Maturity assessment of Kenya's health information system interoperability readiness

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ABSTRACT

Background The use of digital technology in healthcare promises to improve quality of care and reduce costs over time. This promise will be difficult to attain without interoperability: facilitating seamless health information exchange between the deployed digital health information systems (HIS).

Objective To determine the maturity readiness of the interoperability capacity of Kenya's HIS.

Methods We used the HIS Interoperability Maturity Toolkit, developed by MEASURE Evaluation and the Health Data Collaborative's Digital Health and Interoperability Working Group. The assessment was undertaken by eHealth stakeholder representatives primarily from the Ministry of Health's Digital Health Technical Working Group. The toolkit focused on three major domains: leadership and governance, human resources and technology.

Results Most domains are at the lowest two levels of maturity: nascent or emerging. At the nascent level, HIS activities happen by chance or represent isolated, ad hoc efforts. An emerging maturity level characterises a system with defined HIS processes and structures. However, such processes are not systematically documented and lack ongoing monitoring mechanisms.

Conclusion None of the domains had a maturity level greater than level 2 (emerging). The subdomains of governance structures for HIS, defined national enterprise architecture for HIS, defined technical standards for data exchange, nationwide communication network infrastructure, and capacity for operations and maintenance of hardware attained higher maturity levels. These findings are similar to those from interoperability maturity assessments done in Ghana and Uganda.

Summary

What is already known?

► In Kenya and other sub-Saharan African countries, there has been a proliferation of digital health solutions implemented over the past decade aimed at improving health service delivery. However, these implementations have been found to be uncoordinated, fragmented and not integrated into a cohesive national health information network. This fragmentation has led to the duplication of effort by different implementors and the inability to scale pilots, diminishing the potential benefits of digital health interventions.

What does this paper add?

► This paper provides a comprehensive review of Kenya's health information system interoperability readiness and identifies priorities for intervention.

INTRODUCTION

Digital technology has transformed the global way of life over the past three decades. The healthcare space has been part of this revolution with the ubiquitous implementation of digital solutions to tackle healthcare delivery challenges.[1–3] The WHO defines digital health as an umbrella term that includes previous terms such as eHealth and mHealth as well as emerging concepts like the use of advanced computing techniques to manage big data in health, genomics and artificial intelligence.[4] Digital health has the potential to improve the safety and quality of care, reduce the skyrocketing costs of healthcare and increase the patient's participation in their own care.[5–7]

The WHO recognises that digital health presents a unique opportunity for the development and strengthening of public health systems.[8] The recent rise in the number of cell phone users and internet technologies in developing countries, coupled with a reduction in the price of devices and services, has made digital health an attractive potential solution to the challenges of a resource-constrained health system.[9] In Kenya, there has been a proliferation of digital health solutions implemented over the past decade aimed at improving health service delivery. However, these implementations have been found to be uncoordinated, fragmented and not integrated into a cohesive national health information network.[9 10] This fragmentation has led to the duplication of effort by different

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implementors and the lack of scaling of piloted implementations, among other issues that limit the potential benefits of digital health interventions.[11]

To realise the potential of digital health interventions, they need to be implemented in an interoperable environment. Interoperability refers to the capacity for different information systems to meaningfully exchange data. In the context of health information systems (HIS), this enables them to be implemented across organisational boundaries to effectively deliver healthcare services and advance the health status of individuals and communities.[12] Globally, there have been a few successful implementations of HIS interoperability such as in Estonia and in the state of Indiana, USA.[13 14] These examples demonstrate that the goal of HIS interoperability is achievable, and the lessons learnt from their experiences may be useful in our situation.

In Kenya, the National Government, through the Ministry of Health (MoH), has taken steps to facilitate a more conducive environment for health information exchange across different information systems. These include the development of guidance documents on digital health standards for electronic HIS, a national enterprise architecture, a master health facility list and a health worker registry, among others.[15–17] While these are significant milestones in health system interoperability, much is yet to be done. We conducted an assessment of the current state of interoperability in Kenya to determine the progress made so far and to identify gaps that need intervention.

For our assessment, we used the HIS Interoperability Maturity Toolkit by the MEASURE Evaluation project in collaboration with the Health Data Collaborative. This toolkit provides a comprehensive framework for evaluating HIS interoperability at a national level. The toolkit was extensively validated within low-income countries, including Kenya, and has been used to evaluate the HIS maturity for Ghana and Uganda.[18 19] By using it, we were sure to have a comprehensive and comparable measure for HIS maturity for Kenya. It was developed with the following objectives in mind: to identify the domains and subdomains for HIS interoperability and stages of their development toward maturity; to assess and understand where they are on the path to HIS interoperability and identify actions that can accelerate interoperability maturation; to use the results of the assessment to plan, prioritise, and coordinate resources to support a strong, responsive and sustainable national HIS; and to monitor, evaluate, and report on individual or all components of HIS interoperability.

We assessed the state of national HIS interoperability in Kenya, where studies and surveys have reported little or no interoperability among the increasing number of digital health systems and products.

METHODS
Assessment tool
We applied the MEASURE Evaluation project's HIS Interoperability Maturity Toolkit as a framework for the assessment of the HIS interoperability landscape in

Table 1 Domains and subdomains of the interoperability maturity framework

Domain	Subdomains
Leadership and governance	1. Governance structure for HIS 2. Interoperability guidance documents 3. Compliance with data exchange standards 4. Data ethics 5. HIS interoperability monitoring and evaluation 6. Business continuity 7. Financial management 8. Finance resource mobilisation
Human resources	1. Human resources policy 2. Human resources capacity (skills and numbers) 3. Human resources capacity development
Technology	1. National HIS enterprise architecture 2. Technical standards 3. Data management 4. HIS subsystems 5. Operations and maintenance 6. Communication network: LAN and WAN 7. Hardware

HIS, health information systems; LAN, local area network; WAN, wide area network.

Kenya. We chose this toolkit as it had already been developed and validated by the MEASURE team and had been used for similar assessments in Uganda and Ghana (see online supplemental appendix 1 for the Uganda and Ghana assessments). The toolkit addresses three maturity domains: leadership and governance, human resources and technology. Each domain is divided into subdomains, making a total of 18 subdomains as summarised in table 1.

During an assessment, each domain and subdomain is assigned a maturity level in accordance with user guidelines for the maturity toolkit. The maturity levels are described below.

Level 1 (nascent)
The country lacks HIS capacity or does not follow processes systematically. HIS activities happen by chance or represent isolated, ad hoc efforts.

Level 2 (emerging)
The country has defined HIS structures, but they are not systematically documented. No formal or ongoing monitoring or measurement protocol exists.

Level 3 (established)
The country has documented HIS structures. The structures are functional. Metrics for performance monitoring, quality improvement and evaluation are used systematically.

Level 4 (institutionalised)

Government and stakeholders use the national HIS and follow standard practices.

Level 5 (optimised)

The government and stakeholders routinely review interoperability activities and modify them to adapt to changing conditions.

For a domain to be at a given defined maturity level, all its subdomains need to be at or above that level. The score of a domain determines its level maturity, taking the floor of the level if the score is between one level and the next. For example, a domain/subdomain that scores 3+ is judged at level 3 (established) and not level 4 (institutionalised).

For the assessment, we involved a number of Kenya's digital health stakeholders through a workshop, mostly constituting the Digital Health Technical Working Group (TWG) led by the digital health unit of the MoH and represented by different sectors: academia, research, professional bodies, non-governmental organisations and other entities (see online supplemental appendix 2 for the list and classification of participating entities). The participants were individuals and organisational representatives who had experience working within the digital health ecosystem in Kenya at local, county and national levels. These participants, by virtue of being members of the TWG, were best placed to understand the parameters within the MEASURE toolkit and respond to them appropriately. Routine users were not the target of this assessment as this assessment was for national level HIS interoperability and as such, the participants needed to have a national level outlook to be able to respond appropriately to the parameters in the assessment tool.

Participants were presented with the assessment goals, scope and process. They were divided into three groups corresponding to the three domains of HIS interoperability. The groups discussed the maturity domains and subdomains and completed the assessment questionnaire as defined by the toolkit. A consensus-building session on the results was conducted to present the findings from each group and develop a final harmonised set of answers for both the domains and subdomains.

RESULTS

A total of 25 different entities with 39 representatives were involved in the interoperability maturity assessment and discussions. There were 11 representatives from the MoH and other government agencies, 4 representatives from academia, 5 representatives from the private sector and 19 from non-governmental organisations.

Kenya's HIS interoperability maturity matrix

In this assessment, the majority of interoperability subdomains were still in the nascent stage of maturity. In the leadership and governance domain, the 'governance structure for HIS' and 'interoperability guidance documents' subdomains had the highest maturity score at established and institutionalised, respectively, while 'financial management' and 'financial resource mobilisation' subdomains were judged as emerging. The other subdomains were in the nascent stage of maturity. Overall, the human resources domain, comprised of three subdomains, was emerging in maturity. Of the seven subdomains of the technology domain, one (communication network: LAN and WAN) had institutionalised maturity; three (national HIS enterprise architecture, technical standards and HIS subsystems) were established in maturity; two (operations and maintenance, and hardware) were emerging, while data management was the least mature at nascent maturity and thus pulled the entire technology domain to its level. The assessment is summarised in table 2.

DISCUSSION

The HIS interoperability maturity model addresses the components that are critical to interoperability: technology, the broad area of leadership and governance of the HIS, and human resources. The maturity model concept is used to measure the ability of an organisation or government entity, such as a MoH, to continuously improve in a specific discipline until it reaches the desired level of development or maturity.[20] Overall, our findings reveal that the Kenya HIS (KHIS) interoperability subdomains were at the nascent or emerging stage.

While there was no subdomain that had achieved the highest maturity level, there is some progress that should be acknowledged. There is a relatively robust technological environment to support HIS activities with a defined national enterprise architecture for HIS, defined technical standards for data exchange, a nationwide communication network infrastructure and capacity for operations and maintenance of hardware. This shows a clear bias towards the technology that facilitates interoperability and neglect of the other two domains that are important for interoperability.

The leadership and governance domain has two subdomains that are well established. These are governance structure for HIS and availability of interoperability guidance documents. The governance structure for HIS subdomain includes TWGs that support the MoH in its HIS agenda. Interoperability is handled under the Digital Health TWG. The TWGs, as presently constituted, lack defined terms of reference that outline the scope of their mandate. This can potentially result in the lack of focus and difficulty in the monitoring and evaluation of the TWG activities and mandates. Such terms of reference should be reviewed regularly and align with the emerging digital health trends and the ever-increasing number of digital health stakeholders. Its deliberations should be firmly anchored in an evolving interoperability roadmap for the KHIS.

The MoH has published several documents to provide guidance on the implementation of different aspects of

Table 2 Interoperability domain maturity scores

Leadership and governance

Subdomain	Level	Comment
Governance structure for HIS	(3+) established	Kenya's Ministry of Health has an established governance structure for the management of HIS activities. There are technical working groups (TWGs) that meet regularly, namely the HIS TWG, eHealth TWG, Monitoring and Evaluation TWG and the Central Registration of Vital Statistics TWG. Their activities are coordinated through a ministry-led, interagency coordinating committee. These working groups comprise of stakeholders from both the public and private sectors. However, a routine HIS curriculum focused on building an environment that enables policy, building a resource pipeline and creating champions does not exist.
Interoperability guidance documents	(4) institutionalised	The National Government has developed and launched guidance documents to support different aspects of digital health implementation. The Kenya eHIS interoperability standards document is specific to interoperability in the health sector and is based on and supported by other guidance documents in place: the Kenya National eHealth Policy, the Kenya National eHealth Strategy (2011–2017), the Kenya HIS Policy, the Kenya Standards and Guidelines for mHealth systems and the Kenya Health Enterprise Architecture.[15–17 21 22] In general, these documents are intended to guide implementation of HIS interoperability. Plans are underway to review the interoperability document.
Compliance with data exchange standards	(1) nascent	The Kenya eHIS interoperability standards document outlines the data exchange standards that are recommended for system interoperability.[21] Despite its existence, there are no structures, processes or procedures in place to guide or enforce compliance with the data exchange, messaging and data security standards as envisaged in the guidelines.
Data ethics	(2) emerging	This subdomain addresses the moral dimensions of data management, including the policing of adherence to ethical principles throughout data generation, recording, curation, processing, dissemination, sharing and use. No enacted general or healthcare-specific data protection laws, regulatory frameworks or ethics provisions exist to guide data ethics around security, privacy and confidentiality. While the 2018 Data Protection Bill is a good start (currently under review before parliament), it may not adequately address the unique and specific nuances of healthcare data.
HIS interoperability monitoring and evaluation	(1) nascent	This subdomain refers to the use of indicators/attributes from the maturity model to facilitate the tracking of inputs, processes and outputs against desired results of HIS interoperability implementation, and the use of these data to make decisions. The Ministry of Health has a monitoring and evaluation framework that focuses on the improvement of information systems at all levels and a stewardship goal of establishing common data architecture to ease the sharing of data.
Business continuity	(1) nascent	The interoperability maturity tool defines business continuity as the capability of an organisation to continue the delivery of products or services at acceptable predefined levels following a disruptive incident. It entails devising plans and strategies that enable an organisation to continue operations and to recover quickly from any type of disruption. There is currently no government-approved business continuity plan in place for both the national and county levels of HIS.
Financial management Financial resource mobilisation	(2+) emerging (2) emerging	Financial management includes the legal and administrative systems, and procedures that permit a government ministry, its agencies and organisations to conduct activities that adhere to procedural and appropriate use of public funds. Resource mobilisation includes the activities involved in securing new and additional financial resources for HIS management. The government has budgeted for digital health including interoperability activities. Furthermore, it was found that a significant proportion of financial resources for HIS strengthening including HIS interoperability were donor driven.
Domain total	(1) nascent	
Human resources		

Continued

Table 2 Continued

Leadership and governance

Subdomain	Level	Comment
Human resources policy	(2) emerging	The maturity assessment did not identify the presence of a human resources policy that recognises HIS-related cadres. A national needs assessment has been completed showing the number of staff and types of skills needed to support HIS including digital HIS and interoperability. However, there is an absence of a long-term plan to grow and sustain staff with the skills needed to sustain HIS and digital HIS and interoperability. Further, HIS-related cadre roles such as health records and information officers (HRIOs) at county level are mapped to the government's workforce and schemes of work.
Human resources capacity (skills and numbers)	(2) emerging	The country does not have enough staff dedicated to maintaining digital HIS and interoperability. The HRIOs are involved in all aspects of health records and information, but not necessarily digital HIS. Furthermore, it was found that the country depends on technical assistance from external stakeholders to support the national and county digital HIS.
Human resources capacity development	(2+) emerging	Tertiary education institutions such as Moi University and Kenyatta University have started programmes to build capacity for digital health roles. However, there is no plan for or ongoing in-service training for HIS staff to build their skills around digital HIS and interoperability. Furthermore, the country does not have the capacity to train enough staff to support digital HIS and interoperability through in-country, preservice and in-service training institutions or partnerships with other training institutions.
Domain total	(2) emerging	
Technology		
National HIS enterprise architecture	(3+) established	A national enterprise architecture for an HIS defines how HIS subsystems interact and exchange data and shows necessary services for data exchange. Kenya has a validated national HIS enterprise architecture that defines technology requirements and exchange formats for interoperability.[16] There are also foundational tools and rules for HIS interoperability including health information management systems for routine and surveillance data and core authoritative registries (facility registry and health worker registry). These tools are owned and implemented by the National Government.
Technical standards	(3+) established	The technical standards provide a common language and set of expectations that enable interoperability among systems and/or devices. They include standards for data exchange, transmission, messaging, security, privacy and hardware. The National Government, through the Ministry of Health, has published and disseminated standards for data exchange. There are plans to develop a certification mechanism for new HIS subsystems to be integrated into a national HIS using the specified standards. Additionally, an interoperability laboratory, Digital Health Applied Research Centre, has been set up by a collaboration between the Jomo Kenyatta University of Agriculture and Technology and a development partner to test technical standards and new digital HIS.[23]
Data management	(1) nascent	There was no national document for data management procedures for the Kenya HIS.
HIS subsystems	(3) established	Although the standards and guidelines for digital health system interoperability are published, most digital HIS in the country consist of standalone program-specific subsystems working in silos addressing only the basic needs such as routine HIS, surveillance systems and human resource management systems. The government requires that all HIS subsystems comply with the country's interoperability plan, but this has not been effectively enforced.
Operations and maintenance	(2+) emerging	This refers to a set of procedures to ensure a high uptime for computer hardware, software and network resources. Kenya has strong in-country capacity for computer technology maintenance, but the maintenance for network and hardware is a mix of reactive and evolving preventive procedures.

Table 2 Continued

Leadership and governance

Subdomain	Level	Comment
Communication network: LAN and WAN	(4) institutionalised	Through the National Fiber Optic Backbone network, the government has begun implementing a technical solution to ensure permanent connectivity to HIS services. [24] All national offices of the Ministry of Health have a strong and reliable network connection to access the various HIS network services.
Hardware	(2) emerging	These are the physical parts of a system of computers including desktop computers, laptop computers and servers that provide services to a user in the HIS. The country has inadequate hardware (eg, servers, computers, printers and supportive accessories) to support a national HIS.
Domain total	(1) nascent	

HIS, health information systems; LAN, local area network; WAN, wide area network.

digital health in the country. However, the policies and strategies outlined in these documents have received little to no attention. There is potential for future research to further investigate the reasons behind our findings, as this assessment was a snapshot of the state of interoperability at a particular time.

So while other domains and subdomains have received some appreciable progress in maturation, the implementation of subdomains on compliance with data exchange standards, data ethics, monitoring and evaluation, business continuity and financial resource mobilisation has been left out. This gap in policy implementation shows that a holistic approach is indispensable to the attainment of HIS interoperability.

A skilled workforce is central to any enterprise and the HIS domain is no exception. From our findings, human resource capacity has not been adequately addressed. At present, HIS are managed by health records and information officers who have little or no training in digital health. Furthermore, there are currently no plans to provide in-service training on digital health to these staff or long-term plans to grow and sustain staff with required digital health skills needed to maintain modern HIS. This means that even if the other domains are adequately addressed, there will be inadequately skilled manpower in the country to support the maturation of health interoperability. Investment in preservice and in-service national training programmes to build human resource capacity on digital HIS, including interoperability, based on a training curriculum that outlines the required competencies, can catalyse the emergence of skilled digital health practitioners.

The technology domain had four of its seven subdomains being at or above established, with the 'operations and maintenance' and 'hardware' subdomains at the emerging level. The overall domain, however, was nascent due to the nascent score of the 'data management' subdomain. The KHIS lacks a national document for data management procedures yet holds tens to hundreds of millions of data entries and generates more every month. Developing and implementing a data management document will help in the utilisation of the available data for studying patterns of ill-health to inform health policies for better health outcomes.

The findings from this assessment mirror those of similar assessments done in Ghana and Uganda where the results revealed that most subdomains are at the lowest two levels: nascent or emerging. The maturation of country level interoperability is key to regional and continental HIS interoperability.

Moving forward, the MoH and other digital health stakeholders need to continue the collaborative efforts to achieve digital health system interoperability at local, national and regional levels.

CONCLUSION

The maturity model we used provides a holistic framework that the MoH can use to implement its national HIS interoperability vision. It identifies the three domains of leadership and governance, human resources and technology that need to be developed concurrently to achieve interoperability. Our findings show that some domains are more developed than others and this may be one of the reasons that HIS interoperability has so far proven elusive.

Overall, the National Government has made significant steps towards achieving HIS interoperability. We emphasise focusing on the domain of KHIS leadership and governance that is still in the nascent stage for its importance in the coordination and the growth of the human resources and technology domains.

pharmaceutical company or other agency to write this article. The corresponding author had full access to all the data in the study and had final responsibility for the decision to submit for publication.

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APPENDIX 1: UGANDA AND GHANA ASSESSMENTS

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APPENDIX 3: RECOMMENDATIONS

The authors recommended the following:

Leadership and Governance
- That a sub-committee on HIS interoperability be constituted under the auspices of the digital health technical working group to take the lead on interoperability issues.
- That the Digital Health TWG should support the MoH in reviewing, updating and disseminating the digital health guidance documents

- The National Government should adopt viable unique patient identifier strategies and scale up the use of these identifiers.
- The Digital Health TWG and the MoH should define shared medical records (SMR) requirements and functionality and address the ethico-legal implications that will arise due to the use of the SMR
- The MoH should join and actively participate in the global conversation on inter-operability (IHE, OpenHIE)
- There should be an annual review of the progress of HIS interoperability maturity
- There should be an annual showcase on interoperability during which government, organizations, developers, healthcare providers, partners and other stakeholders showcase their progress and innovation in implementing interoperable digital health solutions.
- The interoperability sub-committee of the Digital Health TWG should support the MoH to expedite the implementation of the certification framework for digital health interventions and a policy for enforcing compliance with this framework

Human Resources
- Define and propose minimum digital health competencies to relevant health professional boards

Technology
- There should be an expansion of the current HIS subsystems, including definition and/or adoption of a unified framework of data exchange for the subsystems, as the basis of a working national data exchange platform to support Universal Health Coverage
- The MoH should develop and/or adopt an open access standard drug terminology that contains all medication available in the Kenyan market
- The MoH should develop and/or adopt a standard clinical and procedure nomenclature system
- The MoH should develop and/or adopt a health finances HIS subsystem supported by a robust exchange of financial data for health