Building a Strong and Interoperable Digital Health Information System for Uganda

Summary

Uganda launched its National eHealth Policy and Strategy in May 2018.[1] Leadership and governance, workforce development, enterprise architecture, health information systems integration, and interoperability are the strategy's key areas of implementation. Most important, the strategy calls for "harmonized eHealth initiatives at all levels," given the various digital health information systems (HIS) that have taken root in the country.

To understand how to prioritize investments and implementation toward interoperability within these systems, the Ministry of Health (MOH) of Uganda, with support from MEASURE Evaluation—funded by the United States Agency for International Development (USAID)—conducted a readiness assessment of the interoperability of Uganda's HIS with in-country HIS stakeholders.

The assessment team focused on three major domains of an HIS: leadership and governance, human resources, and technology. They used the Health Information System Interoperability Maturity Toolkit,[2] developed in 2017 by MEASURE Evaluation and the Health Data Collaborative's Digital Health and Interoperability Working Group, with input from digital health stakeholders in Ghana and Kenya. A maturity model measures the ability of an organization or government entity, such as a health ministry, to continuously improve in a specific discipline until it reaches the desired level of development, or maturity. Using the results of the assessment, the team brainstormed activities that Uganda could prioritize to move the country toward a stronger, interoperable digital HIS. This brief describes the assessment process, results, and recommended actions.

[1] Available at http://www.health.go.ug/content/national-ehealth-strategy

[2] Available at https://www.measureevaluation.org/resources/tools/health-information-systems-interoperability-toolkit/health-information-systems-interoperability-toolkit

Background

"Interoperability" denotes the ability of two or more information systems to exchange information and work together in and across organizational boundaries to advance the health status of individuals and communities. Interoperability also underpins effective delivery of healthcare, by enabling clients to move across service delivery points in the same health facility or move to other health facilities and access their records (Healthcare Information and Management Systems Society, 2013).

To build a strong HIS reinforced by digital health, the MOH of Uganda has developed an eHealth strategy and framework, and has established a technical working group (TWG) that meets regularly to guide this work. Within the eHealth framework, certain challenges impede rapid implementation of eHealth: fragmented data sources, numerous and uncoordinated digital health pilot projects, poor computer literacy skills, data security and privacy concerns, a shortage of health staff, and systems that are unable to exchange data. The interoperability readiness assessment is one step toward determining the status of the HIS and its domains, and the assessment results contribute to the development of a roadmap to strengthen the weak areas. (See Figure 1.)

Figure 1. The domains and components of an interoperable HIS
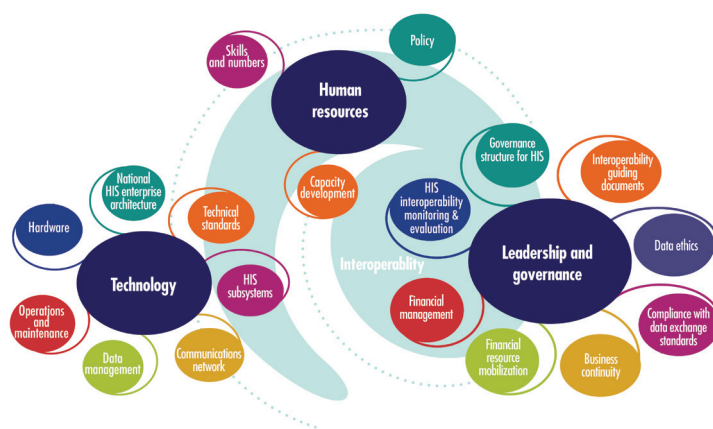
MEASURE Evaluation used the maturity model approach to conduct the assessment and analyze the results. The maturity model comprises a set of structured levels that depict organizational behaviors, practices, and processes that reliably and sustainably produce required outcomes (Hammond, Bailey, Boucher, Spohr, & Whitekar, 2010).

Assessment

MEASURE Evaluation facilitated the HIS interoperability readiness assessment in Uganda in June 2018. The assessment was carried out with the two-step process described below.

1. **Formation of an assessment oversight team to plan the assessment.** The MOH worked with MEASURE Evaluation to identify health professionals with the right expertise, experience, and authority to form the team. The specific mandate for the eight-member team (and two MEASURE Evaluation facilitators) was to provide the overall scope and direction for the assessment, determine which stakeholders would be invited for the assessment, and oversee the assessment. The MEASURE Evaluation team oriented the assessment oversight team to the assessment tools and processes. Table 1 lists the members of the assessment oversight team.

2. **Assessment workshop.** The assessment workshop was a one-day event attended by 27 participants (listed in Table 2), who represented the MOH and other government ministries, the United States Centers for Disease Control and Prevention (CDC), the World Health Organization (WHO), and several of the MOH's implementing partners. The MEASURE Evaluation team presented the assessment's goals, scope, and process. Then, each of the participants completed the assessment questionnaire. Next, the oversight assessment team facilitated a consensus-building session on the results. The aim of the consensus-building process was to develop a final set of answers acceptable to all participants. The assessment results would then help determine the maturity levels of the interoperability domains and their subdomains.

Results

The consensus-building process produced the final results that were further analyzed into scores and mapped onto the maturity model, to produce a visual presentation of maturity levels. Each of the subdomains of the HIS interoperability maturity model has five levels of maturity: nascent, emerging, established, institutionalized, and optimized. The results revealed that most subdomains are at the lowest two levels: nascent or emerging. At the nascent level, HIS activities happen by chance or represent isolated and ad hoc efforts. The emerging level characterizes a system with defined HIS processes and structures. However, such processes are not systematically documented and lack ongoing monitoring or measurement mechanisms. (See Table 3 for the detailed results.)

Several reasons explain the low scores in most of the digital health interoperability domains.

First, the scoring method: The overall domain score is equal to the lowest score of its subdomains. For example, under the leadership and governance domain, the subdomains for "governance structure for HIS" and "financial management" received a score of three and five, respectively. However, the subdomains for "HIS interoperability monitoring and evaluation" and "compliance with data exchange standards" attained a score of one. Going by the logic that the overall domain score is equal to the lowest score of its subdomains, the leadership and governance domain gets a net score of one.

Second, HIS scope: The wider the scope for HIS in the assessment, the higher the likelihood of a lower score. Uganda adopted a broad definition of HIS that includes not only the information systems for collecting patient-level information and human resources, laboratory, and logistics data, but also other auxiliary systems such as civil registration and vital statistics. With a mix of strong and weak systems, the weak systems pull down the net domain score.

Third, the extent of maturity level achievement: A subdomain gets a full maturity score only when the requirements of the maturity level are fully achieved. Partial achievement does not count in the scoring. Partial achievement is, however, demonstrated by a plus sign (+) next to the maturity level score of a subdomain. In this assessment, there were multiple subdomains with partially attained maturity levels (shaded in yellow in Table 3).

Figure 2 shows the subdomains and their respective levels, based on the results of the assessment.
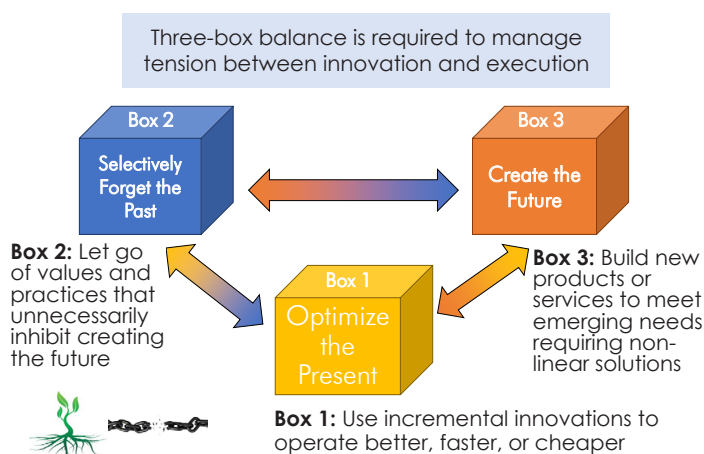
Figure 2. Summary of the results of the Uganda HIS interoperability assessment
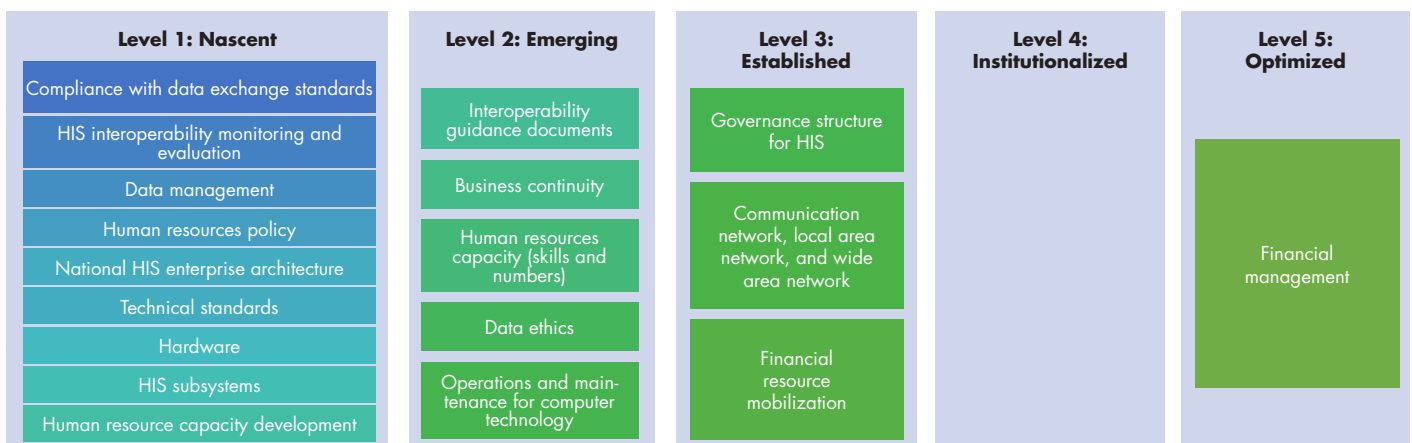
Solutions: The Three-Box "Framework for Innovation" Strategy

After the assessment results were agreed upon, the assessment oversight team held a workshop to discuss activities that Uganda could implement to move the country toward a stronger and interoperable digital HIS ecosystem. To do this, we used the "three-box framework" approach (see Figure 3).

Figure 3. The Three-Box Framework for Innovation Strategy

Three-box balance is required to manage tension between innovation and execution

Box 2
Selectively Forget the Past

Box 3
Create the Future

Box 2: Let go of values and practices that unnecessarily inhibit creating the future

Box 1
Optimize the Present

Box 3: Build new products or services to meet emerging needs requiring non-linear solutions

Box 1: Use incremental innovations to operate better, faster, or cheaper

Source: Govindarajan, V. (2016). The three-box solution: A strategy for leading innovation. Cambridge, MA, USA: Harvard Business Press.

The principle of the three-box framework, designed by Harvard University professor Vijay Govindarajan, is used in finding ways to meet performance requirements for an existing business—one that is thriving—while dramatically reinventing it. The framework is a tool kit with a method of self-analysis for allocating an organization's energy, time, and resources—in balanced measure—across what Govindarajan calls the three boxes. Box 1 represents the present: how to manage the core business and maintain its peak performance. Box 2 represents the past: how to carefully abandon ideas, practices, and attitudes that could inhibit innovation. Box 3 represents the future: how to convert breakthrough ideas into new products and businesses, and how to do things differently. This approach befits countries that are implementing digital health solutions against a backdrop of entrenched manual systems and practices.

Approach

To apply the three-box framework, stakeholders were divided into three groups—one for each of the three boxes. The facilitators gave each group a set of questions to guide them in providing information for their respective

box. Group members contributed information for their box on note paper, and then one group member read through the notes and grouped them by theme, forming affinity maps. Boxes 1 through 3 summarize each group's notes.

Box 1. How to optimize the present

Suggested activities for improving the current HIS:

- Identify and adopt drivers for interoperability of HIS.
- Create a legal framework to support digital health interventions.
- Develop standard operating procedures for HIS and interoperability.
- Retool current human resources approaches to attune them to the needs of digital health.
- Provide digital health tools, such as computers and infrastructure.
- Implement current guidelines for digital health.
- Develop user-centered information systems.
- Provide mentorship and supportive supervision.
- Build mechanisms for strong governance and leadership.
- Develop systems that assure high-quality data.
- Listen to and act on clients' needs.
- Set up regular meetings with stakeholders to ensure that their needs are met.
- Train HIS officers.
- Provide HIS officers with the proper tools.
- Develop national guidelines for HIS.
- Define digital health standards.
- Mobilize financial resources.

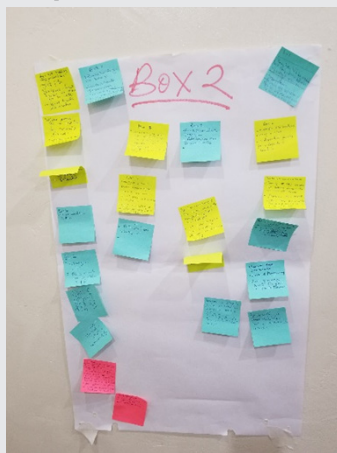**Figure 4. Box 1: Optimizing the present**
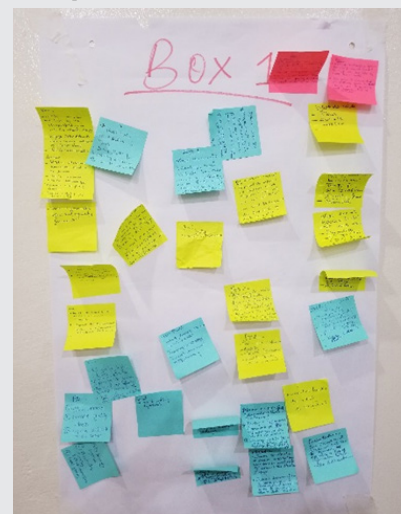
Box 2. How to selectively forget the past

This box examines the practices that hold the organization back from achieving better results. These practices may have worked in the past but are no longer relevant. In this framework, those practices are referred to as "chains" that shackle the organization from advancing. It should be noted, however, that not all past practices are bad. Some practices that worked in the past are still viable for the continuous growth of an organization, and should be sustained. In this framework, such practices are referred to as "roots": they provide an organization with needed support. In this session, stakeholders discussed practices that could encumber the development of a vibrant digital HIS. Below are the ideas generated by the group:

Figure 5. Box 2: Current impediments

- Duplication of activities
- Multiple information systems that serve the same purpose at health facilities
- Overreliance on paper as the chief information system
- Data and program silos
- Poorly coordinated efforts for strengthening HIS
- Low human resources capacity for digital health
- Lack of reliable infrastructure for digital technology
- Low level of data use across all levels of health
- Bias against electronic systems
- Fear of change promised by digital heath
- Information systems that are not interoperable
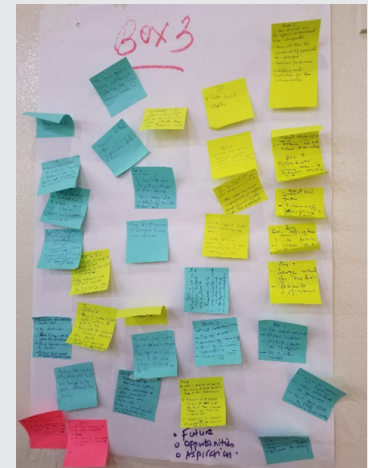- Fragmented ownership of information systems

Box 3. How to create the future

This box is about building new products and services to meet emerging needs. It's about using innovative approaches to build a better future for the organization. The following are ideas that support this process:

- Create interconnected information systems that are results-oriented.
- Identify countries and programs that are good role models for digital health practices.
- Establish and use the open digital health standards.
- Gradually migrate from electronic medical records to personal health records.
- Train more HIS officers on digital HIS.
- Update current digital HIS to adhere to best practices.
- Involve stakeholders at every level.

Figure 6. Box 3: Ideas for the Future

- Establish leadership and governance mechanisms focused on current and future information needs.
- Design and implement a nationally approved HIS architecture.
- Complete HIS assessments in the country and use the results to rationalize current information systems and to upgrade information systems.
- Develop a clear plan to migrate from a paper-based system to a digital one.
- Use a phased approach to implement digital health systems.
- Create capacity and awareness of data use.
- Implement ethical guidelines for digital data management.
- Develop application programming interfaces to enable data exchange.

The Road Ahead

Sustained and structured discussions on interoperability will guide implementation of activities that are critical to achieving national interoperable HIS. Using the assessment results and content from the ensuing group discussions, the assessment oversight team started drafting the HIS interoperability roadmap and highlighted several areas for immediate work under each of the domains assessed

Leadership and governance

In the context of Uganda, it seemed logical for the implementation of digital health and interoperability activities to take place under the auspices of the eHealth TWG, backed up by a monitoring and evaluating framework. This group provides the necessary digital health leadership and governance oversight. Secure funding for digital health and interoperability work, supported by a costed, long-term work plan, will be critical to the success of interoperability. Additionally, once the adapted standards are published, compliance mechanisms need to be established and enforced. Uganda has already launched a number of eHealth documents to shepherd the digital health and interoperability work—notably, an eHealth policy and eHealth framework. In fact, the eHealth policy and strategy stipulate that specific guidelines for interoperability standards should be developed for all players to follow.

Human resources

Without adequate numbers of competent digital health and HIS experts, it will be an uphill task to implement many of the activities in the interoperability roadmap, much less to sustain them. The MOH and its partners, and the eHealth TWG need to embark on long-term capacity-building activities for staff at all levels of the health system. A natural starting point would be to develop or adapt normative guiding documents for implementers to use.

Technology

The assessment and follow-up discussions yielded a number of items that need attention now. Data management, data exchange, and data security and privacy standards are urgently needed to standardize digital health work across programs. In addition, a long-term plan for software and hardware maintenance is needed, as well as the continued involvement of National Information Technology Authority-Uganda (NITA-U) to provide the data communication infrastructure. Internationally acclaimed standards exist that can be adapted and published for the country's use. In fact, NITA-U already has reference standards for the ongoing work of establishing e-Government projects; the health sector can adapt them.

In addition, Uganda has embarked on e-Government projects and has some structures and artifacts in place, which the health sector can adapt or learn from. For example, the national information and communication technology policy outlines business continuity and disaster recovery strategies for the country that the digital health ecosystem can use.

To sustain established momentum for eHealth, the Uganda MOH should take the following steps:

- Present the findings of this assessment to the eHealth TWG for discussion and adoption. Seek the commitment of the TWG to provide ongoing oversight of the development and implementation of the HIS interoperability roadmap, backed by a monitoring and evaluation framework.

- Create a subcommittee focused on HIS interoperability, as a subset of the eHealth working group, to lead HIS interoperability work.

- Complete the HIS interoperability framework/roadmap. MEASURE Evaluation helped the oversight assessment team to start drafting its responses, but more meetings and resources will be needed to complete this work and align it with other ongoing activities.

- To implement the findings from the assessment, it is imperative to develop a costed work plan and use it to advocate resources. As a starting point, the Ministry of Health-Division of Health Information brought two volunteer health informatics specialists on board to support the implementation of the eHealth policy and strategy while other capacity building activities are ongoing.

Table 1. The oversight team

Name	Ministry/Agency/Department	Role
Dr. Sarah Byakika	Ministry of Health	Ag. Commissioner Health Services–Planning Department
Caroline Kyozira	Ministry of Health	Ag. Assistant Commissioner–Division of Health Information
Mpiima Jamiru	Ministry of Health	Health Informatics Specialist
Expeditus Ahimbisibwe	Ministry of Health	Principal Health Planner
Catherine Kabahuma	Ministry of Health	Health Informatics Specialist
Emily Nakazi	National Information Technology IT Authority–Uganda (NITA-U)	Application Solutions Manager
Lordwin Kasambula	Ministry of Health	M&E Specialist
Emmy Muramuzi	Ministry of Health	Senior M&E Specialist
Sam Wambugu	MEASURE Evaluation	Facilitator
Christina Villella	MEASURE Evaluation	Facilitator

Table 2. Assessment and roadmap workshop participants

Name	Organization
Carol Kyozira	MOH–Division of Health Information
Mpiima Jamiru	MOH–Division of Health Information
Emily Nakkazi	NITA-U
Catherine Kabahuma	MOH–Division of Health Information
Lordwin Kasambula	MOH–AIDS Control Program
Twesige Nowen Stephen	NITA-U
Winfred Ingabire	Ministry of Gender, Labour and Social Development
Juliet Tumwikirize	USAID–Strategic Information Technical Support Project (SITES)
Akello Lilian Perry	MOH–Human Resource
Akena Stephen Abwoye	MOH–Division of Health Information
Dr. Henry Mwanje	Uganda–UK Health Alliance
Expeditus Ahimbisibwe	MOH–Planning department
Musenge Kenneth	CDC
Moses Bagyendera	WHO
Emmy Muramuzi	MOH–AIDS Control Program
Vincent Ndizima	CDC
Nic Luwgenjo	USAID–SITES
Nsubuga John D.S.	MOH
Kayanja Edward	MOH–Division of Health Information
Lubwama Samuel	CDC M&E Technical Support (METS)
Kyarisiima Dinnah	MOH–Reproductive Health
Oyo Godfrey	MOH–Human Resources
Muyingo Edmond	MOH–Division of Health Information
Muwanguzi Samuel	MOH–Information, Communications, and Technology (ICT)
Ssali Tamale Muzamiru	MOH–ICT
Ebony Quinto	MOH–National Tuberculosis and Leprosy Control
Lubowa Nathan	MOH–Pharmacy Department
Irongo Daniel	World Vision
Steve Wanyee	IntelliSOFT Kenya

Table 3. Uganda health information systems interoperability maturity assessment results

HEALTH INFORMATION SYSTEMS INTEROPERABILITY MATURITY MODEL WORKSHEET							
Domain	**Subdomain**	**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 processes and structures, but they are not systematically documented. No formal or ongoing monitoring or measurement protocol exists.	**Level 3: Established** The country has documented HIS processes and structures. The structures are functional. Metrics for performance monitoring, quality improvement, and evaluation are systematically used.	**Level 4: Institutionalized** Government and stakeholders use the national HIS systems and follow standard practices.	**Level 5: Optimized** The government and stakeholders routinely review interoperability activities and modify them to adapt to changing conditions.	**Maturity Level**
Leadership and Governance	**Governance structure for HIS**	Evolving governing body for health information systems (HIS) is constituted on a case-by-case basis OR no governing body exists.	An HIS governing body is formally constituted and has a scope of work that includes the people responsible for data governance oversight. The governing body oversees interoperability directly or through a separate TWG.	The HIS governing body conducts regular meetings with stakeholder participation.	The HIS governing body is government-led, consults with other ministries, and monitors implementation of HIS interoperability using a work plan. It mobilizes resources—financial, human resources (HR), and political—to accomplish its goals.	The HIS governing body is legally protected from interference or organizational changes. The HIS governing body and its TWGs are nationally recognized as the lead for HIS interoperability. The governing body works in liaison with other similar working groups regionally and/or around the world.	3+
	Interoperability guidance documents[1]	HIS interoperability guidance documents are absent, and HIS interoperability is implemented on a case-by-case basis.	The governing body for HIS interoperability has drafted the necessary HIS interoperability guidance documents.	Interoperability guidance documents developed, tested, and adopted, and include reference terminologies and technical standards for data exchange.	The interoperability guidance documents are government-owned. They are consistently used and referenced in efforts to guide implementation of HIS interoperability.	Processes are in place to regularly monitor the implementation of the interoperability guidance documents. The interoperability guidance documents are regularly reviewed and updated based on lessons learned from implementation. These documents reflect international best practices.	2

[1] The approved documents (policies, strategies, and frameworks) that guide HIS and digital health/eHealth work in a country.

Current subdomain level: The level at which all the attributes at that level and the levels below have been achieved

Level with all attributes achieved: Level above the current subdomain level with all attributes in that level achieved

Level with some attributes achieved: Level above current subdomain level with some attributes of that level achieved

Domain	Subdomain	Level 1: Nascent	Level 2: Emerging	Level 3: Established	Level 4: Institutionalized	Level 5: Optimized	Subdomain Level
Leadership and Governance	Compliance with data exchange standards	No structure, processes, and procedures (e.g., working groups, steering committees, or units) are in place to guide or enforce compliance with data exchange, messaging, and data security standards. No criteria for certification and compliance exist. No regulatory framework for compliance exists.	Structures (working groups, steering committees, or units) are in place to guide or enforce compliance.	The HIS has developed or adopted and implemented a regulatory framework for compliance.	The government enforces the regulatory framework for compliance. The subsystems in the national HIS are required to meet compliance and certification criteria.	Compliance with standards for data exchange, messaging, and security is regularly reviewed. The regulatory framework is reviewed and updated to reflect best practices for data exchange, messaging, and systems security.	1
	Data ethics	The country lacks HIS capacity or does not follow processes systematically. HIS activities happen by chance or represent isolated, ad hoc efforts.	The country has defined HIS processes and structures, but they are not systematically documented. No formal or ongoing monitoring or measurement protocol exists.	The country has documented HIS processes and structures. The structures are functional. Metrics for performance monitoring, quality improvement, and evaluation are systematically used.	Government and stakeholders use the national HIS systems and follow standard practices.	The government and stakeholders routinely review interoperability activities and modify them to adapt to changing conditions.	2+
	HIS interoperability M&E	No tracking, or ad hoc tracking, is done of HIS interoperability activities related to plans, resources, and budgets for the national HIS.	The methods and tools to report on HIS interoperability implementation are defined and documented.	HIS interoperability activities are regularly monitored and reviewed accordingly. Regular reports on HIS interoperability performance are generated and disseminated to stakeholders.	Mechanisms to track and measure performance of HIS interoperability work are government-approved and government-led.	Results from monitoring of HIS interoperability are used for planning. Decisions about future activities take this analysis into consideration.	1
	Business continuity	No government-approved business continuity plan (BCP) is in place at the national or subnational levels of the HIS.	The HIS has developed a BCP that outlines the processes needed to ensure continuity of critical business processes.	The BCP has been audited. Audit results show that at least 50% of the BCP has been implemented.	The BCP has been audited. Audit results show that at least 75% of the BCP has been implemented.	The BCP has been audited. Audit results show that all or most of the BCP has been implemented.	2

Domain	Subdomain	Level 1: Nascent	Level 2: Emerging	Level 3: Established	Level 4: Institutionalized	Level 5: Optimized	Subdomain Level
Leadership and Governance 5	**Financial management**	No clear plan exists for financial management of HIS, including interoperability activities.	High-level financial management structures, including budgets, are developed for the national HIS, including interoperability in the country based on HIS work plans.	Detailed financial management structures, including budgets for HIS interoperability at the national and subnational levels, are developed based on the HIS work plan. HIS expenditures are monitored against HIS budgets.	The HIS budget is part of the Ministry of Health's budgeting process. Financial audit processes are in place and are carried out regularly to promote accountability in HIS spending.	An established, long-term HIS financial management system is owned, reviewed, tracked, and updated by the government, and is supported by stakeholders.	5
	Financial resource mobilization	There is no documented plan for financial resources for HIS strengthening, including HIS interoperability.	Financial resources for HIS strengthening, including HIS interoperability, are mostly donor driven.	A costed work plan at national and subnational levels is in place that covers both the information and communications technology (ICT) infrastructure (network, hardware, and software), and personnel for HIS needed for HIS strengthening, including HIS interoperability. At a minimum, this work plan identifies the activities, timeframe, costs, and sources of funding for HIS interoperability.	Government and implementing partners have sufficient funding to implement the costed work plan. The government owns the costed work plan.	A government-owned, costed, long-term work plan (five years or more) is in place to support ICT and human resources for HIS strengthening, including HIS interoperability. A mechanism is in place to regularly review and update the work plan.	3+
						Domain maturity level: Leadership and Governance	1

Domain	Subdomain	Level 1: Nascent	Level 2: Emerging	Level 3: Established	Level 4: Institutionalized	Level 5: Optimized	Subdomain Level
Human Resources	Human resources policy	There is no HR policy that recognizes HIS-related cadres. Distribution of HIS human resources is ad hoc.	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. HIS-related cadre roles and responsibilities are mapped to the government's workforce and schemes of work.	An HR policy or strategic plan exists that identifies the HIS, digital HIS, and interoperability skills and functions needed to support the national HIS and its digital HIS and interoperability.	Implementation plans are in place for growing a cadre of staff at national and subnational levels for digital HIS and interoperability.	A long-term plan is in place to grow and sustain staff with the skills needed to sustain HIS and digital HIS and interoperability. Performance management systems are in place to monitor growth and sustainability of the HIS workforce.	1+
	Human resources capacity (skills and numbers)	The country has no dedicated cadre of staff for maintaining the digital HIS and interoperability. Responsibility for the HIS is added to existing positions.	The country depends on technical assistance from external stakeholders to support the national and subnational digital HIS and interoperability.	The country has a growing staff with skills in governance and leadership, data collection, data management, data sources, health information technology (IT), and managing information products. The staff are sufficient in numbers and skills at the national level, but inadequate at subnational levels.	The country has staff in sufficient numbers with relevant skills to support the digital HIS and interoperability at national and subnational levels.	The country has a sufficient and sustainable number of staff with an appropriate mix of skill sets to support the digital HIS and interoperability at national and subnational levels, and the interoperability of key systems. A human resources for health strategic plan is in place to continuously upgrade staff skills to reflect international best practices in digital HIS and interoperability, preferably with locally generated funds.	2+
	Human resource capacity development	The country has no national training programs to build human resource capacity on digital HIS, including interoperability.	A nationally recognized pre-service training curriculum exists that outlines needed competencies for human resources for digital HIS and the interoperability of the HIS.	A plan exists for in-service training of HIS staff to build skills around digital HIS and interoperability based on a nationally or internationally recognized HIS curriculum.	The country has the capacity to train enough staff to support digital HIS and interoperability, through in-country pre-service and in-service training institutions or partnerships with other training institutions. Government and stakeholders provide sustainable resources for health ministry staff to receive training on HIS, including digital HIS and interoperability.	Opportunities and incentives are in place for continuing education in digital HIS and interoperability for HIS-related cadre staff, to keep them up-to-date as the HIS field evolves.	1+
					Domain maturity level: Human Resources		1+

Domain	Subdomain	Level 1: Nascent	Level 2: Emerging	Level 3: Established	Level 4: Institutionalized	Level 5: Optimized	Subdomain Level
Technology	**National HIS enterprise architecture**	A national HIS enterprise architecture document defining technology requirements and data exchange formats for interoperability does not exist, or there is a draft document, but it has not been validated or shared with the country's HIS community.	A validated national HIS enterprise architecture exists that defines technology requirements and exchange formats for interoperability. It is validated, but not widely shared or systematically applied by the HIS community. Point to point data exchange between some HIS applications exists, but there is no systematic implementation of the agreed-upon architecture.	Foundational tools and rules for HIS interoperability exist. They include a health information management system for routine and surveillance data, and core authoritative registries (Facility Registry, Metadata Dictionary, Master Patient Index, and Health Worker Registry). The Interoperability Service Layer (ISL) for the HIS is operational and provides core functions, such as data authentication, translation, an interpretation.	The government owns, enforces, and leads implementation of the national HIS enterprise architecture, including the ISL and core authoritative registries (Facility Registry, Metadata Dictionary, Master Patient Index, and Health Worker Registry).	The national HIS enterprise architecture and its ISL are fully implemented using industry standards. The ISL provides core data exchange functions and is periodically reviewed and updated to meet the changing country data needs. There is continuous learning, innovation, and quality control in the work on HIS interoperability.	1+
	Technical standards[2]	No defined technical standards exist for use in the country's HIS data exchange. Applications are hosted by the providers without any control from the government or MOH.	An HIS ICT infrastructure assessment has been conducted and the needs for a coherent HIS ICT infrastructure architecture have been documented. The country has adopted or developed technical standards for health data exchange, messaging, and security.	An interoperability lab exists for new partners to test technical standards or for onboarding new HIS subsystems, and a certification mechanism exists for new HIS subsystems to be integrated in the national HIS.	Technical standards for national data exchange have been published and disseminated in the country under the government's leadership. The ISL is orchestrating data exchange between existing HIS applications hosted by the integrated ICT infrastructure supporting the national HIS.	A routine review of standards and requirements compliance is conducted to ensure continuous integration of the various subsystems.	1

[2] Including standards for data exchange, transmission, messaging, security, privacy, and hardware

Domain	Subdomain	Level 1: Nascent	Level 2: Emerging	Level 3: Established	Level 4: Institutionalized	Level 5: Optimized	Subdomain Level
Technology	Data management[3]	No national document for data management procedures exists for the national HIS.	Electronic data management procedures for the HIS areclearly developed and documented in a nationally recognized document.	A roadmap is in place to migrate data collection and reporting from a paper system to an electronic system, complete with necessary data security safeguards. A documented mechanism is in place for maintaining data quality throughout the data supply chain.	National electronic data management processes are published and disseminated for the HIS. A standard operating procedure and/or data use plan is in place to facilitate data use by the country and its stakeholders. A data warehouse, integrating data from all HIS subsystems and allowing for data triangulation and quality control, is fully functional and in use.	Data access and use are constantly monitored, and data management systems are updated accordingly. Electronic data transmission is the default method to move data among information systems. Dashboards displaying information from multiple sources are available todecision makers.	1+
	HIS subsystems	The country's HIS mainly consists of stand-alone program- specific subsystems working in silos, and addressing only the asic information needs (routine HIS, surveillance system, and human resources). Program-specific parallel systems exist.	HIS data exchange is mainly facilitated by a single subsystem directly linked to other subsystems to enable basic data exchange.	Guidelines for compliance with technical standards for HIS subsystem interoperability with the national HIS have been disseminated. An increasing number of HIS subsystems areweb-based and integrated with the ISL following the national standards requirements.	The government requires all HIS subsystems to comply with the country's interoperability plan, including use of technical standards.	Most HIS subsystems are exchanging data electronically, according to industry standards/ best practices.	1+
	Operations and maintenance (for computer technology)	Operations and maintenance services for electronic systems are ad hoc or non-existent.	Maintenance for network and hardware is a mix of reactive and evolving preventive procedures.	The country is receiving technical support to build a strong in-country capacity for computer technology maintenance. Standard operating procedures exist that detail protocols for routine network and hardware maintenance.v	The country has the capacity for strong in-country technical maintenance. Computer operations and maintenance services are part of the HIS plan or the country's strategic plan for health. A disaster recovery plan for digital HIS is in place, and it meets best practices.	The operations and maintenance services plan is continuously reviewed and adapted to evolving HIS interoperability requirements, and follows industry-based standards. Regular simulations are undertaken to increase the ability of technology staff to respond to a disaster.	2

[3] Procedures on how data are captured, stored, analyzed, transmitted, and packaged for use across the data supply chain.

Domain	Subdomain	Level 1: Nascent	Level 2: Emerging	Level 3: Established	Level 4: Institutionalized	Level 5: Optimized	Subdomain Level
Technology	**Communication network: local area network (LAN) and wide area network (WAN)**	The country has no reliable network connection to support anational HIS.	An ICT infrastructure assessment has been conducted to determine LAN and WAN requirements for the country's HIS. The country is using mainly unreliable wireless (2G, 3G or 4G) modems to connect to the HIS services.	A national implementation plan to meet the LAN and WAN requirements in the country exists. A national network maintenance plan exists to ensure high uptime, including procedures to recover from network failure. The country has started to implement a technical solution to ensure permanent connectivity to the HIS services.	All national offices and at least 50% of the subnational offices of the MOH and health service providers have a strong and reliable network connection to the various HIS network services. An HIS-dedicated ICT and network support team is in place.	All or almost (>75%) all the MOH's national and subnational offices and health service providers have a reliable and robust network connection. A team dedicated to support connectivity exists and has adequate financial, human, and technology resources. Industry-based standards are followed.	3+
	Hardware	The country has limited/inadequate hardware (servers, user computers, printers, and supportive accessories) to support a national HIS.	An ICT infrastructure assessment has been done to identify the hardware required at national and subnational levels. Less than 50% of the MOH's national and subnational offices have the required hardware (computers, printers, connecting devices, etc.).	Fifty percent (50%) or more of the MOH's national and subnational offices have the required hardware, including back-up hardware.	Seventy-five percent (75%) of the MOH's national and subnational offices have the required hardware. There is a back-up and recovery plan for the national HIS.	The hardware meets national and/or international specifications, and a long-term plan (five years or more) is in place that details how to keep hardware up to date.	1+
					Domain maturity level: Technology		1