-priority applications that will provide reusable data across other systems.</p> <p>Improve alignment of investments and initiatives:</p> <ul style="list-style-type: none"> • Strengthen and/or develop an online inventory of existing and planned digital health systems/technologies and initiatives in the public domain to improve transparency and coordination of funding, reduce costly duplication of effort and initiatives, and enhance sustainability. The Digital Health Atlas^b can assist with addressing the need for a digital inventory accessible to stakeholders.

	eHealth Building Block	Findings and Recommended Actions
	Services & Applications	<ul style="list-style-type: none"> • Announce a call to action for donors, partners, and the private sector to capture innovative digital health solutions (preferably open source) in the public inventory to prevent duplication and identify opportunities to partner/leverage/scale. • Include a requirement in grants and contracts, donor agreements, etc. to share information on digital health investments in the online inventory. • Strengthen and/or develop a roadmap for standardized and digitized business processes for KwaZulu-Natal to enable the adoption and integration of information systems in preparation for an EHR. <p>Scale proven, existing applications that are low-cost, high-impact interventions to enhance coverage, quality of care, and efficiency:</p> <ul style="list-style-type: none"> • The CommCare for community health workers (CHWs) and the District Health Information Software 2 (DHIS2) Tracker for CHWs mobile applications (both Global Goods) digitize the capturing of data collected by CHWs to assist with CHW activity planning, service provision, monitoring, and reporting. • The eTick Register, which allows digital collection and aggregation of essential patient data from the National Indicator Data Set (NIDS) in public health facilities, assists in addressing challenges such as inefficient use of clinician time, shortages of data capturers, poor data quality, and inadequate data use. <p>Expand use of mobile applications to meet current stakeholder needs and address challenges:</p> <ul style="list-style-type: none"> • Fund maintenance of the existing NIDS mobile application (called the “NIDS app”), which is a low-cost, high-impact intervention that makes the NIDS definitions, descriptions, and guidance on which data collection tools are to be used, available at the push of a button. Standardized implementation of these indicators is crucial to optimize the quality of data used for planning, monitoring, and reporting. • Develop a mobile application to support standardized implementation of the health patient registration number (HPRN) as a unique identifier in all digital and paper tools across connected and nonconnected health facilities in support of a master patient index (MPI). • Digitize existing paper-based data collection tools for HIV (after prioritization within each province), including tools for HIV counseling, voluntary medical male circumcision, pre-exposure prophylaxis (PrEP), post-exposure prophylaxis, and sexual assault.

Sources:

- a. Wolmarans M, Tanna G, Dombo M, et al. (2015).⁴⁷
- b. World Health Organization Digital Health Atlas website. [Countries page](#). Accessed Oct 25, 2022.

Conclusion

Across South Africa, progress has been made toward achieving HIV prevention, treatment, and 90-90-90 targets, but challenges persist. Digital health solutions offer an opportunity to accelerate progress through access to comprehensive patient information, improved data for decision-making, and more efficient workflows.




Gauteng and KwaZulu-Natal provincial health leaders, donors, and other partners can use the recommendations from this assessment to prioritize gaps that, when addressed, will strengthen the digital health ecosystem. The recommendations are anchored in South Africa’s integrated health services approach and are designed to support achievement of HIV goals while benefitting the health system more broadly. Any organizations acting on the recommendations should engage directly with the province and other relevant stakeholders to ensure they are acting on the highest priority needs in line with existing efforts.

Top-level actions that donors and provinces can take immediately are:


- ✓ **Coordinate with key stakeholders to review the digital health landscape findings and further prioritize recommended actions.**
- ✓ **Leverage existing investments in South Africa’s enabling environment to address gap areas.**
- ✓ **Engage directly with provincial leaders and relevant stakeholders to ensure alignment with government priorities and needs.**



Appendix A: Inventory of Systems, Applications and Tools



Not all the items listed in the inventory table below are systems, applications, or tools. Some can be categorized under the [World Health Organization \(WHO\) Classification of Digital Health Interventions for Clients](#) (including 1.6.1 Client look-up of health information). All links in the appendix were last accessed on June 23, 2022.





Legend	
	A global good or a system, application, or tool based on / using one or more global good
	In the Digital Health Atlas (currently only 10 of the inventory items below are listed in the DHA)
	A registry / service




Digital Health Atlas (DHA): “A WHO global technology registry platform aiming to strengthen the value and impact of digital health investments, improve coordination, and facilitate institutionalization and scale.” This Knowledge Management System Global Good “is an open source web platform designed to support governments, technologists, implementers and donors to better coordinate digital health activities globally.” The DHA also “supports implementers to assess the maturity of their digital health projects and gain access to global resources on current best practices in digital health.” Source: World Health Organization (WHO). Digital Health Atlas (DHA) website. [Welcome page](#). Accessed June 23, 2022.





No	Name [global good name]	Description and Source Link(s)
1	AitaHealth	Developed by Mezzanine, University of Pretoria, and Vodacom for CHWs to register and capture household and individual household member information and schedule and track follow-up visits. It has in-application validation and skip logic functions and a web reporting interface. Data are cloud hosted and can integrate with third-party solutions via an API. https://mezzanineaware.com/aitahealth-4-years-and-1-million-individuals-registered/
2	Alliance Medical imaging tools	Life Healthcare (private hospital group) uses Alliance Medical's imaging tools, including MRI, CT [computed tomography], PET [positron emission tomography] CT, X-ray, DXA [dual-energy x-ray absorptiometry], Ultrasound, Cardiac Calcium Scoring and radio pharmacy. https://www.rvo.nl/sites/default/files/2021/03/Overview-of-the-health-technology-sector-in-South-Africa-Opportunities-for-collaboration.pdf , https://www.lifehealthcare.co.za/news-and-info-hub/latest-news/sa-molecular-imaging-expansion-through-new-joint-venture-for-radiopharmacy-sites/ , https://www.alliancemedical.ie/about-us/
3	 ART (antiretroviral therapy) Cohort System [DHIS2]	Data are imported from TIER.Net into the DHIS2 ART Cohort System, which is accessible to all approved DOH users at all levels, to enable monitoring of ART cohort data. Tables and dashboards are available together with legend sets for different targets. (See DHIS2 for general information). https://art.dhis.dhmis.org/dhis-web-dashboard/#/XTTAcnZqzK0
4	BAS (Basic Accounting System)	A National Treasury system used by 182 departments to process and disburse payments and compile annual financial statements. Compensation of employee transactions is interfaced into the BAS application from PERSAL. http://www.treasury.gov.za/search.aspx?cx=018115738860957273853%3A-j5zowsrmpI&cof=FORID%3A11&q=Chapter%20%20Bas [Chapter 2 – BAS and the Standard Chart of Accounts]
5	Be In the Know	A website providing information to the general population about HIV in SA. https://www.beintheknow.org/understanding-hiv-epidemic/data/glance-hiv-south-africa , https://www.prepwatch.org/wp-content/uploads/2022/02/PROMISE-Digital_Health_Landscaping_Report.pdf
6	B-Wise	A website with information on reproductive health and services available. Chatbot (Sister Uthani) answers questions and guides users on the site. Includes quizzes to identify the right form of contraception and to see whether PrEP is right for the user. Has an active Facebook page with over 24,000 followers. https://www.facebook.com/BWiseHealth/?ref=page_internal , https://www.prepwatch.org/wp-content/uploads/2022/02/PROMISE-Digital_Health_Landscaping_Report.pdf
7	CapeRay – Acesco	Integrates digital mammography and automated breast ultrasound into a single device, enabling simultaneous acquisition of both sets of images (developed by the SA company Cape Ray). https://www.caperay.com/
8	Catch & Match	A mobile tool for CHWs and supervisors, used during home visits to screen patients for TB, HIV and other health risks in Western Cape Province. Key partners are CIDER-UCT, Mobenzi, Jembi, and the Western Cape DOH. It feeds information into the Provincial Health Data Centre (PHDC) [Source: Research and Training for Health and Development. <i>Review of mHealth Solutions for TB in South Africa</i> , unpublished revised draft report, 2019]



9	Cellnostics	Developed by researchers from the Council of Scientific and Industrial Research (CSIR), in partnership with the NHLS, to perform quick and effective on-site blood tests to reduce the time between tests and diagnosis and subsequent treatment. The portable wireless blood analyzer allows for two-way communication between the clinic and a central laboratory. Medical professionals can also access the information with cell phones and tablets https://www.csir.co.za/technology-better-healthcare
10	CHARISMA ^a project – HEART (HEALTHy Relationships Assessment Tool)	The CHARISMA intervention relies on a scaled relationship assessment tool called HEART, followed by tailored counseling with lay counselors using manualized content and soap-opera-style videos to stimulate discussion. It can be adapted for different contexts and is low cost and flexible. Research Triangle Institute (RTI) International, along with Family Health International (FHI) 360 and Wits Reproductive Health and HIV Institute (Wits RHI), put the CHARISMA intervention online to make it accessible. The intervention includes (i) a relationship quiz, (ii) empowerment counseling based on quiz result, (iii) educational materials for male partners, and (iv) support and referrals to community-based services. https://www.mycharisma.org (<i>connection not private</i>), or ^a .
11	ChattyCuz	A digital platform for young women to learn about healthy relationships. Chat bot on WhatsApp, now in rolling-out stage. https://www.praekelt.org/chattycuz , https://www.prepwatch.org/wp-content/uploads/2022/02/PROMISE-Digital_Health_Landscaping_Report.pdf
12	Child PIP (Child Healthcare Problem Identification Programme)	Developed by the University of Pretoria Research Centre for Maternal, Foetal, Newborn and Child Health Care Strategies, with some support by the South African Medical Research Council and the CDC. Similar to the Perinatal Problem Identification Programme (PIIP) but designed specifically to capture causes of death in children (including avoidable contributing factors) to improve quality of care. Child PIP is a web application that works off-line, is hosted on facility/provider computers, and is not interoperable with other government information systems. It was initially developed 20 years ago and is well embedded in the health system with mandatory use in public health facilities where child deaths occur. https://globalizationandhealth.biomedcentral.com/articles/10.1186/s12992-021-00716-1 , https://www.up.ac.za/centre-for-maternal-fetal-newborn-and-child-healthcare/article/2871749/the-perinatal-problem-identification-programme , https://www.up.ac.za/media/shared/717/Child%20PIP/Child%20PIP%20training/child-pip-v3.1-training-and-reference-manual-complete.zp185127.pdf
13	Choma	An interactive online magazine for young women providing information on issues including health, beauty, and fashion. Includes chat (Ask Choma), Facebook, and WhatsApp messaging to answer questions. Includes quizzes for users (e.g., one on whether to consider PrEP). Active Facebook page with over 150,000 followers. https://www.facebook.com/ChomaMagazine , https://www.prepwatch.org/wp-content/uploads/2022/02/PROMISE-Digital_Health_Landscaping_Report.pdf
14	CLINICOM Hospital Information System	A proprietary hospital information system managed by Datacentrix that has been in use in the Western Cape since 1999. The CLINICOM online database is a repository of each patient's medical information and includes data from all patient visits, scanned copies of physician and nursing notes, radiological images, test results, and medications dispensed. Using the same patient number enables patient detail and history to be viewed across health institutions. The system enhances patient management and includes an outpatient appointment booking system, and the billing system enhances the efficiency in collection of patient fees where applicable. https://www.westerncape.gov.za/news/new-patient-administrative-ar-and-billing-system-prince-albert-hospital , https://elischolar.library.yale.edu/cgi/viewcontent.cgi?article=2159&context=ymtl
15	 CommCare for CHWs (community health workers) [Commcare; OpenHIE]	A mobile application for CHW data collection. Designed to complement stand-alone apps that run on the health workers' phones and to support more complex back-end integrations through a REST (representational state transfer) API and using OpenHIE standards. Applications can integrate with the broader health system through integrations with software such as OpenMRS (Medical Record System), DHIS2, and RapidPro. In Ekurhuleni District in Gauteng, data are extracted from the CommCare database, combined with data collected using paper tools (where no mobile capturing devices are available), and aggregated data are then captured in the DHIS2. https://static1.squarespace.com/static/59bc3457ccc5c5890fe7cacd/t/6061f423e9c30f0939b94873/1617032231588/Global+Goods+Guidebook+V2_update+29+Mar+2021.pdf
16	 COVID-19 Surveillance [DHIS2]	A DHIS2 Tracker Android app for COVID-19 surveillance, customized for the NDOH by HISP-SA in collaboration with local partners. https://www.dhis2.org/covid-19 , https://community.dhis2.org/c/implementation/covid-19/41 , https://digitalhealthatlas.org/en/-/projects/1318/published
17	Da Vinci surgical robotic technology	Intuitive Surgical's Da Vinci surgical robotic technology is used at Netcare (private hospital group), and the Western Cape Government also implemented da Vinci Xi systems in the Tygerberg and Groote Schuur government hospitals in 2021. https://www.netcarehospitals.co.za/Specialised-services/Robotic-assisted-surgery , https://www.westerncape.gov.za/news/tygerberg-hospital-first-government-institution-perform-robotic-surgery , https://www.news.uct.ac.za/article/2021-10-19-robotic-surgery-african-first-at-groote-schuur , https://www.davincisurgery.com/da-vinci-systems/about-da-vinci-systems


18	DATCOV	NICD sentinel hospital surveillance system, designed to monitor and describe trends of COVID-19. The NICD daily hospital surveillance report for COVID-19 summarizes data from COVID-19 cases admitted to sentinel hospital surveillance sites in all provinces. https://www.nicd.ac.za/wp-content/uploads/2022/06/NICD-COVID-19-Daily-Sentinel-Hospital-Surveillance-report-National-20220602.pdf
19	Delta 9 / UniCare	A health care administrative system developed by Delta 9. Used in more than 100 private and public hospitals and clinics in SA, Mozambique, and Namibia for the efficient management of various aspects of hospital administration, such as pre-admissions, admissions, billing, electronic claims, credit control, dispensing, and stock control. Delta 9 is used in the Eastern Cape and Western Cape Provinces. https://www.itweb.co.za/content/nWJadMb8JDpVbjO1 , https://www.hst.org.za/publications/NonHST%20Publications/eHealth_Strategy_South_Africa_2012-2016.pdf
20	 DHIS2 (District Health Information Software 2) [OpenHIE]. Called “South African HMIS” (health management information system) in the DHA	DHIS2 is an open source, web-based platform with data warehousing and visualization features, designed for resource-constrained settings. Developed for the NDOH by HISP, and network managed by the HISP Centre at the University of Oslo. DHIS2 supports technologies from a core web platform that facilitates aggregate data reporting at any level of an organizational system (i.e., the <i>South African HMIS</i> , NDD, Integrated School Health Programme [ISHP], Rapid Internal Performance Data Audit [RIPDA]) to a Tracker module for individual case-based data (i.e., DHIS2 Tracker for CHWs, Patient Experience of Care [PEC]), and an Android app that allows for mobile data capture. In SA the DHIS2 HMIS is the national data repository for the NIDS supporting routine data capturing, as well as monitoring and reporting of aggregate data across all public health facilities. https://dhis2.org/about/ , https://digitalhealthatlas.org/en/-/projects/1114/published
21	 DHIS2 Tracker for CHWs (community health workers) [DHIS2]	Developed by HISP-SA and supported by CDC funding. Originally called ERPMS [Electronic Registration and Performance Management System], it was extended to include data elements for CHW WBOs [Ward-Based Outreach Teams] to capture household registration, individual patient, referral, and back referral data using tablets. Data are accessible to team leaders for monitoring; aggregated data feed into the DHIS2 provincial instance automatically and are accessible to users from the facility to the provincial level within 24 hours by means of dashboards. It was piloted in one district in the Free State with positive feedback from CHWs and managers but wasn't scaled due to funding limitations.
22	DigiTech platform	Africa's first “app store,” created by the South African government, available not only to applications in the country but applications across the region. https://www.itweb.co.za/content/j5alrMQARQVMpYQk
23	EDRWeb (Electronic Drug-Resistant [tuberculosis] software)	Developed by WAMTechnology on behalf of the NDOH and partially funded by PEPFAR, with technical assistance from the CDC and the Global AIDS Program SA. It is an online central database of drug-resistant TB surveillance, program monitoring, and evaluation of treatment and outcomes. It is implemented in 85 drug-resistant TB units throughout the nine provinces. https://www.wamsys.co.za/pages/product-info.php?cat_id=46
24	eHealth@Joburg	An EHR implemented by Med-e-Mas, a private vendor in PHC facilities in the City of Johannesburg District in Gauteng in 2016 to replace paper records. In August 2018, 500,000 patients were registered on the system, and 64 clinics were connected via the Wide Area Network, consisting of either fiber optics as the primary source or radio links, and in some cases a combination of the two. In case of power failure, the system is connected to a solution that consists of generators, a solar energy system, an uninterrupted power supply system, and electrical reticulation. https://www.joburg.org.za/media/_MediaStatements/Pages/2018%20Press%20Releases/500-000th-patient-on-eHealth-system.aspx
25	eHMS (Electronic Health Management System)	A new (2022) electronic health system implemented in all City of Tshwane District-owned health facilities in Gauteng to streamline operations and enhance communication across facilities through a fully integrated and interoperable system. It improves health care response times, bookings, integrated and accurate data management, reporting, and stock management and deals with problems such as inadequate filing storage and lost patient files. It also offers geographic health risk profiling representations to improve service delivery, planning, decision-making, and ultimately, efficiency. https://rekord.co.za/417318/no-more-lost-patient-files-as-city-clinics-gear-for-new-r32m-electronic-system/
26	eLabs	An Android application developed by the NHLS in collaboration with USAID, PEPFAR, and EQUIP to tighten the laboratory chain. Drivers collecting samples scan barcodes and storage temperatures at points of collection and delivery. Results are sent directly to health care workers, who then notify the patients. [Source: Research and Training for Health and Development. <i>Review of MHealth Solutions for TB in South Africa</i> , unpublished revised draft report, 2019], https://wiki.mezzanineware.com/display/ES/eLABS#eLABS-eLABS-
27	EMGuidance (Essential Medical)	A free mobile and web-based medicines and treatment platform for medical professionals providing up-to-date information to help make informed decisions at the point of care. It offers content and tools in partnership with global and local pharmaceutical manufacturers, NDOHs, medical societies, and leading local academic and scientific institutions, as well as pharmaceutical and health care companies. Situated in Johannesburg, Gauteng. https://emguidance.com/about



28	EML (Essential Medicines List)	A mobile application which includes the Standard Treatment Guidelines (STG) and EML published by the NDOH. It enables point-of-care access to the latest STGs and EML and the use of clinical calculation tools to assist with decision-making. https://play.google.com/store/apps/details?id=org.jembi.healthconnect.guides.ps.eml&hl=en_ZA&gl=US
29	eTick Register	Development was initiated by the Public Health unit in the Ekurhuleni District of Gauteng to digitize the paper tick registers used countrywide in all government PHC facilities for collecting NIDS data. It has an easy interface and saves time needed for data capturing, validation, and aggregation, which enables clinicians to focus on patient care. Facility managers can log in to monitor performance, and aggregated data (by facility) are incorporated into the DHIS2 semiautomatically. It was recommended for scaling as a tested solution to address various data capturing and paper-based register challenges and to improve continuity of care, data quality, and data use.
30	EVDS (Electronic Vaccination Data System)	Developed by the NDOH for real-time data capturing on COVID-19 vaccination by the public and private sectors. It complies with the interoperability standards for digital health, allows for secure sharing of data between different systems, expands on the HPRS, includes identity verification, and uses the Business Intelligence Platform and Data Lake functionality. https://www.gov.za/speeches/minister-zweli-mkhise-launch-evds-registration-covid-19-vaccination-citizens-aged-60-and , https://sacoronavirus.co.za/
31	 Flutter. Called "COVID 19 – Safe Entry Management" in the DHA	A mobile application for COVID-19 self-screening in the workplace or any place of gathering with a dashboard for managers and human resource departments to manage self-isolation for COVID-19-positive staff. Not implemented yet. https://digitalhealthatlas.org/en/-/projects/1456/published
32	Health-e News	A website with general audience focus providing overall news about health issues. Has an active Facebook page with 7,500 members. https://www.facebook.com/HealtheNewsSA/ , https://www.prepwatch.org/wp-content/uploads/2022/02/PROMISE-Digital_Health_Landscaping_Report.pdf
33	Hello Doctor	An app that connects clients to health care providers. It allows users to chat or send a message with questions to providers. It also sends users daily health tips. https://www.hellodoctor.co.za/ , https://www.prepwatch.org/wp-content/uploads/2022/02/PROMISE-Digital_Health_Landscaping_Report.pdf
34	 HPRS (Health Patient Registration System)	<i>Patient Registry / Master Patient Index (MPI):</i> A networked electronic system used to register all patients treated at public health facilities, allowing for the unique identification and tracking of a patient across health care service platforms within the public sector. It generates and assigns a ten-digit health patient registration number (HPRN), which is a secondary unique identifier, linked to the South African ID number, passport number, driver's license, asylum permits, refugee permits, or any other type of unique identifier. The HPRN supports the development of a MPI to facilitate implementation of an EHR. The HPRS is also linked to the standardized filing system, thus assisting with faster file retrieval and storage. https://www.profnetmedical.co.za/media/1177/south-african-health-review-2014-15-part-3compressed.pdf , https://hprs.health.gov.za/
35	 HPV (human papillomavirus) [DHIS2]	A DHIS2 Tracker application that supports HPV data capturing (both online and off-line) in the field (mainly at schools). Data are automatically fed into the campaign database, which has a dashboard for monitoring and reporting. The mobile app aims to capture the details of each learner in the first round so that the same cohort can be tracked to establish coverage of individuals with the second HPV vaccination dose. Not in use anymore due to inadequate funding. https://www.hisp.org/?page_id=561
36	 HRIS (Human Resource Information System)	<i>Provider / Health Worker Registry:</i> The National Digital Health Strategy for South Africa 2019–2024 indicates that a service provider registration system (which will contain demographic information of health service providers, including doctors, nurses, and CHWs) will be created in preparation for National Health Insurance (NHI) implementation. The aim is to establish an electronic HRIS that provides the information necessary to support the health workforce and training and which will include a Human Resources for Health (HRH) registry and an HRH data warehouse, as envisaged by the World Health Organization (WHO) workforce accounts approach. No information on progress could be obtained. https://www.health.gov.za/wp-content/uploads/2020/11/national-digital-strategy-for-south-africa-2019-2024-b.pdf
37	Ideal Clinic System	Developed for the NDOH to monitor progress toward quality health care. It is a web-based application that allows managers at all levels to monitor the various elements on a dashboard, which comprises 208 elements, categorized into 10 components and 32 sub-components. https://www.idealhealthfacility.org.za/
38	 IONIC. Called "Respo Screening Services" in the DHA	COVID-19 tracking of customer visits and screening for improved customer analysis and branch performance analysis. https://digitalhealthatlas.org/en/-/projects/1547/published



39	 ISHP (Integrated School Health Programme) [DHIS2]	School health teams collect data on individual learners which is then aggregated for the School Health NIDS and captured in the ISHP DHIS2 module. Dashboards are available for monitoring progress at all levels. https://www.gov.za/about-government/government-programmes/schoolhealth
40	Ithaka HIV self-test tool	Developed by Aviro to provide untrained HIV self-test users with a mobile platform for listening to pre-and posttest counseling and self-reporting their self-test results independent of a formal clinical setting. It is a Progressive Web App, which is accessible as a reverse-billed mobi-site, where the provider pays data costs, rendering the tool free to end users. https://sajhivmed.org.za/index.php/hivmed/article/view/1197/2255 , https://www.avirohealth.com/
41	JAC Pharmacy System	A proprietary pharmacy management system. In 2018 it was used in 109 health facilities in the Western Cape. https://scholar.sun.ac.za/handle/10019.1/106925
42	KwaZulu-Natal eHealth System	An in-house-developed, province-specific hospital information system that is compliant with the National Health Normative Standards Framework (HNSF) for Interoperability in eHealth 2014, and that digitizes manual business processes and interfaces with existing information systems (such as RX Solution) through linking with the HPRS to establish a single, integrated EMR. It has several modules, including administration, patient registration, outpatient and in-patient management, billing, scheduling of staff, and patient appointments. [Source: KwaZulu-Natal Department of Health. <i>Draft KZN eHealth Rollout Project Charter</i> (v. 01), unpublished draft, 2020]. Interviewees stated that it was piloted in 2 hospitals in March 2020 and has since been deployed to 14 hospitals. It is still at the developmental stage, and progress is slow.
43	LOGIS (Logistical Information System)	A National Treasury supply chain sub-system used for procurement of goods and services. It is designed to administer stores, monitor stock levels, and provide an asset and inventory management facility and is used in most national and provincial government departments in SA. Interfaces with other Treasury systems, such as BAS. http://www.treasury.gov.za/search.aspx?cx=018115738860957273853%3Aj5zowsrmpI&cof=FORID%3A11&q=Chapter%202%20Bas [Chapter 2 – BAS and the Standard Chart of Accounts]
44	loveLife	LoveLife is a local organization with over 20 years in HIV prevention, focusing on youth. They post information on prevention and have an active Facebook page with over 80,000 followers. https://www.facebook.com/loveLifeNGO/ , https://www.prepwatch.org/wp-content/uploads/2022/02/PROMISE-Digital_Health_Landscaping_Report.pdf
45	Lynx Health ADC (automated data collection) Online	Lynx mHealth is a mobile-based data collection tool developed by Quode to facilitate HIV testing services at the point of care. It improves the consistency, accuracy, and completeness of data by eliminating paper-based data collection methods. In addition to Lynx mHealth, the Lynx Health solution features a Lynx eHealth online ADC system—a web-based portal that captures historic paper-based sources but is also suitable for capturing any customized form. Data captured in the online form is submitted to Qode Knowledge Centre, which enables the merging of historic data captured on paper, with live data being captured through Lynx mHealth. https://qode.healthcare/products
46	 Malaria [DHIS2]	A DHIS2 system (including GIS [geographic information system]), implemented in malaria-endemic provinces in 2018 to capture all data necessary to measure progress against set indicators in the M&E plan for data-driven decision-making at all levels within the program. https://www.nicd.ac.za/wp-content/uploads/2019/10/MALARIA-ELIMINATION-STRATEGIC-PLAN-FOR-SOUTH-AFRICA-2019-2023-MALARIA-ELIMINATION-STRATEGIC-PLAN-2019-2023.pdf
47	MAMMAS (Maternal Morbidity and Mortality Audit System)	The National Committee for Confidential Enquiry into Maternal Deaths monitors causes of maternal deaths to improve quality of care. The University of Pretoria Research Centre for Maternal, Foetal, Newborn and Child Health Care Strategies created the MAMMAS database to capture and analyze data, including maternal age, HIV status, mode of delivery, and avoidable factors. This program has been adopted as the NDOH audit tool and is implemented in public health facilities providing delivery services. https://www.up.ac.za/centre-for-maternal-fetal-newborn-and-child-healthcare/article/2809803/clinical-audit-programmes
48	 MFL (Mater Facility List)	<i>Facilities Registry</i> : The “Master Facility List: A Collection of South African Health Facilities and Services” claims to contain a complete list of all health facilities in the country, both in the public and private sector. However, to view the list one must first register as a facility representative (for which a PERSAL number and facility name is required) or as an external system representative (to integrate third-party systems with the MFL); no other options are available. It could not be established whether the MFL contains an up-to-date list of all health facilities for SA, as is claimed. https://mfl.csir.co.za/
49	Medicom	An integrated web-enabled hospital information system used in Gauteng, KwaZulu-Natal, and Limpopo Provinces. SA's first-ever paperless and filmless hospital, Inkosi Albert Luthuli Central Hospital in Durban, uses the fully integrated Medicom hospital information system. https://www.hst.org.za/publications/NonHST%20Publications/eHealth_Strategy_South_Africa_2012-2016.pdf , https://researchspace.ukzn.ac.za/bitstream/handle/10413/10383/Magaqa_Vuminkosi_Lionel_Longsdale_2010.pdf?sequence=1&isAllowed=y

50	MEDITECH	MEDITECH's EHR solutions are used in the Free State and KwaZulu-Natal Provinces. In KwaZulu Natal some hospitals have used it since 1999, with 11 hospitals running the Billing Solution module in 2017 while additional modules were being implemented (i.e., Registration and Health Information Management, Order Management and Coding, Scanning and Archiving, EMR, Management of Emergency Department and Operating Theatres, Pharmacy Management, and interfacing to the NHLS. https://ehr.meditech.com/news/meditech-expands-solutions-in-the-kwazulu-natal-province-of-south-africa , https://www.hst.org.za/publications/NonHST%20Publications/eHealth_Strategy_South_Africa_2012-2016.pdf
51	MEDSAS (Medical Supplier Administration System)	A National Treasury sub-system used by the provincial DOHs and their trading entities for the procurement and management of pharmaceutical products (mainly medicine). It is one of the independent stand-alone systems which interfaces with BAS, from where expenditure transactions are initiated, together with PERSAL and LOGIS. http://www.treasury.gov.za/search.aspx?cx=018115738860957273853%3Aj5zowsrmpI&cof=FORID%3A11&q=MEDSAS
52	MoyaApp	A data-free app that allows users to chat, read news, get sports scores, check weather, and communicate with government services free of charge. Available from Google Play Store and Hauwei. https://moya.app/ , https://www.prepwatch.org/wp-content/uploads/2022/02/PROMISE-Digital_Health_Landscaping_Report.pdf
53	MojaLove	A TV channel dedicated to portraying life in SA. Their Facebook page promotes/lists upcoming shows and has over 495,000 followers. https://www.facebook.com/MojaLoveTV/ , https://www.prepwatch.org/wp-content/uploads/2022/02/PROMISE-Digital_Health_Landscaping_Report.pdf
54	MomConnect	An NDOH initiative through a coalition of public and private partners (e.g., Praekelt, Jembi, and HISP-SA). It uses a mobile application (at no cost to user) to support pregnant women in seeking early pregnancy registration and obtaining messages during antenatal care, delivery, and postnatal care periods in all 11 official languages. Mothers can opt in to baby and childcare messages, and women can request additional information and provide feedback on the quality of health care. The complementary NurseConnect service expands the service to PHC facility nurses. Selected data are imported into the DHIS2 for planning, monitoring, and reporting purposes. https://www.health.gov.za/momconnect/ , https://www.jembi.org/Project/MomConnect
55	 MOTECH [CommCare, OpenHIE]	Dimagi's MOTECH is a CommCare-based interface that supports the integration of scalable mobile services and health information systems. MOTECH implements the OpenHIE standards and is designed to enable integration with a set of self-service features, enabling the sharing of data between systems to be configured without software developers or code changes. MOTECH supports integration with DHIS2 and OpenMRS (Medical Record System). https://digitalsquare.org/global-goods-guidebook
56	My PrEP (pre-exposure prophylaxis) South Africa	A website supported by the NDOH and She Conquers. Provides overall information on PrEP, including job aids for providers and training materials, quizzes to determine if PrEP is right for the user, and a directory of sites for getting PrEP based on user location. Has an active Facebook page with over 18,000 users and a Twitter account with just over 700 followers. https://www.facebook.com/myPrEPSouthAfrica , https://twitter.com/myPrEP_SA , https://www.prepwatch.org/wp-content/uploads/2022/02/PROMISE-Digital_Health_Landscaping_Report.pdf
57	 National Population Register	<i>Population Registry</i> : An electronic register which is maintained by the Department of Home Affairs. The Births and Deaths Registration Amendment Act (Act No. 18 of 2010) stipulates that all births must be registered within 30 days from the date of occurrence, and notification of deaths (including still births) should take place within 72 hours. https://www.gov.za/sites/default/files/gcis_document/201409/a1820100.pdf
58	 NHAP (NACOSA Health Analytics Platform)	NACOSA is a network of over 2,500 civil society organizations working together to turn the tide on HIV, AIDS, and TB in Southern Africa. NHAP was developed with Global Fund support. It integrates programmatic, financial and individual-level data to better understand service delivery performance, client retention, cost-effectiveness, and spending efficiency. https://digitalhealthatlas.org/en/-/projects/980/published , https://www.nacosa.org.za/about/
59	 NDD (National Data Dictionary) [DHIS2]	<i>Facilities Registry and Metadata Repository</i> : Developed to facilitate data exchange between electronic systems used to support the District Health Management Information Systems policy. It contains the names of all public health care facilities in SA that submits data through the DHIS2. The list is openly available, with registration only required to submit changes for approval. It is also a reference point for selected health information standards to support health care activities, providing the most up-to-date version of NIDS specifications (specifically data elements, indicators, and data validation rules). https://dd.dhmis.org/
60	NDOH (National Department of Health) App Store	Hosts and provides access to NDOH-certified mobile apps. It provides a mHealth framework developed to support new and existing mobile applications by reducing mobile application fragmentation, assisting in the enforcement of Protection of Personal Information (POPI) Act, and providing valuable insight into mobile application uptake, usage, and impact. The mobile management functions include SIM management, content management, and mobile app management. It also allows text messages to be sent to users without data-enabled services, while ensuring NDOH oversight of the process. The framework has incorporated a reversed bill service with all South African mobile network operators to allow free downloading and browsing of apps by the end users. https://www.jembi.org/Project/National-Department-of-Health-App-Store

61	NICD (National Institute for Communicable Diseases) HIV dashboards	Dashboards include HIV M&E reporting for all ages and < 19-year-olds, geographic distribution of HIV-positive patients, integrated DHIS2 and NHLS data, and trends down to the facility level. The dashboards are built on top of the NHLS Central Surveillance Data Warehouse, which comprises laboratory data from TrakCare and data from the Central Data Warehouse. They also draw data from the DHIS2 and population data from Statistics SA and are updated with information from private laboratories and medical aids. There are multiple user types with different levels of access, including the public, who can access a pared-down version. [Source: Research and Training for Health and Development. <i>Review of MHealth Solutions for TB in South Africa</i> , unpublished revised draft report, 2019]. https://mstrweb.nicd.ac.za/MicroStrategy/asp/Main.aspx?src=Main.aspx_2048001&evt=2048001&documentID=0C711AC04BD64A71C-6DEED8127152D28&currentViewMedia=1&visMode=0&Server=NICDSANDMSTRIO1&Port=0&Project=Surveillance&
62	NIDS (National Indicator Data Set) app	A mobile application developed for the NDOH by MEASURE Evaluation-Strategic Information for SA, supported by PEPFAR through USAID. It makes NIDS definitions, descriptions, and guidance (on which data collection tools to be used) accessible at the push of a button to assist in maximizing the accuracy and understanding of the NIDS data, as in the NDD. The NIDS app was available on Google Play Store but has since been removed due to funding limitations for maintenance. https://dd.dhmis.org/ , https://apkpure.com/national-indicator-data-set-nids/za.doh.nids
63	NMC (Notifiable Medical Condition) surveillance system	NICD, a subdivision of the NHLS, is mandated and funded by the NDOH to house and manage the national NMC surveillance system, which includes COVID-19. Capturing of NMC data is mandated for public and private health facilities and health care providers. The NMC software application can be downloaded on electronic devices, including Android App, Huawei App, and Apple App (tablets and cell phones), or as a WebPortal. The NHLS data are housed in the central data warehouse at NICD and includes data from the laboratory information system (TrakCare) and private laboratories. Upon saving of captured data, the data and the notifications are automatically sent to all relevant focal people at the health establishments, subdistrict-, district-, and provincial DoHs, and the NDOH. The website contains tutorials and dashboards which can be accessed by guest users. https://www.nicd.ac.za/nmc-overview/notification-process/ , https://www.nicd.ac.za/wp-content/uploads/2017/06/NMC-list_2018.pdf
64	Nurse Connect	An NDOH initiative to support nurses and midwives in their daily work. Developed through a coalition of public and private partners (e.g., Praekelt, Jembi) and HISP-SA and in close collaboration with nurses and midwives. Complementary to MomConnect and expanding the MomConnect service to PHC facility nurses. Selected data are imported into the DHIS2 for planning, monitoring, and reporting purposes. https://www.knowledgehub.org.za/system/files/elibdownloads/2019-07/NurseConnect%2520Fact%2520Sheet.pdf
65	 OpenHIE (Open Health Information Exchange). Called “Instant HIE” in the DHA	Describes a reusable architectural framework that leverages health information standards, enables flexible implementation by country partners and supports exchange of individual components. OpenHIE also serves as a global community of practice to support countries in moving toward open and collaborative development and country-driven, large-scale health information sharing architectures. https://www.who.int/publications/i/item/9789240010567 , https://digitalhealthatlas.org/en/-/projects/138/published
66	 OpenHIM (Open Health Information Mediator)	Functions as an interoperability layer, providing a single point of entry into the services of an HIE. OpenHIM receives transactions from client systems and coordinates interactions between different components of an HIE by routing requests to the correct orchestrator or registry. It also provides a centralized set of common functions (such as security, auditing, logging) to simplify data exchange. In addition, the OpenHIM’s customizable mediator framework provides for additional mediation functions for transactions within an HIE, supporting and simplifying custom business logic and the use of health data standards (e.g., HL7’s FHIR that are required by client systems to interact with the HIE, making it easier and faster for point-of-service applications to connect to the HIE. https://www.who.int/publications/i/item/9789240010567 , https://digitalhealthatlas.org/en/-/projects/646/published
67	PAAB (Patient Administration and Billing) System	A hospital system owned by the DOH, mainly used in Gauteng, Mpumalanga, and North-West Provinces. It is used for administration, such as capturing patient profile information, billing, registering new patients, admitting and discharging patients, and scheduling appointments. PAAB does not support electronic linkage to pharmacy systems, direct importing of laboratory or radiology results, and decision support. https://uir.unisa.ac.za/bitstream/handle/10500/27239/dissertation_chuma_kg.pdf?sequence=1&isAllowed=y , https://www.hst.org.za/publications/NonHST%20Publications/eHealth_Strategy_South_Africa_2012-2016.pdf
68	PACS (Picture Archiving and Communication Systems)	PACS from different vendors are implemented in many South African public-sector hospitals. While current digital radiology imaging machines use the Digital Communications in Medicine Standard to communicate standard information on images, PACS vendors use different formats for non-image data (patient identifiers and clinical details), file registry, and repository. Thus, vendors’ systems are not interoperable, and significant costs are involved in changing files when migrating to another vendor’s system. https://www.researchgate.net/publication/320859337_Electronic_health_information_systems_for_public_health_care_in_South_Africa_a_review_of_current_operational_systems

69	 PEC (Patient Experience of Care)[DHIS2]	A DHIS2 module developed by HISP-SA for the NDOH to capture annual PEC survey data for monitoring satisfaction with health care received at public health facilities. Results are displayed by the section/ward in a facility, the health facility, district, and province. https://www.idealhealthfacility.org.za/ , https://www.medbox.org/document/national-guideline-on-conducting-patient-experience-of-care-survey-in-public-health-establishments#GO
70	PERSAL (Personnel and Salary System)	A Central National Treasury system used for administration of the public service payroll in most national and provincial government departments. Information is updated and viewed through a portal called Vulindlela. PERSAL had been largely used as a payroll mechanism rather than a human resources information management system. It is outdated and is in line to be replaced / made redundant as per Parliament portfolio committee meetings. https://pmg.org.za/committee-meeting/11882/ , http://www.treasury.gov.za/search.aspx?cx=018115738860957273853%3Aj5zowsrmpI&cof=FORID%3A11&q=Chapter%20%20Bas [Chapter 2 – BAS and the Standard Chart of Accounts]
71	PHCIS (Primary Health Care Information System)	An administrative system, developed for public-sector community health centers and clinics in the Western Cape that provides demographic data and ICD-10 [international classification of diseases 10th revision] codes for patient visits. It uses a unique patient identification number (administered by CLINICOM) that is attached to a patient's paper record as a bar code and used throughout the health facilities in the province, allowing for operability in admissions, discharges and transfers, appointment scheduling, and maintaining of full patient records. https://www.westerncape.gov.za/news/primary-health-care-information-system-community-health-centres , https://www.researchgate.net/publication/320859337_Electronic_health_information_systems_for_public_health_care_in_South_Africa_a_review_of_current_operational_systems
72	Philips Connected Care	Mediclinic (private hospital group) is using Philips' Connected Care enterprise monitoring and patient care solutions in 21 of its hospitals, enabling big data analysis. https://www.rvo.nl/sites/default/files/2021/03/Overview-of-the-health-technology-sector-in-South-Africa-Opportunities-for-collaboration.pdf , https://www.philips.co.za/healthcare/solutions/enterprise-telehealth
73	PREHMIS (Patient Record and Health Management Information System)	A Linux-based system operated by the City of Cape Town in primary care clinics to capture basic patient information and various services provided to patients. It is not an EMR system, it focuses on management information and therefore not all clinical information is stored in the system. Data capturers read patient records, select an indicator from a printed menu, and then scan the barcode into a computer. https://prehmis.capetown.gov.za/content?page=about , https://www.researchgate.net/publication/320859337_Electronic_health_information_systems_for_public_health_care_in_South_Africa_a_review_of_current_operational_systems
74	Pro-Clin	Developed by Digi Group, a South African company operating in 6 African countries. It is a fully fledged hospital management information system with 13 modules. Pro-Clin is implemented in King Edward and St Aidens hospitals in KwaZulu-Natal. https://www.digidata.co.za/61-2/
75	Provincial Data Warehouse / PHDC (Provincial Health Data Centre): <i>KwaZulu-Natal</i>	Through the PHDC Project, KwaZulu-Natal is setting up a formal data warehouse model (based on the Western Cape Province's) to expand data science capacity, promote interoperability and pave the way for using individual patient data for more accurate assessment of health program coverage and impact, starting with HIV and TB. The PHDC will enable data-driven patient care and evidence-based decisions based on data drawn from the HPRS, TIER.NET, the NHLS, hospital information systems, the CCMDD system, and mortality data. However, feedback from an interviewee indicated that little progress has been made. [Source: KwaZulu-Natal Department of Health. <i>KZN Data Warehouse Project Charter (v. 1.4)</i> , unpublished, 2021]
76	Provincial Data Warehouse / PHDC (Provincial Health Data Centre): <i>Western Cape</i>	In SA the Western Cape is the only province with a formal data warehouse model. The Western Cape PHDC is housed entirely within the government and consolidates person-level clinical data across government services from a range of source systems, usually daily. https://ijpds.org/article/view/1143/3163
77	PPIP (Perinatal Problem Identification Programme)	Developed by the University of Pretoria Research Centre for Maternal, Foetal, Newborn and Child Health Care Strategies, with some support by the South African Medical Research Council and the CDC, to capture causes of perinatal deaths (including avoidable contributing factors) for detailed analysis to improve quality of care. It is hosted on facility computers with centrally based servers. It is well embedded in the health system with mandatory use in public health facilities where delivery services are provided. https://www.up.ac.za/centre-for-maternal-fetal-newborn-and-child-healthcare/article/2871749/the-perinatal-problem-identification-programme , https://globalizationandhealth.biomedcentral.com/articles/10.1186/s12992-021-00716-1
78	Re-Action SA (South Africa) – LOLA	Re-Action co-creates and implements well-being and regenerative programs within communities and workplaces. Their social services include the LOLA app, which provides girls and young women with a platform to access information about a wide range of pertinent topics, complete survey questions, and access linkages to relevant services within their communities. https://www.re-action.co.za/lola/?doing_wp_cron=1641160527.1958980560302734375000 , https://www.prepwatch.org/wp-content/uploads/2022/02/PROMISE-Digital_Health_Landscaping_Report.pdf

79	 Ribbon blockchain Incentive platform. Called “Public Health Incentives – Software other” in the DHA	An app that enables CHWs to enroll as Care Partners to assist patients to earn incentives for testing, treatment initiation, adherence to medicine, disease suppression, and healthier lifestyles. It also enables patients to rate their experience of care, thereby enabling practitioners to earn an incentive based on the quality of care. https://incentives.ribbonblockchain.com/#/ , https://digitalhealthatlas.org/en/-/projects/894/published
80	Right ePharmacy	Provides solutions for the dispensing, distribution, and collection of medicine. Activities and products are aligned with the NDOH adherence strategy for achieving the 90-90-90- HIV targets and support the NDOH CCMDD model. https://rightepharmacy.co.za/solutions/
81	 RIPDA (Rapid Internal Performance Data Audit) [DHIS2]	Developed by HISP-SA for capturing six monthly data quality audits. The process mimics the Auditor-General performance data audits, where policy documents are assessed and DHIS2 data are compared with original source data. Findings are captured in the RIPDA database, and feedback reports are generated for improvement plans to be developed by facility managers. https://www.hst.org.za/hstconference/hstconference2016/Presentations/ripda_for_hst_conference.pdf , https://ripda.dhis.dhmis.org/dhis-web-commons/security/recovery_action
82	RxSolution	A web-based national pharmaceutical management system supported by the USAID-funded Global Health Supply Chain Program – Technical Assistance at national and provincial levels. It enables tracking of medicine availability, approving and submitting of orders, tracking of stock expiry dates, and tracking of patients and their prescriptions to enable informed supply chain planning and decision-making. An API automatically extracts and submits the data from RxSolution to the National Surveillance Centre daily. https://www.ghsupplychain.org/news/going-digital-utilizing-rxsolution-improve-medicine-management-south-africas-eastern-cape , https://www.mtapsprogram.org/our-resources/rxsolution
83	She Conquers	Three-year national campaign targeting young women. Provides information on gender-based violence, education, HIV, and pregnancy. Includes links to B-Wise health. Includes quizzes to help guide users to services they need. Has a Facebook page with over 1,000 followers, semi-active. https://www.facebook.com/SheConquersSA/ , https://www.prepwatch.org/wp-content/uploads/2022/02/PROMISE-Digital_Health_Landscaping_Report.pdf
84	Signapps	A mobile integrated care coordination product developed in SA. It enables health and social care teams to transform outcomes for people with complex conditions by making it simple and efficient to deliver multidisciplinary care, resulting in reduced hospital stay, lower readmission rates, reduced paperwork, improved patient outcomes, and scaling of care teams across organizations and geographies. https://getsignapps.com/
85	SmartLink	Smartphone application providing CD4 and viral load laboratory results to patients as a means to improve the initial linkage to care after HIV diagnosis. A study was conducted by the Wits Reproductive Health and HIV Institute (Wits RHI), the South African NHLS, and World Bank Group using routinely collected laboratory results from the NHLS database. https://documents1.worldbank.org/curated/en/374611542662090016/pdf/WP-132214-SmartLTCEvaluationReportUpdateNovFINAL.pdf
86	Soul City Institute for Social Justice	Local organization focusing on social justice. Activities include RISE clubs for young women aged 15–35 years in SA that empower them to demand and have access to HIV prevention and reproductive health services. Other activities include blogs, short TV series, and talk shows. Facebook page has close to 20,000 followers and is active. https://www.facebook.com/SoulCitySA/ , https://www.prepwatch.org/wp-content/uploads/2022/02/PROMISE-Digital_Health_Landscaping_Report.pdf
87	SVS (Stock Visibility System)	The SVS, managed by the NDOH, was developed by Mezzanine in partnership with Vodacom Business, with the USAID-funded Global Health Supply Chain Program – Technical Assistance providing technical assistance. It is a web-based management tool with a mobile application used in public health facilities to alert staff and broader supply chain stakeholders of low stock levels to prevent stockouts. Health facilities capture stock levels routinely on the SVS application, and data are synchronized in real time to a cloud-based server and is available to view on the designated SVS web portal by approved users. The portal generates automated email and SMS system alerts, and the data are also made available to the NDOH’s National Surveillance Centre on a dashboard. https://mezzanineaware.com/african-tech-startup/digital-technology-solutions , https://www.ghsupplychain.org/sites/default/files/2020-12/GHSC-TA%20Technical%20Brief_Stock%20Visibility%20System_2019.09.16%20V.F_508%20compliant.pdf , https://mezzanineaware.com/digital-productivity-technology/healthcare-technology-solutions/medical-stock-visibility-app/
88	SyNCH (Synchronised National Communication in Health) for CCMDD	The CCMDD program was established to improve access to essential chronic medication (including ARTs) for public-sector patients through pickup points at community halls, private pharmacies and other community spaces to avoid queuing at the clinics for medication. Health Systems Trust (HST) developed SyNCH, a web-based system, for the CCMDD programme on behalf of the NDOH. It enables online patient registration, electronic submission of prescriptions to dispensing service providers, scanning capability for medicine parcels received at pick-up points, as well as the issuing of parcels to patients. Automated reporting includes facility notification regarding patients who failed to collect their medicines to activate patient tracing processes. https://www.hst.org.za/projects/Pages/chronic-meds-at-the-click-of-a-button.aspx , https://www.ccmdd.org.za/help_files/6.%20SyNCH%20Health%20Facility%20Interface%20(incl%20Prescribing)%20Guide.pdf

89	TIER.Net	Developed by CIDER-UCT for the NDOH. The non-web-based solution with a separate local server for each facility is used to track care for HIV and TB patients at public PHC facilities. Data are captured by data capturers from paper patient records, and laboratory results are manually captured when received from the NHLS. Data are extracted monthly via an encrypted dispatch file, which is emailed and uploaded to a central site or physically transported on a USB drive to the next level (usually the subdistrict or district office), where it is imported into the next level of the TIER.Net database. Routine performance data are extracted via an XML file for import into the DHIS2 at the lowest level where the DHIS2 is available. https://www.tbhivinfosys.org.za/wp-content/uploads/2022/02/2019_NDOH_SOP_Part2_Web_final-signed.pdf
90	TrakCare	The proprietary TrakCare Lab system (InterSystems Corporation) which is used in 22 countries, was implemented by the NHLS in 2008. It is used in 322 laboratories throughout the nine provinces and includes TrakCare Lab Webview, which enables health care providers to search for laboratory results of individual patients. Patient details are entered into the system either manually or scanned from barcodes. Results are available electronically or can be printed. https://trakcarelabwebview.nhls.ac.za/trakcarelab/default.htm , https://www.intersystems.com/trakcare/lab-enterprise
91	Turn.io / Big Sis	In partnership with Girl Effect, Turn.io developed a “Big Sis” chatbot who offers private and trusted advice about sex and relationships for girls aged 13–17 years. https://www.turn.io/news/girl-effect , https://www.prepwatch.org/wp-content/uploads/2022/02/PROMISE-Digital_Health_Landscaping_Report.pdf .
92	Twitter NDOH (National Department of Health)	Official twitter account of the NDOH SA. Has close to 350,000 followers. Posts information on relevant health issues. https://twitter.com/HealthZA?ref_src=twsrc%5Egoogle%7Ctwcamp%5Eserp%7Ctwgr%5Eauthor , https://www.prepwatch.org/wp-content/uploads/2022/02/PROMISE-Digital_Health_Landscaping_Report.pdf
93	 Vantage HIV Solution	Vantage Solutions are built on the Microsoft suite of applications and leverages 4IR technologies. It is cloud based and applies advanced analytics, artificial intelligence, and machine learning to mine data and transform it into insights and clear recommendations for improving efficiency and quality of care. The Vantage Health Technologies HIV Solution for Patient Adherence is used by BroadReach in KwaZulu-Natal. A machine learning algorithm generates a list of patients likely to drop off treatment, which is used to target support actions. https://broadreachcorporation.com/broadreach-health-development/ , https://digitalhealthatlas.org/en/-/projects/1429/published
94	 Vantage COVID-19. Called “BroadReach COVID-19 Pandemic Management” in the DHA	Vantage Solutions are built on the Microsoft suite of applications and leverages 4IR technologies. It is cloud based and applies advanced analytics, artificial intelligence and machine learning to mine data and transform it into insights and clear recommendations for improving efficiency and quality of care. BroadReach deployed the Vantage COVID-19 Solution to identify hot spots, track facility readiness, and monitor health care workers. https://broadreachcorporation.com/vantage/ , https://digitalhealthatlas.org/en/-/projects/1287/published
95	Vula Health Referral and Advice	A mobile app that provides a standard referral form to be completed by a clinician with a follow-up chat function. It is downloaded on phones through Google Play Store and Apple App Store. Vula Mobile is built to meet FHIR (HL7) requirements to allow interoperability with any approved backend system. https://www.vulamobile.com/our-solutions
96	Vulendlela	A portal through which PERSAL information is updated and viewed (see PERSAL above).




Abbreviations: **4IR**, Fourth Industrial Revolution; **API**, application programming interface; **BAS**, Basic Accounting System; **CCMDD**, Central Chronic Medicines Dispensing and Distribution; **CDC**, Centers for Disease Control and Prevention; **CHW**, community health worker; **CIDER-UCT**, Centre for Infectious Disease and Epidemiology Research at the University of Cape Town; **DHIS2**, District Health Information Software 2; **DOH**, Department of Health; **EHR**, electronic health record; **EMR**, electronic medical record; **FHIR**, Fast Healthcare Interoperable Resources; **HIE**, health information exchange; **HISP**, Health Information Systems Program; **HL7**, Health Level 7; **HPRS**, Health Patient Registration System; **LOGIS**, Logistical Information System; **M&E**, monitoring and evaluation; **NDD**, National Data Dictionary; **NDOH**, National Department of Health; **NHLS**, National Health Laboratory Service; **NICD**, National Institute for Communicable Diseases; **NIDS**, National Indicator Data Set; **PEPFAR**, US President’s Emergency Plan for AIDS Relief; **PERSAL**, Personnel and Salary System; **PHC**, primary health care; **PrEP**, pre-exposure prophylaxis; **SA**, South Africa; **TB**, tuberculosis; **USAID**, US Agency for International Development.









a. According to the CHARISMA project, “CHARISMA is an acronym for ‘Community Health Clinic Model for Agency in Relationships and Safer Microbicide Adherence.’ We refer to it only as CHARISMA because the community component was dropped after the pilot study and the term ‘microbicides’ is not being used in PrEP [pre-exposure prophylaxis] programs.” (Family Health International (FHI) 360, Research Triangle Institute (RTI) International, Wits Reproductive Health and HIV Institute (Wits RHI). [CHARISMA Toolkit Guide to Implementation and Adaptation: Empowerment Counseling to Improve Women’s Ability to Use PrEP Safely and Effectively](#). Durham, NC: FHI 360; 2020: 3.)







Appendix B: Additional Information for Systems, Applications, and Tools from Online Questionnaire






Incomplete data in the questionnaire were complemented by following up with individuals and by referring to literature where possible, but all gaps could not be filled, and all information could not be verified.

An integrated table containing the systems, applications and tools identified by [Map & Match](#) and [Vital Wave](#) can be viewed on the Digital Square website.

Legend		
	A global good or a system, application, or tool based on / using one or more global good	
	A registry / service	
		 A mobile application

No	Name and Description [global good name]	Scale	WHO Primary User Category ^a • Clients • Providers • Managers • Data services	WHO Digital Health System Category ^a	Use Case • HIV • Other	Govt. Contribution • Not yet contributed • Partially funded / contributed in-kind people or time • Fully government funded • Don't know	License / IP • Public domain • Freemium • Proprietary • Non-protective free & open source (OS) • Protective free & OS • Don't know	Online / Off-line • Off-line functionality, intermittent internet required • No off-line functionality • Not applicable (N/A) • Don't know	Data Exchange Meta registries, tools, and/or systems with which data are currently exchanged
1	 AitaHealth	Some districts	Providers Managers Data services	F. Community-based information system	HIV Other	Partially funded / contributed in-kind people or time	Don't know	Off-line functionality, intermittent internet required	Don't know
2	 ART (antiretroviral therapy) Cohort System [DHIS2]	Countrywide	Providers Managers Data services	H. Electronic medical record V. Public health and disease surveillance system	HIV	Partially funded / contributed in-kind people or time	Public domain	Off-line functionality, intermittent internet required	Data are imported from TIER.Net
3	BAS (Basic Accounting System)	Countrywide	Managers	M. Health finance and insurance information system	Other	Fully government funded	Don't know	No off-line functionality	Treasury stand-alone systems - PERSAL, LOGIS, MEDSAS
4	 CHARISMA ^b project – HEART (HEALTHY Relationships Assessment Tool)	Countrywide (integrated into B-Wise)	Clients Providers Managers Data services	C. Client applications D. Client communication system	HIV Other	Partially funded / contributed in-kind people or time	Don't know	No off-line functionality	Don't know
5	 CommCare for CHWs (community health workers) [Commcare; OpenHIE] 	Ekurhuleni District in Gauteng	Providers Managers Data services	F. Community-based information system	HIV Other	Partially funded / contributed in-kind people or time	Don't know	Off-line functionality, intermittent internet required	Don't know
6	 DHIS2 (District Health Information Software 2) [OpenHIE]	Countrywide	Providers Managers Data services	N. Health management information system	HIV Other	Partially funded / contributed in-kind people or time	Public domain	Off-line functionality, intermittent internet required	Don't know
7	 DHIS2 Tracker for CHWs (community health workers) [DHIS2] 	Piloted in 1 district in Free State, not scaled (funding restrictions)	Providers Managers Data services	F. Community-based information system	HIV Other	Partially funded / contributed in-kind people or time	Public domain	Off-line functionality, intermittent internet required	Don't know

No	Name and Description [global good name]	Scale	WHO Primary User Category ^a • Clients • Providers • Managers • Data services	WHO Digital Health System Category ^a	Use Case • HIV • Other	Govt. Contribution • Not yet contributed • Partially funded / contributed in-kind people or time • Fully government funded • Don't know	License / IP • Public domain • Freemium • Proprietary • Non-protective free & open source (OS) • Protective free & OS • Don't know	Online / Off-line • Off-line functionality, intermittent internet required • No off-line functionality • Not applicable (N/A) • Don't know	Data Exchange Meta registries, tools, and/or systems with which data are currently exchanged
8	EDRWeb (Electronic Drug-Resistant [tuberculosis] software)	Countrywide	Providers Managers Data services	V. Public health and disease surveillance system	HIV Other	Partially funded / contributed in-kind people or time	Don't know	No off-line functionality	Don't know
9	EVDS (Electronic Vaccination Data System)	Countrywide	Clients Providers Managers Data services	V. Public health and disease surveillance system	Other	Fully government funded	Don't know	No off-line functionality	Don't know
10	 HPRS (Health Patient Registration System)	Countrywide	Providers Managers Data services	P. Identification registries and directories	Other	Partially funded / contributed in-kind people or time	Don't know	Don't know	Don't know
11	 HPV (human papillomavirus) [DHIS2]	Countrywide	Providers Managers Data services	V. Public health and disease surveillance system	Other	Fully government funded	Public domain	Off-line functionality, intermittent internet required	Don't know
12	Ideal Clinic System	Countrywide	Providers Managers Data services	K. Facility management information system	Other	Partially funded / contributed in-kind people or time	Don't know	Don't know	Don't know
13	 ISHP (Integrated School Health Programme) [DHIS2]	Countrywide	Providers Managers Data services	V. Public health and disease surveillance system	Other	Fully government funded	Public domain	Off-line functionality, intermittent internet required	Don't know
14	 Ithaka HIV self-test tool	Some districts	Clients Providers Managers Data services	V. Public health and disease surveillance system	HIV Other	Not yet contributed	Don't know	Don't know	Don't know
15	 Lynx Health ADC (automated data collection) Online	Countrywide	Providers Managers Data services	V. Public health and disease surveillance system	HIV Other	Not yet contributed	Proprietary	Partial off-line functionality, intermittent internet required	N/A
16	 MomConnect	Countrywide	Clients Providers Managers Data services	C. Client applications D. Client communication system	HIV Other	Partially funded / contributed in-kind people or time	Don't know	Off-line functionality, intermittent internet required	Don't know

No	Name and Description [global good name]	Scale	WHO Primary User Category ^a • Clients • Providers • Managers • Data services	WHO Digital Health System Category ^a	Use Case • HIV • Other	Govt. Contribution • Not yet contributed • Partially funded / contributed in-kind people or time • Fully government funded • Don't know	License / IP • Public domain • Freemium • Proprietary • Non-protective free & open source (OS) • Protective free & OS • Don't know	Online / Off-line • Off-line functionality, intermittent internet required • No off-line functionality • Not applicable (N/A) • Don't know	Data Exchange Meta registries, tools, and/or systems with which data are currently exchanged
17	 NDD (National Data Dictionary) [DHIS2]	Countrywide	Providers Managers Data services	P. Identification registries and directories	HIV Other	Partially funded / contributed in-kind people or time	Public domain	Off-line functionality, intermittent internet required	Don't know
18	 NIDS (National Indicator Data Set) app	Previously countrywide, not used now (no funding)	Providers Managers Data services	P. Identification registries and directories	HIV Other	Not yet contributed	Don't know	Off-line functionality, intermittent internet required	N/A
19	 PEC (Patient Experience of Care) [DHIS2]	Countrywide	Providers Managers Data services	K. Facility management information system	Other	Fully government funded	Public domain	Off-line functionality, intermittent internet required	Don't know
20	PERSAL (Personnel and Salary System)	Countrywide	Managers Data services	O. Human resource information system	Other	Fully government funded	Don't know	No off-line functionality	Independent treasury stand-alone systems (e.g., with BAS)
21	PPIP (Perinatal Problem Identification Programme)	Countrywide	Providers Managers Data services	V. Public health and disease surveillance system	HIV Other	Partially funded / contributed in-kind people or time	Don't know	Don't know	Not interoperable with other systems
22	 RIPDA (Rapid Internal Performance Data Audit) [DHIS2]	Countrywide	Providers Managers Data services	K. Facility management information system	HIV Other	Partially funded / contributed in-kind people or time	Public domain	Off-line functionality, intermittent internet required	Don't know
23	 SVS (Stock Visibility System)	Countrywide	Providers Managers Data services	T. Logistics management information system	HIV Other	Partially funded / contributed in-kind people or time	Proprietary	Partial off-line functionality, intermittent internet required	N/A
24	TIER.Net	Countrywide	Providers Managers Data services	H. Electronic medical record V. Public health and disease surveillance system	HIV Other	Partially funded / contributed in-kind people or time	Protective free and open source	N/A	N/A

Abbreviations: **DHIS2**, District Health Information Software 2; **Govt.**, government; **HIE**, health information exchange; **IP**, internet protocol; **LOGIS**, Logistical Information System; **MEDSAS**, Medical Supplier Administration System; **PERSAL**, Personnel and Salary System; **WHO**, World Health Organization.

a. Source: World Health Organization (2018).³

b. According to the CHARISMA project, "CHARISMA is an acronym for 'Community Health Clinic Model for Agency in Relationships and Safer Microbicide Adherence.' We refer to it only as CHARISMA because the community component was dropped after the pilot study and the term 'microbicides' is not being used in PrEP [pre-exposure prophylaxis] programs." (Family Health International (FHI) 360, Research Triangle Institute (RTI) International, Wits Reproductive Health and HIV Institute (Wits RHI). [CHARISMA Toolkit Guide to Implementation and Adaptation: Empowerment Counseling to Improve Women's Ability to Use PrEP Safely and Effectively](#). Durham, NC: FHI 360; 2020: 3.)

Appendix C: References

All links in the appendix were last accessed on October 25, 2022.

1. Statistics South Africa. *Mid-year Population Estimates, 2021*. Pretoria: Government Printer; 2021: vi. Statistical release P0302. <https://www.statssa.gov.za/publications/P0302/P03022021.pdf#page=6>.
2. World Health Organization (WHO). *WHO Guideline Recommendations on Digital Interventions for Health System Strengthening*. Geneva: WHO; 2019. <http://apps.who.int/iris/bitstream/handle/10665/311941/9789241550505-eng.pdf?ua=1>.
3. World Health Organization (WHO). *Digital Implementation Investment Guide (DIIG): Integrating Digital Interventions into Health Programmes*. Geneva: WHO; 2020. <https://www.who.int/publications/i/item/9789240010567>.
4. World Health Organization (WHO). *Classification of Digital Health Interventions*. Geneva: WHO; 2018. <https://www.who.int/publications/i/item/WHO-RHR-18.06>.
5. National Department of Health. *Annual Performance Plan 2021/22*. Pretoria: Government Printers; 2021. <https://www.health.gov.za/wp-content/uploads/2021/10/Annual-Performance-Plan-2021-2022-1.pdf>.
6. Statistics South Africa. *General Household Survey, 2019*. Pretoria: Government Printer; 2019. <https://www.statssa.gov.za/publications/P0318/P03182019.pdf>.
7. Kaiser Family Foundation / Global Health Policy website. The global HIV/AIDS epidemic fact sheet page. March 2, 2021. <https://www.kff.org/global-health-policy/fact-sheet/the-global-hivaids-epidemic/>.
8. Institute of Health Programs and Systems. *Midterm Review of the National Strategic Plan for HIV, TB, and STIs 2017–2022*. Pretoria: South African National AIDS Council (SANAC) Trust; 2019. <https://sanac.org.za/wp-content/uploads/2021/05/NSP-MTR-Full-Report-2017-2022-FINAL.pdf>.
9. South African National AIDS Council (SANAC) Trust. *Let Our Actions Count: National Strategic Plan on HIV, TB and STIs 2017–2022*. Pretoria: SANAC Trust; 2017. https://www.gov.za/sites/default/files/gcis_document/201705/nsp-hiv-tb-stia.pdf.
10. Diseko L, Overmeyer R. South Africa DSD update. Presented at: 3rd Annual HIV Coverage, Quality, and Impact Network Meeting, November 10–14, 2019; Johannesburg, South Africa. <https://cquin.icap.columbia.edu/wp-content/uploads/2019/12/South-Africa-MOH-presentation-121119-Final.pdf>.
11. Joint United Nations Programme on HIV/AIDS (UNAIDS) website. 90-90-90: Treatment for all [topic page]. <https://www.unaids.org/en/resources/909090>.
12. National Department of Health. *National Digital Health Strategy for South Africa 2019–2024*. Pretoria: Government Printers; 2019. <https://www.health.gov.za/wp-content/uploads/2020/11/national-digital-strategy-for-south-africa-2019-2024-b.pdf>.
13. University of Cape Town. Libraries website. South African Government Policy: Library Guide: ICT page. <https://libguides.lib.uct.ac.za/c.php?g=194637&p=5398709>.
14. Gauteng Department of Health. *Annual Performance Plan 2021/22*, unpublished, 2021.
15. KwaZulu-Natal Department of Health. *Annual Performance Plan 2021/22 –2023/24*. Pietermaritzburg, South Africa: Provincial Government of KwaZulu-Natal; 2021. <http://www.kznhealth.gov.za/app/APP-2021-22.pdf>.
16. Gauteng Department of Health. *Information and Communications Technology (ICT) Strategic Plan 2019/20 – 2023/24*, unpublished, 2020.
17. Department of Communications and Digital Technologies. *Draft National Data and Cloud Policy*. Pretoria: Government Printing Works; April 1, 2021. Government Gazette No. 44389. https://www.gov.za/sites/default/files/gcis_document/202104/44389gon206.pdf.
18. Office of the Presidency, Republic of South Africa. *No. 61 of 2003: National Health Act, 2004*. Cape Town: Government Printing Works; July 23, 2004. Government Gazette No. 26595, vol.469. https://www.gov.za/sites/default/files/gcis_document/201409/a61-03.pdf.

19. Government of the Republic of South Africa. *2019/20 South Africa Yearbook*. Pretoria: Government Printers; 2020. <https://www.gcis.gov.za/sites/default/files/docs/resourcecentre/yearbook/Yearbook2020-9-Health.pdf>.
20. National Department of Health. *District Health Management Information System (DHMIS) Policy*. Pretoria: Government Printers; 2011. <https://www.knowledgehub.org.za/elibrary/district-health-management-information-system-dhmis-policy>.
21. Department of Telecommunications and Postal Services. *Presidential Commission on the Fourth Industrial Revolution*. Pretoria: Government Printing Works; April 9, 2019. Government Gazette No. 42388. https://www.gov.za/sites/default/files/gcis_document/201904/42388gen209.pdf.
22. National Department of Health. *Presidential Health Summit 2018: Strengthening the South African Health System Towards an Integrated and Unified Health System*. Pretoria: Government Printers; 2019. https://www.gov.za/sites/default/files/gcis_document/201902/presidential-health-summit-report.pdf.
23. Gauteng Department of e-Government. *Revised Strategic Plan 2020–2025*. Pretoria: Government of Gauteng Province; 2020. <https://cmbinary.gauteng.gov.za/Media?path=e-gov/Documents/Strategic%20Plans/Department%20of%20e-Government%20Strategic%20Plan%202020-2025.pdf&Item=76&Type=Documents&Location=/e-gov>.
24. KwaZulu-Natal Department of Health. *KwaZulu-Natal Health Act 2009*. Pietermaritzburg, South Africa: Provincial Government of KwaZulu-Natal; April 3, 2009. Extraordinary Provincial Gazette of KwaZulu-Natal No. 5. <http://www.kznhealth.gov.za/legislation/kznhealthact.pdf>.
25. KwaZulu-Natal Department of Health. *Draft ICT Strategic Plan 2020/21 – 2024/25 (v. 1.2)*, unpublished, 2021.
26. National Department of Health. *National Health Insurance Policy: Towards Universal Coverage*. Pretoria: Government Printing Works; June 30, 2017. Government Gazette No. 40955. https://www.gov.za/sites/default/files/gcis_document/201707/40955gon627.pdf.
27. National Department of Health. *2030 Human Resources for Health Strategy: Investing in the Health Workforce for Universal Health Coverage*. Pretoria: Government Printers; 2020. <https://www.spotlightnsp.co.za/wp-content/uploads/2020/08/2030-HRH-strategy-19-3-2020.pdf>.
28. Schönfeldt A. *Provincial Department of Health Data Governance Framework*, unpublished, 2022.
29. National Planning Commission. *National Development Plan 2030: Our Future – Make It Work*. Pretoria: Government Printers; 2012. https://www.gov.za/sites/default/files/gcis_document/201409/ndp-2030-our-future-make-it-workr.pdf.
30. National Department of Health. *Strategic Plan 2020/21 – 2024/25*. Pretoria: Government Printers; 2020. <https://www.health.gov.za/wp-content/uploads/2020/11/depthealthstrategicplanfinal2020-21to2024-25.pdf>.
31. Gauteng AIDS Council Secretariat. *Gauteng Strategic Implementation Plan for 2017 to 2022*. Johannesburg: Gauteng AIDS Council Secretariat; 2017. https://www.nacosa.org.za/wp-content/uploads/2020/06/GSIP-REVISED-LAYOUT_Round-Three.pdf.
32. KwaZulu-Natal Office of the Premier HIV/AIDS Directorate. *Multi-Sectoral Response Plan for HIV, TB and STIs for KwaZulu-Natal Province 2017–2022*. Pietermaritzburg, South Africa: Provincial Government of KwaZulu-Natal; 2017. https://sanac.org.za/wp-content/uploads/2019/02/PIP_KZN_Final-1.pdf.
33. National Treasury, Republic of South Africa. *Budget Review 2021*. Pretoria: Government Printers; 2021. <http://www.treasury.gov.za/documents/national%20budget/2021/review/FullBR.pdf>.
34. Gerber J. EXPLAINED: When will the NHI be implemented? [news article]. *News 24*. August 15, 2019. <https://www.news24.com/news24/SouthAfrica/News/explained-when-will-the-national-health-insurance-be-implemented-20190815>.
35. Department of Telecommunications and Postal Services. *National eGovernment Strategy and Roadmap*. Pretoria: Government Printing Works; November 10, 2017. Government Gazette No. 41241. https://www.gov.za/sites/default/files/gcis_document/201711/41241gen886.pdf.
36. National Department of Health. *eHealth Strategy South Africa*. Pretoria: Government Printers; 2012. <https://health-e.org.za/wp-content/uploads/2014/08/South-Africa-eHealth-Strategy-2012-2017.pdf>.

37. KwaZulu-Natal Office of the Premier. *2020–2025 KwaZulu-Natal Provincial ICT Integration Plan for Digital Transformation Strategy*. v. 1.1. Pietermaritzburg, South Africa: Provincial Government of KwaZulu-Natal; 2020: 5. <http://www.kznonline.gov.za/images/Downloads/Downloads/Cloud%20Policies/KZN%20Provincial%20Integration%20Plan.pdf#page=6>.
38. KwaZulu-Natal Department of Health. *Draft KZN eHealth Rollout Project Charter* (v. 01), unpublished draft, 2020.
39. KwaZulu-Natal Department of Health. *KZN Data Warehouse Project Charter* (v. 1.4), unpublished, 2021.
40. Department of Communications and Digital Technologies. *National Digital and Future Skills Strategy: Originality, Agility, Critical Thinking and Problem-Solving for Digital Inclusion*. Pretoria: Government Printing Works; September 23, 2020. Government Gazette No. 43730. <https://www.gov.za/documents/national-integrated-ict-policy-white-paper-national-digital-and-future-skills-strategy>.
41. Knowledge Hub website. <https://www.knowledgehub.org.za/>.
42. Statistics South Africa. *General Household Survey 2020*. Pretoria: Government Printer; 2020. <http://www.statssa.gov.za/publications/P0318/P03182020.pdf>.
43. SITA website. About SITA page. <https://www.sita.co.za/page/about>.
44. Mzekandaba S. Bold targets set for phase two of SA Connect [article]. *IT Web*. February 16, 2022. <https://www.itweb.co.za/content/mYZRX79aKRr7OgA8>.
45. US Agency for International Development (USAID). *A Vision for action in Digital Health 2020–2024: Accelerating the Journey to Self-Reliance Through Strategic Investments in Digital Technologies*. Washington, DC: USAID; 2020. https://www.usaid.gov/sites/default/files/documents/USAID-A-Digital-Health-Vision-for-Action-v10.28_FINAL_508.pdf.
46. National Department of Health. *National Health Normative Standards Framework for Interoperability in eHealth in South Africa*. v. 2.0. Pretoria: Government Printers; 2014. <https://www.colleaga.org/sites/default/files/attachments/hnsf-complete-version%201.pdf>.
47. Wolmarans M, Tanna G, Dombo M, et al. eHealth Programme reference implementation in primary health care facilities. In: Padarath A, King J, English R, eds. *South African Health Review 2014/15*. Durban: Health Systems Trust; 2015. <https://www.profnetmedical.co.za/media/1177/south-african-health-review-2014-15-part-3compressed.pdf>.
48. Kati Collective website. Early Stage Digital Health Investment Tool (EDIT) page. <https://katicollective.com/tools>.
49. PATH. *South African Pre-Exposure Prophylaxis (PrEP) Digital Landscaping 2021*, unpublished, 2021.
50. mLab Southern Africa and reHealth Africa. *South African mHealth Start-ups* [infographic]. Pretoria: mLab/reHealth; 2018. <https://mlab.co.za/wp-content/uploads/2018/07/mHealth-Startup-Map-2018.pdf>.
51. National Department of Health. *Vaccine Site Registration: Master Facility List (MFL) Guidelines of Updates and Curation for Users and Stakeholders and Its Application for Vaccination Sites*. Pretoria: Government Printers; 2021. https://www.westerncape.gov.za/assets/departments/health/COVID-19/mfl_guide_word_version.docx.
52. News24 website. Health24 page. *Differing views on Gauteng's new health information system*. July 15, 2022. <https://www.news24.com/health24/news/public-health/differing-views-on-gautengs-new-health-information-system-20220714>.
53. Digital Square. *Global Goods Guidebook*. 3rd ed. Seattle: PATH; 2022. <https://digitalsquare.org/resourcesrepository/global-goods-guidebook>.
54. Gulube SM, Wynchank S. Telemedicine in South Africa: success or failure? *PubMed*. 2001;7. <https://pubmed.ncbi.nlm.nih.gov/11747657/>.
55. National Department of Health. National Data Dictionary website. Home page. <https://dd.dhmis.org/>.
56. National Department of Health. *Integrated TB/HIV Data Management Standard Operating Procedure—Part I: Facility-Level*. v. 2. Pretoria: Government Printers; 2019. <https://www.tbhivinfosys.org.za/wp-content/uploads/2022/02/Integrated-TB-HIV-Data-Management-SOP-Part-1-Facility-Level.pdf#page=16>.
57. Boulle A, Heekes A, Tiffin N, et al. Data Centre profile: the Provincial Health Data Centre of the Western Cape Province, South Africa. *International Journal of Population Data Science*. 2019;4(2):1143. <https://doi.org/10.23889/ijpds.v4i2.1143>.
58. BenDor A, Källander K, Mehl G, Wilson K. Exploring digital public good alignment and vetting: How WHO, UNICEF and Digital Square are coordinating for the digital health community. Presented at: Global Digital Health Forum, December 7, 2020; [virtual]. https://wiki.digitalsquare.io/images/d/df/Exploring_Digital_Public_Good_Alignment_and_Vetting.pdf.



Digital Square is a PATH-led initiative funded by the US Agency for International Development (USAID), the Bill & Melinda Gates Foundation, and a consortium of other donors. For more information on Digital Square, please visit our website at www.digitalsquare.org or email digitalsquare@path.org.

For more technical information on Digital Square–approved global goods, please visit our wiki at https://en.wikipedia.org/wiki/Digital_public_square.

This report is made possible by the support of the Bill & Melinda Gates Foundation. The contents of this report do not necessarily reflect the views of the foundation, PATH, Digital Square, the US government, or other funders.

This work is licensed under the Creative Commons Attribution-ShareAlike 4.0 International License (CC BY-SA 4.0). To view a copy of this license, visit <https://creativecommons.org/licenses/by-sa/4.0/legalcode> or send a letter to Creative Commons, 171 Second Street, Suite 300, San Francisco, California, 94105, USA. The content in this document may be freely used in accordance with this license provided the material is accompanied by the following attribution: Digital Health to Support HIV Care: A landscape assessment of KwaZulu-Natal and Gauteng Provinces in South Africa (2022). Copyright 2022 PATH.

Suggested citation: PATH. *Digital Health to Support HIV Care: A landscape assessment of KwaZulu-Natal and Gauteng Provinces in South Africa (2022)*. Seattle: PATH; 2022.