East African Community Digital Health and Interoperability Assessments

Rwanda

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ABBREVIATIONS

CEBE	Center of Excellence in Biomedical Engineering
CDC	United States Centers for Disease Control and Prevention
Digital REACH	Digital Regional East African Community Health [Initiative]
EAC	East African Community
EASTECO	East African Science and Technology Commission
EMR	electronic medical record(s)
HIE	health information exchange
HIS	health information system(s)
HMIS	health management information system
ICT	information and communication technology
IL	interoperability layer
M&E	monitoring and evaluation
MOH	Ministry of Health
MINICT	Ministry of ICT and Innovation
NICI	National Information and Communication Integration
PSM	Procurement and Supply Chain Management
RBC	Rwanda Biomedical Center
RHEA	Rwanda Health Enterprise Architecture
RHIE	Rwanda Health Information Exchange
RISA	Rwanda Information Society Agency
SMART	service-oriented, modern, accountable, and real-time
SRMP	SMART Rwanda Master Plan
TWG	technical working group
USAID	United States Agency for International Development

EXECUTIVE SUMMARY

Over the past decade the East African Community (EAC) has prioritized digital health by hosting several regional conferences and committing to regional actions to strengthen the enabling environment for it. One such commitment was to conduct a regional readiness assessment for eHealth and interoperability. Similarly, Rwanda has been taking steps to strengthen the enabling environment for digital health and health information systems (HIS) interoperability. Rwanda was one of the first countries in the region to develop a national Health Information Exchange (HIE). At the time of this assessment, the country was also developing its Healthcare Digital Transformation Strategy: an approach to digitizing the national health system that focuses on improving patient-centered care.

In 2019, the Ministry of Health (MOH) of Rwanda partnered with MEASURE Evaluation—a project funded by the United States Agency for International Development (USAID)—to conduct an HIS interoperability readiness assessment, as part of a broader EAC-commissioned regional assessment to understand the status of eHealth and interoperability in each of the Member States. The MOH and MEASURE Evaluation used the HIS Interoperability Maturity Assessment Toolkit (MEASURE Evaluation, 2019) to understand the status of the three key domains: leadership and governance, human resources, and technology. The assessment consisted of three components: a desk review of existing literature and policies on digital health; meetings with HIS and digital health stakeholders; and workshops with HIS and digital health stakeholders. Rwanda's government has strong political will to strengthen healthcare using digital technologies, as evidenced by the robust collaboration between the MOH and the Ministry of ICT [Information and Communication Technology] and Innovation (MINICT), the development of a Health Care Digital Transformation Strategy, and the existence of an eHealth team that brings together departments within the MOH. Nevertheless, stakeholders in the broader HIS and digital health space such as donors and implementing partners are not always aware of MOH documents, policies, and procedures. The eHealth team should continue to engage with broader stakeholders and disseminate critical documents in order to strengthen coordination and collaboration among partners. Rwanda has expanding capabilities to train staff in digital health and interoperability skills through the Center of Excellence in Biomedical Engineering and in-service training through the Rwanda Biomedical Center (RBC). The MOH would benefit from having a human resources policy that identifies the HIS, digital HIS, and interoperability skills needed to support the health system, so that it can advocate additional capacity development resources and key positions. At the national information systems level, there is little duplication of systems—probably owing, in part, to Rwanda's early adoption of a national HIE. Work to strengthen the HIE remains to be done—especially revitalizing some of the components that have been dormant because of lack of funding and adopting additional standards to facilitate data exchange. The MEASURE Evaluation assessment team recommends incorporating the findings from this assessment in the Healthcare Digital Transformation Strategy so that one central plan drives interoperability and HIS in Rwanda.

BACKGROUND

East African Community and Digital Regional East African Community Health Initiative

There has been a lot of momentum in digital health in the East African region. The EAC has been especially engaged in leading several regional initiatives in digital health. In 2010, the EAC convened a Regional eHealth Workshop and Ministerial Conference for member countries to share experiences and insights on how to move eHealth forward in the region. Following this meeting, and as a follow-on to this inaugural conference, the East African Science and Technology Commission (EASTECO), in collaboration with the EAC Secretariat and partner states, convened the 2nd EAC Regional e-Health and Telemedicine Workshop, Ministerial Conference, and International Trade Exhibit, in Kigali, Rwanda, in May 2018 (EASTECO, 2018). At the closing of this two-day conference, it was agreed that EASTECO, in collaboration with the EAC Secretariat, East African Health Research Commission, Member States' national science and technology commissions, sectoral councils, and partners would accomplish the following tasks:

1. Conduct an EAC regional eHealth readiness assessment that would incorporate aspects of systems interoperability, costs, and benefits in eHealth investment by December 30, 2019.

2. Promote the growth of local digital health solutions and submit progress reports to relevant sectoral and ministerial councils every two years.

3. Coordinate the development of regional policies, laws, regulations, guidelines, and standards on health facility and patient safety, data sharing, data security, and privacy to facilitate eHealth in-country and cross-border patient referrals in the EAC partner states by June 2020.

4. Take leadership in convening the biannual EAC Regional eHealth and Telemedicine Ministerial Conference and its associated workshops and international exhibitions on a rotational basis among the Member States during the last week of October as part of the EAC Sectoral Council of Ministers meetings, who are responsible for health in collaboration with the EAC Secretariat, the East African Health Research Commission, and the EAC Regional Center for Excellence for Biomedical Engineering and eHealth.

In 2018, the EAC launched the Digital Regional East African Community Health (Digital REACH) Initiative, whose mission statement is: "Maximise the power of digital health in East Africa by ensuring an enabling environment and by implementing scaled, coordinated, transformational, and innovative approaches" through a shared roadmap for creating a regional enabling environment for digital health (Digital REACH Initiative, n.d.). The roadmap consists of nine work streams under which responsibilities are divided for the region and the Member States. The work streams are organization formation and management; health programs; infrastructure; services and applications; leadership and governance; strategy and investment; legislation, policy, and compliance; workforce; and harmonization, standards, and interoperability (East African Health Research Commission, 2017). The premise behind the regional initiative is that regional ownership and development of some key components of the enabling environment for digital health will help partner states reduce costs by sharing services, for example, by hosting common technology components on a shared cloud, standardizing digital health training, and aggregating demand for certain services, such as telemedicine. The Digital Reach Initiative will also develop the enabling environment, including policies, to facilitate cross-border data and information sharing.

Status of eHealth and Interoperability in Rwanda

Rwanda has made many strides in the last decade and one-half to strengthen the use of technology in the health sector, especially in the HIS and at the point of patient care. In 2010, the MOH, with support from its partners (i.e., Jembi Health Systems, Innovative Support to Emergencies, Diseases, and Disasters [InSTEDD], IntraHealth International, and the Regenstrief Institute) developed the Rwanda Health Information Exchange (RHIE) to improve maternal and childcare at the health facility level. This activity was also known as the Rwanda Health Enterprise Architecture (RHEA) project. The goal was to make client information, including medical histories, more easily available to healthcare providers to enable them to more efficiently and effectively provide healthcare services. The foundational architecture of the RHIE included key national service components, such as a national shared health record and an interoperability layer (IL). Rwanda's health sector was experiencing the effects of the fragmentation of its national HIS caused by the uncoordinated implementation of digital health solutions. This national health information exchange (HIE) was implemented in several phases, with the first phase focusing on the implementation of foundational services and the improvement of interoperability between two point of care information systems supporting maternal health in the Rwamagana district in Rwanda, including 13 health centers. The focus of the project was to enable the sharing of maternal health information between point-of-service applications in a single district.

The Government of Rwanda recognized the role of information and communication technology (ICT) in social and economic development and clearly expressed its priorities through the National Information and Communication Integration (NICI) document, which committed the government to an integrated ICT-led socioeconomic policy and plan. In this policy, the MOH established the eHealth Steering Committee, which recommended the creation of an eHealth Department to spearhead the planning and implementation of eHealth initiatives. The mission of the Department was to "provide and maintain highly effective, reliable, secure, and innovative information systems to support clinical decision making, patient management, education and research functions of the health sector in Rwanda in a bid to improve healthcare service delivery" (Gakuba, 2009).

The work of the eHealth Department and Rwanda's HIS and eHealth systems are governed and guided by several key documents that lay out the goals, strategies, and policies for eHealth in Rwanda. The Health Sector Strategic Plan IV (2018–2024) (Republic of Rwanda, MOH, 2017) covers many areas of the health sector and goals for outcomes. The Plan documents the structure of the health system and mentions the use of "technology" and "eHealth" in several program areas as a key innovation, thereby setting the tone for the importance of the use of ICT in the health sector. The Plan also lays out a strategic direction for eHealth and research, which is: "By 2024, ensure the availability of interoperable, responsive and functional information systems providing high quality data in a timely manner to inform planning and decision-making. Ensure availability of a robust research system providing policy relevant evidence." The Health Sector Strategic Plan IV also specifies several strategies and innovations related to HIS that will support the health sector in achieving its goals. Examples of strategies include developing and enforcing policies for data protection, extending the deployment of the electronic medical records (EMR) system to improve patient management, and synchronizing HIS to improve patient management and data use.

Although still in draft form at the time of the writing this report, another key document is Rwanda's National Digital Health Strategic Plan (2018–2023), which provides rich information about Rwanda's vision for digital health. The strategic plan was developed in 2018 and builds on the existing strategic plan from 2009. The strategic plan lays out the long-term vision for eHealth, with a focus on the next five

years. It complements the Service-Oriented, Modern, Accountable, and Real-Time (SMART) Rwanda Master Plan (SRMP) 2015–2020 (discussed below) and responds to health sector goals as defined in the Health Sector Strategic Plan IV. The strategic plans lays out the four flagship projects that Rwanda is prioritizing over the next five years: (1) health enterprise architecture; (2) EMR; (3) citizen's health portal; and (4) telehealth. The strategic plan lists nine key strategies and interventions that will serve as the policy objectives for digital health in Rwanda. The strategies and interventions primarily focus on improving the different use cases of technology in the health sector, from EMR to laboratory information systems to eLearning, among many other uses. The strategic plan also outlines the current governance structure for eHealth and the budget of the five-year plan.

Also in draft form at the time of the writing this report, the National Digital Health Policy that promotes citizen-centered digital health services is well anchored in the Health Sector Strategic Plan III (Government of Rwanda, MOH, n.d.) and the SRMP, which puts the patient (and the citizen) at the center of all investments in the health sector. This policy recognizes and promotes the goal of investments in digital health interventions, from disease surveillance and reporting to efficient and effective delivery of quality health services to the individual patient. Standards-based interoperability and integration of the multiple digital health technologies are centerpieces of this policy. Private sector engagement through functional public-private partnerships is well addressed in the policy. The policy notes that capacity to meet Rwanda's health sector needs will significantly increase through the adoption and use of digital health technologies. Access to information that is accurate, valid, reliable, timely, relevant, and complete, as further elaborated in the nine policy directions, will enhance improvements in healthcare. The digital health policy includes the same four flagship projects as the National Digital Health Strategic Plan.

The National Digital Health Policy describes a digital health governance framework that includes policy development, coordination, planning, follow-up, evaluation, and promotion as a mandate of the MOH, and overall responsibility for the implementation of digital health activities to the RBC. To ensure effective coordination of digital health work in a manner that provides for the participation of all stakeholders, relevant eHealth technical working groups (TWGs), with guidance from the MOH eHealth Unit, will need to be in place. Intersectoral collaboration is also well described, with the MOH working closely with actors from other sectors, as necessary, to provide input in the following areas: electricity; broadband connectivity and hosting; unique patient identification; national enterprise service bus; health worker capacity building; and the establishment of public-private partnerships. Clear sustainability plans, including contributions from private sector partners, savings from the delivery of health services based on the use of digital health technologies, and a better understanding of the total cost of ownership, are some of the measures and recommendations made. Last, active monitoring and evaluation (M&E) are planned using the details included in the National Digital Health Strategic Plan. The eHealth Unit at the MOH will coordinate M&E, including operational research focusing on the return on investment and impact evaluations, among other priority areas, to ensure that the MOH effectively tracks and measures progress being made through investments in digital health.

The SRMP (Republic of Rwanda, Ministry of Youth and ICT, n.d.) reviews and analyses the current national socioeconomic development policies, strategy, and provisions, and ICT development, deployment, and use in the country through a baseline study. The SRMP builds on the past NICI plans: NICI Plan Phase I (2001–2005) (Government of Rwanda, 2000), NICI Plan Phase II (2006 to 2010) (Government of Rwanda, n.d.), NICI Plan Phase III (2011 to 2015) (Government of Rwanda, n.d.), and NICI Plan Phase IV (2015 to 2020). The SRMP's objectives focus on further strengthening the country's

economic base and improving its economic development for accelerated growth to achieve a predominantly information and knowledge-based economy. It proposes the "Think Big, Start Small, Scale Fast" approach as one of the ways to leverage powerful ICT innovations, such as open data, big data analytics, cloud computing, and mobile apps to transform society into a smart society. The SRMP vision is summarized in Figure 1.

Figure 1. SRMP vision
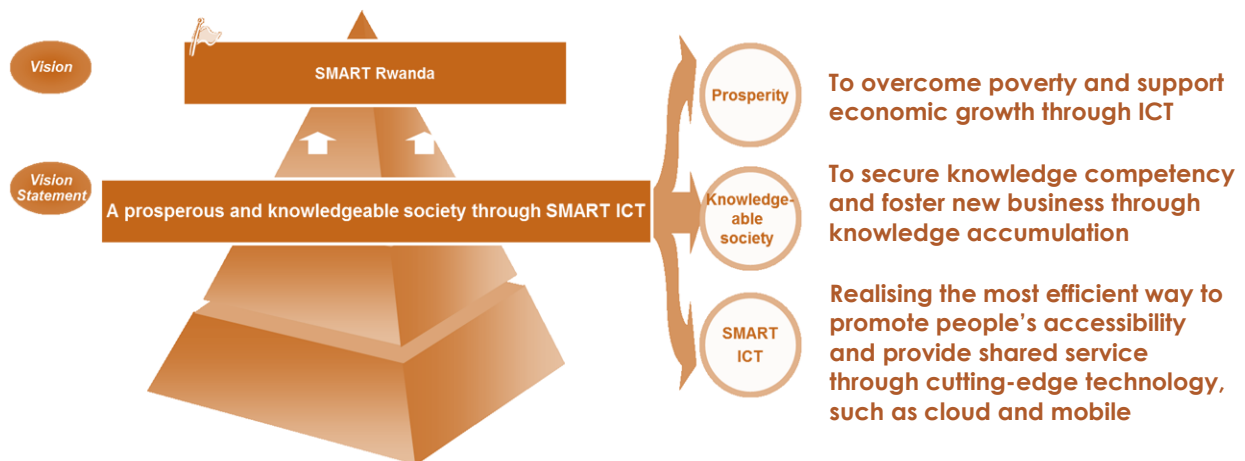
Source: Republic of Rwanda, Ministry of Youth and ICT, n.d.

The SRMP includes the expansion of the mandate of the National ICT Steering Committee; the establishment of a board that has representatives of key economic and social sectors and members from the private sector; relocation of SRMP governance and management responsibility to the Rwanda Information Society Agency (RISA) from the Rwanda Development Board where it is currently managed; reassignment of the M&E function from the Rwanda Development Board to the Ministry of Youth and ICT and Innovation (MINICT); and centralized management of government ICT under RISA to a drive common standards, infrastructure, and capabilities strategy. Health is one of the seven sectoral pillars in the SRMP. The Plan identifies common infrastructure, standards, and capabilities that the sectors will share to increase the use of ICT to improve economic growth. The MOH must liaise closely with the MINICT and RISA on the implementation of eHealth programs and solutions to ensure that they fit in with the national ICT architecture and vision for Rwanda.

As part of the SMART Rwanda Initiative, the MOH and RISA recently worked with Microsoft to develop a plan for the digital transformation of healthcare in Rwanda. The digital healthcare transformation is built on the key aims of the Rwanda healthcare system, which are:

- Improving the health of the people of Rwanda.
- Improving the service delivery environment for healthcare providers to increase their productivity and experience.
- Reducing the direct and indirect costs of healthcare per patient, per encounter.
- Improving the entire experience of patients when they interact with the health system.

This approach intends to transform the health system from a reactive one to a proactive one that is well positioned to benefit from emerging and frontier technologies, including artificial intelligence, big data analytics, and visualization, among others. The main pillars of the digital health transformation strategy are:

- Empower care teams
- Engage patients
- Optimize clinical and operational effectiveness
- Transform the care continuum

With patient care driving this transformation, interoperability of point-of-care systems is at the forefront of plans, such that there is one health record for each citizen (as opposed to siloed health records in various systems). This is different from other countries, where the goal is focused on the need to collate data at subnational and national levels. Although Rwanda also needs strong data for health system planning, interoperability is starting by examining point-of-care systems. And, although the country has made great progress in the adoption and use of digital health solutions, fundamental challenges remain, including a shortage of qualified and skilled health workers. It is well recognized that the magnitude of the health sector's challenges require the digital health transformation to be approached as a journey and not as an event. Key foundational and fundamental investments on which digital health solutions will be based are essential first steps. This includes appropriate infrastructure, qualified and skilled health workers, and sustainable financing mechanisms. The Healthcare Digital Transformation Strategy includes a roadmap for achieving its goals. It focuses heavily on reviving various components of the RHIE, and ensuring that the correct systems and standards are in place for HIS interoperability. This roadmap seems to be the document that will guide digital health investments in the future.

The Rwanda MOH implements the approved ICT security policy, which describes the requirements, classification access level, etc. for ICT used in the health sector (Republic of Rwanda, MOH, 2016). This policy also details cloud computing regulations and data exchange requirements. The policy's guiding principles are to classify information according to an appropriate level of confidentiality, integrity, and availability, and in accordance with relevant legislative, regulatory and contractual requirements; and that health information must be complete, accurate, timely, and consistent.

Assessment Objectives

Given this background information, the regional health program of USAID/Kenya and the USAID East Africa Mission, in coordination with the USAID Global Health Bureau, United States Global Development Lab, and USAID Bureau for Africa, engaged MEASURE Evaluation to provide technical support to EASTECO to conduct an EAC regional digital health readiness assessment, incorporating aspects of systems interoperability and the cost of investing in eHealth in the EAC region. The assessment will be conducted in four EAC Member States (Kenya, Rwanda, the United Republic of Tanzania, and Uganda). This report presents the results of the Rwanda assessment, which had two objectives:

- Review the status of digital health and HIS interoperability in Rwanda by assessing the processes, structures, and capacities needed to support the enabling environment for digital health and interoperability in the country.

- Using the Rwandan assessment results, contribute to the assessment of the regional landscape for digital health and interoperability in the EAC to inform a regional analysis of and recommendations for moving digital health forward in the EAC.

METHODS

Assessment Oversight Team and Meetings with Stakeholders

To conduct the HIS interoperability assessment, an oversight team was formed to plan the exercise. The MOH and RISA worked with MEASURE Evaluation to identify professionals in the government with the right expertise, experience, and authority to participate on the team. The team's mandate (and the three MEASURE Evaluation facilitators) was to provide the overall scope and direction for the assessment, determine which stakeholders would be invited to contribute to the assessment, and oversee the assessment. The MEASURE Evaluation team oriented the assessment oversight team to the tools and processes to be used. Appendix A, Table A lists the members of the assessment oversight team. The team oversaw the HIS interoperability assessment and consensus building processes, as described in the next sections of this report.

Desk Review

In preparation for the HIS interoperability assessment, the MEASURE Evaluation team reviewed key documents received from the assessment oversight team on HIS, digital health, and interoperability in Rwanda. A review of these documents provided the context for the assessment, which is summarized in the background section above. The list of documents reviewed is provided in the References section of this report.

Meetings with Stakeholders

In preparation for the assessment, the MEASURE Evaluation team met with key stakeholders on a one-on-one basis to understand the landscape of digital health and interoperability in the country before the assessment workshops. Stakeholders included staff from key ministries, departments, and agencies, such as the MOH and RBC; nongovernmental organizations and implementing partners working in digital health and HIS; and donors, among others. (Appendix A, Table B provides the list of stakeholders.)

Tools

The methods used among participating EAC Member States consisted of triangulating data from the following tools: the HIS Interoperability Maturity Toolkit, the Global Digital Health Index, and the Digital Health Atlas. While planning the Rwanda activity, the assessment oversight team decided to focus on the HIS Interoperability Maturity Toolkit and not to use the other two tools. The MOH stated that it plans to adopt the Digital Health Atlas but was not in a position to start it as a project at the time of the assessment. This section describes how the HIS Interoperability Maturity Toolkit was implemented in Rwanda.

The HIS Interoperability Maturity Toolkit, 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, uses a maturity model to measure 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. The HIS Interoperability Maturity Model focuses on three major domains of an HIS: leadership and governance, human resources, and technology. As described below, MEASURE Evaluation used this tool to conduct the assessment and applied the maturity model approach to analyze and interpret the results. The assessment has three main

components:(1) facilitator training; (2) the assessment workshop; and (3) the consensus building workshop, as described below.

Facilitator Training

In preparation for the HIS interoperability assessment workshop, the assessment oversight team convened a half-day meeting. The MEASURE Evaluation facilitators introduced the EAC digital health and interoperability assessment, the HIS Interoperability Maturity Toolkit, and the structure of the assessment to the assessment oversight team. As part of this training, the team reviewed the assessment invitation list to ensure that the correct entities would be represented at the workshop.

Assessment Workshop

The assessment workshop was a one-day event (Appendix B provides the workshop agenda) attended by 20 participants (Appendix A, Table C), who represented the MOH, RBC, RISA, Rwanda Social Security Board, and other government ministries; USAID; the United States Centers for Disease Control and Prevention (CDC); the World Health Organization; and several of the MOH's implementing partners. The MEASURE Evaluation team presented the assessment's goals, scope, and process. Participants broke into working groups to complete the assessment questionnaire. The assessment oversight team then facilitated a consensus building session on the results. The objective of the consensus building process was to develop a final set of answers acceptable to all participants. The assessment results help determine the maturity levels of the interoperability domains and their subdomains, and will be used to develop subsequent action plans. Following the assessment workshop, the MEASURE Evaluation team used the answers from the assessment tool to determine Rwanda's maturity level for each subdomain and domain of the HIS Interoperability Maturity Model. Appendix C provides the results of the HIS interoperability assessment.

Consensus Building Workshop

The consensus building workshop was a half-day event, (Appendix B provides the workshop agenda), attended by 11 participants from the assessment workshop. MEASURE Evaluation presented the subdomain and domain level scores for the HIS Interoperability Maturity Model. In a few instances, participants decided to change the assessment answers to adjust the maturity level to more accurately reflect Rwanda's status in a particular subdomain. After reviewing the assessment results as a group, MEASURE Evaluation led the team through a reflection on the results. Participants shared in plenary the strengths, weaknesses, gaps, and follow-up actions that they saw in the assessment results by domain, which are summarized in Table 1 in the Results section below. The MEASURE Evaluation team then grouped these bullet points into thematic clusters, which formed the basis for the recommendations in the Recommendations section of this report.

RESULTS

Summary of Themes from the Stakeholder Meetings

This section contains the key themes from the MEASURE Evaluation assessment team's meetings with stakeholders. Although each meeting was a little different, the assessment team asked all stakeholders what they saw as the opportunities and challenges for HIS interoperability in the country.

HIS Interoperability Opportunities

Rwanda has very strong political will to advance technology in the public sector. This is evidenced by the SRMP, which describes the use of technology across various public sectors, including health. In addition. a fairly functional management structure is in place that provides leadership and governance for the eHealth initiatives being implemented in the public sector. The current eHealth team at the MOH has representation from the eHealth Unit, the national health management information system (HMIS), RBC, and ICT. The cross-ministry nature of this team is important to ensure collaboration among many stakeholders. The stakeholders consulted for this assessment mentioned that there is not much duplication in the core systems of the HIS in Rwanda, and they were able to talk about the same systems. Examples of core systems are the electronic logistics management system, human resource information system, integrated disease surveillance systems, and SMS-based system for real-time reporting. The lack of duplication demonstrates that the governance structure is having a positive effect on eHealth implementation.

Another unique opportunity for interoperability in Rwanda is that the focus of the Healthcare Digital Transformation Strategy is on patient care and being patient-centered. The foundational elements being implemented or revived as part of this plan are on being able to exchange patient data across all levels of the healthcare system. This will force Rwanda to implement key components of a functional, interoperable HIS, including a unique patient identifier, master facility list, and defined standards and terminologies for various parts of the healthcare sector. In conjunction with other government agencies, such as the Rwanda Social Security Board, the MOH is developing the schema for a unique patient identifier. One step in this direction is that a national ID is being developed for those who are 18 years and older. The country is still exploring how to identify children from when they are newborns. Rwanda has already made some big strides in identifying and adopting standards as part of the health system. They have identified the International Classification of Diseases, Eleventh Version (ICD-11) for the diagnosis codes, and are working to adapt the logistics management systems to be compliant with Global Standards One (GS1) standards for pharmaceutical traceability. The Healthcare Digital Transformation Roadmap includes steps for the adoption and definition of other needed standards for HIS interoperability.

HIS Interoperability Challenges

Although the government's management structure is strong, the MEASURE Evaluation assessment team learned during meetings with stakeholders that the eHealth TWG has not met in over one year. According to the draft digital health strategy and policy, this group brings together members of the eHealth team with other government stakeholders, implementing partners, and donors. The TWG is meant to be a space for coordination and providing recommendations to the MOH on new initiatives. In a similar vein of governance challenges, the stakeholder meetings revealed that the digital health strategy and policy have been draft documents since 2018 and the stakeholders did not know their status. Another challenge mentioned in most meetings was the lack of human resource capacity for some of the very technical aspects of interoperability. Respondents acknowledged that although Rwanda has a lot of

technical and innovative capacity, that capacity is not yet in the health sector. The lack of capacity forces the health sector to rely on external assistance.

There is an existing HIE architecture, but it has not been used in several years. It stopped being used a little after the RHEA project ended in 2014. Many components need updating because the technology has advanced since that project. Moreover, some projects are building point-to-point integration without using the IL because it is not yet up and running. Bypassing the IL now could lead to more duplication of effort in the future when the HIE is functional.

Other Notable Highlights

In several conversations, it was stated that there needs to be a way to automate and integrate billing in the digital health systems because this would help generate revenue for health centers. They could then better afford the infrastructure for digital health solutions.

HIS Interoperability Assessment

This section describes the results of the HIS interoperability assessment, which were obtained by using the HIS interoperability assessment tool and mapping them to the HIS Interoperability Maturity Model. The results are presented by the three domains in the Maturity Model: leadership and governance, human resources, and technology. Each section includes a figure with a bar graph showing the scores for the individual subdomain levels in that domain.

Leadership and Governance

Rwanda has some strong structures and documents guiding the vision and implementation of digital HIS and interoperability. The current eHealth team at the MOH, which includes representation from the eHealth Unit, HMIS, RBC, and ICT, is legally protected from changes in the government and oversees the implementation of HIS interoperability. The Healthcare Digital Transformation Strategy is going to bring about an even more robust governance structure, which will include representation from outside ministries and departments, such as the Ministry of ICT and Innovation, the Ministry of Finance, and the Rwanda Social Security Board. The Healthcare Digital Transformation Strategy approaches interoperability from the patient-centered perspective and describes how HIS should be structured to improve patient care. This document is the key interoperability guidance document. Moreover, RISA assesses digital health systems to ensure that they meet certain requirements, and there is a new health data law, along with a health sector research committee, which will serve as part of the regulatory framework for protecting digital health data. Rwanda's HIS also has broad implementation of its business continuity plan, as demonstrated by a recent ICT audit and a strong financial management system where budget line items and expenditures are coded by category.

Rwanda's HIS does not currently have measures in place to monitor the implementation of interoperability activities, although this will happen when the Healthcare Digital Transformation Strategy is further rolled out. The country's workplan for HIS is not costed, which led to a lower score in the subdomain of financial resource mobilization (Figure 2).

Figure 2. Leadership and governance subdomain maturity levels as of 2019
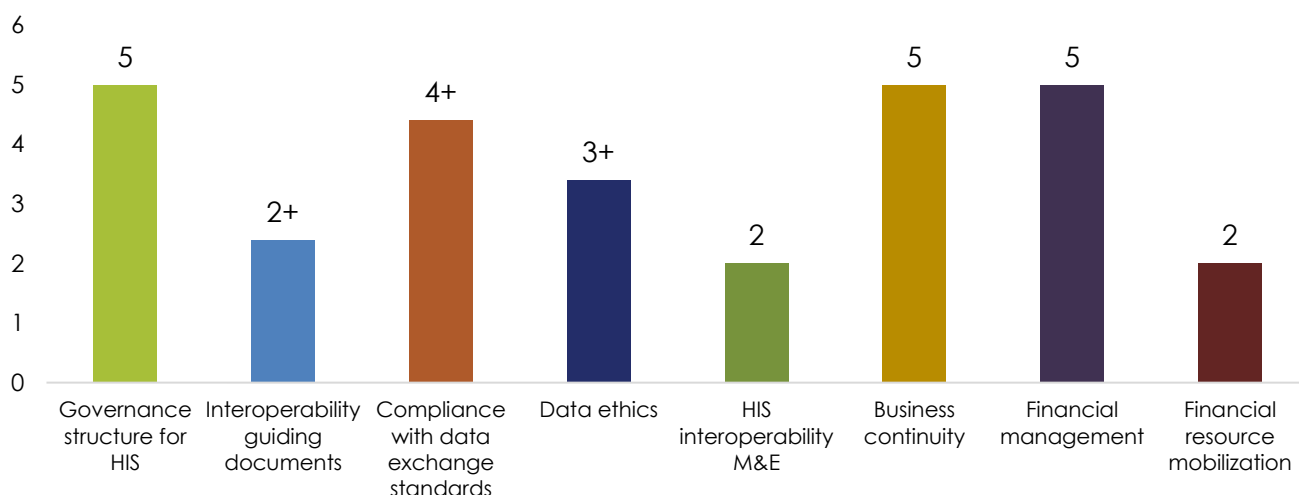
Human Resources

When developing the Digital Healthcare Transformation Strategy, the MOH completed a needs assessment to identify the core staff and skills needed to support digital HIS and interoperability. The governance structure was proposed as one of the core results of this needs assessment. A long-term plan to support the sustainability of staff and skills development exists and articulates how staff performance can be monitored. Staff incentives are also defined and monitored through a performance-based funding system at the national level. Training for all government ICT staff is handled by the MINICT. There is pre-service training through the Center of Excellence in Biomedical Engineering (CEBE) and in-service training on the EMR system offered through RBC.

The MOH has growing capacity in the public health sector for digital health, with support from agencies and implementing partners. All nursing and medical schools in Rwanda conduct pre-service training specific to digital health using a nationally recognized pre-service training curriculum. There is an eLearning platform that has some HIS courses and they expect to include other modules. Rwanda is also working with other EAC organizations for a common HIS curriculum, and has training contracts with other institutions in such areas as data analysis, interoperability of other systems, and information technology.

However, the MOH does not have a human resources policy or strategic plan that identifies the HIS, digital HIS, and interoperability skills and functions needed to support the national digital HIS. There are also gaps in skill sets at all levels, and staff capacity is not sufficient to drive the digital health and HIS interoperability work (Figure 3).

Figure 3. Human resources subdomain maturity levels as of 2019
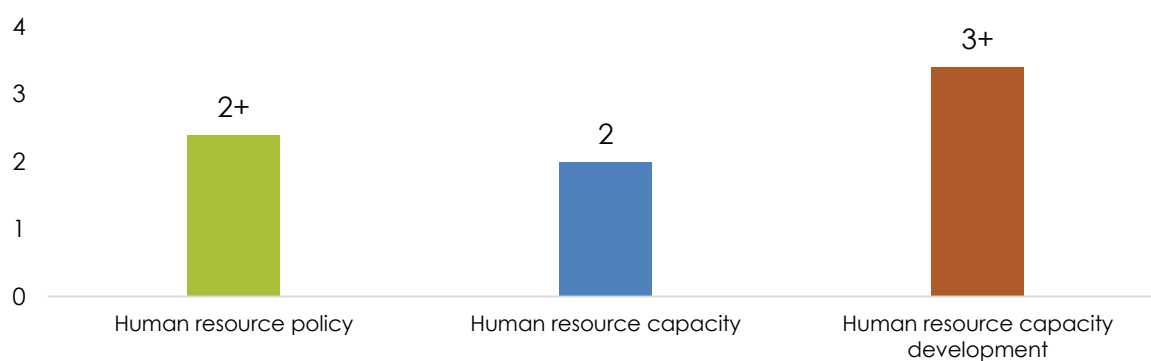
Technology

The MOH has diligently explored and extensively used digital health technologies, ranging from those used to manage patients at points of service at health facilities and by community health workers, to those used at the national level for population management, including informing the development of health policies and resource distribution. Rwanda was one of the first countries to implement a national HIE under the RHEA project. However, since that project ended, some pieces of the architecture have not been maintained and, therefore, Rwanda is currently devising plans to revive specific pieces of the architecture, including the master facility list, interoperability services layer, and terminology service. The MOH has harnessed this experience through the implementation of evidence-informed eHealth strategies, policies, standards, and guidelines that have enabled the eHealth space to make steady progress. Rwanda also has a strong technology infrastructure that will serve as an important foundation for reviving the HIE, including robust connectivity and support for operations and maintenance of information technology in the country (Figure 4).

However, the implementation experiences have also contributed to current challenges, including the fragmentation of the national HIS. The underlying cause is the lack of technical and data standards to enable the meaningful exchange of data collected by multiple systems. Other challenges include the absence of an effective plan to ensure that initiatives and projects, like the RHEA, are sustained, and are gradually expanded to include other important national digital health services, such as a facility registry, terminology service, and client registry. Whereas this is a technology challenge, other co-contributors are aspects of leadership and governance. A notable step in the right direction is the institutionalization of technical standards and the establishment of a mechanism to enforce compliance with those standards by vendors and implementers. The MOH is still in the initial phase of implementing these technical and technology standards.

Figure 4. Technology subdomain maturity levels as of 2019
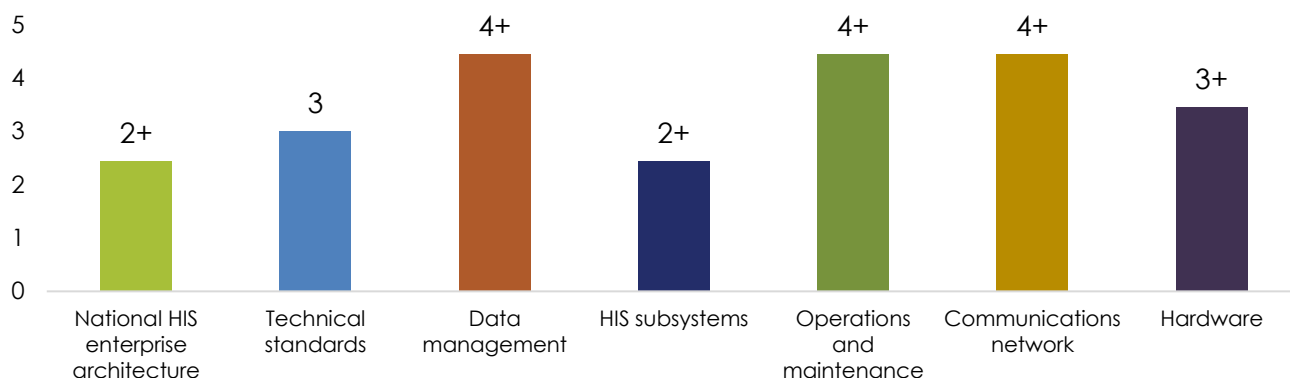
Data from the Brainstorming Session at the Consensus Building Workshop

Table 1 contains the raw data from the brainstorming session conducted at the consensus building workshop after participants had validated the assessment results. During this session, participants were asked to share what they found notable in the results, and any next steps or follow-up actions they envisioned based on the results.

Table 1. Raw data from the brainstorming session at the consensus building workshop

Leadership and governance	Human resources	Technology
• Doing a lot of activities but lack of documentation • We are monitoring but need an M&E plan • There should be a committee for data ethics that has a focus on new technology • Regular review of M&E plans and share with stakeholders • A lot of donor funding needs to change to engage the Government of Rwanda • Certification framework: Involve governance structure and RISA guidelines. Also conduct periodic reviews • Risk assessment of HIS	• We have not been paying attention to HIS staff • Capacity building for HIS is limited • Just one training center (CEBE) • For all civil servants: training • Not enough people; need more centers for training • Only one center; came up with a plan for having in-country capacity (does not need to be public sector) • Speed up discussion on what health system support model to use; this will determine staffing, infrastructure; central versus facility level • Work with academia for pre-service health workers (right now it's just an introduction to them) • Work with the private sector to support maintenance • Revise curriculum for OpenMRS, DHIS2, HIS in general • Establish a national health informatics professional association/society to bring together informatics experts and grow the profession	• Technical standards: need detailed standards to be published (we have some but need to publish) • Enterprise architecture; shows layers to build • We now know if a system fits in our architecture • Network: one government network project; RISA helping agencies to have well-structured local area network (government network) • Hardware: do not have a disposal policy. Needs to be enforced • National/subnational have good ICT • As build out the HIE, the gaps in HIS subsystems will be filled • Need the government service bus to connect all systems and this is in progress • Clear documentation of technology: architecture, systems, standards; doing a lot but it is not all documented

DISCUSSION

This section merges all data sources of this assessment to comment on the strengths and weaknesses of HIS interoperability in Rwanda, by domain area.

Leadership and Governance

Overall, the political will for Rwanda to be a leader in ICT in the public sector has played a large role in the strengths of the governance of digital HIS and interoperability. From the assessment, it is clear that the MOH and the MINICT are working closely on many issues for interoperability and digital health, which is a necessary partnership for a strong HIS. Rwanda's Healthcare Digital Transformation Strategy's focus on patient care is one of the first digital transformation strategies to be driven by patient care as opposed to data needs. This means that many digital health priorities are focused on building the country's national EMR and the use of a unique patient identifier, both pillars of HIS interoperability. Moreover, Rwanda does not have many duplicate systems, which could be partly due to a strong governance structure and the fact that all systems must go through an approval process with RISA to ensure that they meet government requirements. Many of the guidance documents for HIS interoperability and digital health were in draft form at the time of the writing of this report and, therefore, stakeholders outside the government were not aware of them and could not use them in their planning. Moreover, although many of the guidance documents laid out the systems needed for strong, interoperable HIS, they often did not place much emphasis on the governance and human resource capacity needed to roll out such large scale initiatives. The lack of such details could make it difficult to implement the vision for digital HIS without a lot of external technical assistance.

Human Resources

The MOH is steadily focusing on improving the skills and addressing staff gaps to facilitate the realization of the Healthcare Digital Transformation Strategy to enable the country to deliver healthcare services with ICT as an enabler. HIS assessments have been conducted to identify existing skills and competencies. The country has several interventions in place to equip staff with skills through training, including pre-service training at nursing and medical schools and the CEBE, and in-service training for use of the EMR systems. There are also electronic platforms for staff at different levels to take online courses for capacity development. Rwanda has several systems to support staff development and performance monitoring. Examples are HealthApix from IntraHealth for planning and targeting at the district level, an electronic human resource information system for human resource tracking, and performance-based financing for performance monitoring and appraisals, among others.

However, the MOH has no human resource policy or strategic plan that clearly identifies the HIS or digital HIS and interoperability skills needed to facilitate the development of a functional digital HIS. Gaps still exist in specialized technical skill sets to support the realization of the digital HIS; it sometimes relies on expertise from implementing partners and agencies. It is also hard to get new staff into government positions; for example, the RBC only issues job descriptions once a year, which implies that the hiring process takes a year. This affects the short term tasks and capacity needs for upcoming initiatives.

Technology

Rwanda is among the first countries to implement a successful national HIE through the RHEA project. The RHEA project informed initiatives that founded the OpenHIE. Rwanda has a rich history of using other digital health global goods, including OpenMRS and DHIS2, and has contributed greatly to the current achievements of those global goods. The cross-sectoral collaboration under the umbrella of the SMART Rwanda Initiative has resulted in the establishment and availability of reliable ICT infrastructure in the health sector, including a telecommunications backbone network. RISA has played a significant role in the improved operations and maintenance of ICT investments in the health sector. This includes the implementation of ICT policies that also provide guidance on the management of hardware and communications devices. Rwanda also hosts the eHealth Center of Excellence in the EAC, which has elevated the country's investment in eHealth, especially in human capacity development.

However, notable observations were made in such areas as the HIE where the RHEA project stalled around 2013, and no significant investments and developments have been made in either upgrading or establishing a modern and functional HIE. Although the MOH and RISA have tried to adopt and implement technical and data standards, progress has been slow and the standards are not yet comprehensive. This is a critical, foundational area for a functional, interoperable HIS that requires serious attention and investment. Although the MOH has instituted robust leadership and governance structures, the management of HIS subsystems is still not well developed. This includes the lack of a current inventory of the subsystems, and their distribution, custodianship, and use. The MOH is working to establish the Digital Health Atlas to be used to both regulate those systems and to guide future investments in digital health subsystems. Due to the strong governance systems, data management is fairly well established, with a clear protocolized system that dictates how data are collected, stored, transmitted, and used. There is evidence of data use, especially at the national level through the national HMIS powered by the DHIS2.

Limitations of the Assessment

There are some limitations to this assessment and its results. First, the assessment was conducted at the national level of the health sector. There may be differences across the regions and districts in the status of digital health and interoperability; for example, some subnational units may have variations in the strength of capacity or governance structures. Rwanda chose not to begin data collection for the Digital Health Atlas at this time. There was therefore no systematic way to collect information about the existing digital health systems being used in the country. The information the assessment team obtained about current digital health systems was through the one-on-one meetings with stakeholders. Moreover, Rwanda chose not to complete the Global Digital Health Index at this time. Therefore, the results of this assessment are skewed toward the use of digital health for HIS because that is what is covered in the HIS interoperability assessment.

RECOMMENDATIONS

Recommendations and Next Steps from the Consensus Building Workshop

The MEASURE Evaluation team collated and grouped the observations and actions from the consensus workshop brainstorming session (Table 1) into five themes for recommended next steps to strengthen the digital HIS landscape and to continue to build the foundation for HIS interoperability.

Document and Disseminate

During the assessment, it was evident that the MOH and RISA have many processes and standards for conducting HIS interoperability. However, one challenge is that not all stakeholders are aware of the processes because of a lack of documentation. To strengthen coordination and collaboration across partners and stakeholders, it is important to document key processes and standards so that everyone can be on the same page about what is expected and the vision for HIS for Rwanda. Once these processes, plans, and standards are documented, they should be disseminated to all relevant stakeholders. This includes donors and implementing partners so that they know what the government is planning and what requirements they will be expected to meet. Examples of the documentation needed and documents that should be disseminated are:

- M&E plan for monitoring HIS interoperability: This could also be part of the larger M&E plan for the Healthcare Digital Transformation Roadmap.

- Detailed technical standards for all areas of the HIS.

- Technology to be used, including systems, security, and messaging standards.

- Financial resources needed for interoperability and who will provide the resources: The easiest way to document the resources needed is through a costed workplan. The costed workplan should be detailed enough to show the expected cost of the different activities, including system maintenance, support, and training. This workplan can then be shared with various development donors and partners so that they can commit resources for the plan.

- Workforce capacity development plan: As part of the Healthcare Digital Transformation journey, Rwanda should develop a plan for how to build the necessary skills for public sector staff to oversee, implement, and manage digital health systems and interoperability. During the assessment, it was mentioned several times that there are training programs for information technology skills, but that they need to be combined with the health information content to build a workforce that can work on these systems.

- Healthcare Digital Transformation Strategy and Roadmap: Many stakeholders with whom the assessment team met that were not part of the government did not know about this plan. Once it is finalized, the government should make sure that it is properly disseminated to all relevant stakeholders to enhance coordination, collaboration, and transparency.

Build Capacity

One of the most prominent themes emerging from the one-on-one stakeholder meetings was the need to build more in-country capacity to support the technical complexities of digital health and interoperability. During the assessment, participants said that the ultimate goal of capacity building is to develop, support, sustain, and maintain HIS interoperability and use. To achieve this goal, participants defined the following next steps:

- Incorporate the health sector training plan in the national capacity building plan: This includes adding in-service training for ICT staff, including a focus on HIS.

- Advocate for increased training centers: This will help increase the number of skilled staff who can work in the public sector. These training centers could be in academia or other private sector institutes. Although the CEBE is a great resource for Rwanda, it cannot be the sole training institute for digital health and interoperability skills.

- Engage the private sector to build, maintain, and support systems: This is especially important for the complex pieces of interoperability, where highly specialized skills may be needed. One way to engage the private sector is through the public-private partnership model.

- Revise the curriculum for HIS: This revision should be for the different staff who interact with the systems, from those who use them (health workers) to those who develop and maintain them (health informatics workforce).

Implement

As part of the reflection on the assessment results, participants identified some key initiatives to be implemented to continue to build the enabling environment for a functional, interoperable HIS:

- Conduct a regular risk assessment of the HIS.

- Fully implement the government's Healthcare Digital Transformation Strategy to establish a functional HIE and ICT infrastructure. This includes:
  - Ensuring that appropriate connectivity and ICT infrastructure at all levels of the health system are in place.
  - Monitoring network connectivity across the entire government.

- Establish a national health informatics professional association or society to bring together informatics experts and grow the profession. The national society would also contribute greatly to and support the development and certification of in-service health workers in the meaningful use of digital health solutions.

- Formalize the system certification process used to assess systems using the existing "certification framework" that RISA uses. This includes documenting the requirements and certification process so that stakeholders can ensure that their system meets the requirements.

Monitor

Not only is it important to implement digital health initiatives and systems, it is critical to continuously monitor them to ensure compliance and proper security. Three monitoring initiatives that should be put in place are:

- A committee on data ethics that focuses on digital technology in health to ensure that proper procedures and safeguards are in place to minimize any threats to data security and confidentiality.

- Regular monitoring of implementation plans for Healthcare Digital Transformation Strategy and interoperability, which includes sharing results with stakeholders.

- Periodic review of certified systems to ensure that they remain compliant with requirements and standards.

Additional Recommendations

In addition to the recommendations for next steps that emerged from the consensus building workshop, the MEASURE Evaluation assessment team recommends the following actions to continue building the enabling environment for an interoperable HIS:

- Merge recommendations from this assessment into the Healthcare Digital Transformation Strategy so that there is just one plan driving interoperability and HIS strengthening in the country.

- Revive the eHealth TWG that brings together donors and partners with the MOH so that everyone is on the same page about the vision for digital health in Rwanda. This will help increase coordination and collaboration.

- Finalize documents, such as the digital health strategy and policy, so that partners and donors can use them as guidance documents for their work.

- Add more activities focused on the development of policies and human resources in the digital strategies for Rwanda. The digital health strategy and policy and the Healthcare Digital Transformation Strategy lay out the vision for systems in Rwanda. However, the plans seem to lack key details about other pieces of the ecosystem, such as policies and human resource development.

- Implement the Digital Health Atlas to strengthen governance of digital health implementation in Rwanda.

- Develop a registry complete with profiles of essential data and technical standards with which all digital health solutions will be required to comply.

- Establish a digital health "testing and certification" lab to support the regulatory aspects and research and innovation in digital health.

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APPENDIX A. ASSESSMENT PARTICIPANTS

Table A. Assessment oversight team

Name	Organization
Jean Baptist Byiringiro	RBC-HIS
Erick Gaju	MOH- eHealth
Odette Kampire	Rwanda Social Security Board
Edward Kamuhamgire	MOH- Clinical Services
Sylvere Mugumya	RISA-Health Sector Digitization
Andrew Muhire	MOH- HMIS
Dr. Zuberi Muvunyi	MOH- Clinical Services
Edith Munyana	MOH- ICT
Pierre Celestin Nizeyimana	RISA
Sylvie Nsanga	RISA
Rodrigue B. Ruhashya	MINICT
Antoine Sebera	RISA
Dr. Albert Tuyishime	RBC
Dr. Parfait Uwarilaye	MOH- Planning, Health Financing, and Information Systems

Table B. Stakeholders who met with MEASURE Evaluation assessment team

Name	Organization
Ines Gege Buki	Global Health Supply Chain (PSM)
Dr. Manzi Emmanuel	UNICEF
Erick Gaju	MOH-eHealth
Richard Gakuba	Jembi
Max Kabalisa	Global Health Supply Chain-Procurement and Supply Chain Management (PSM)
Saidi Kibeya	EASTECO
Mutho Maharajan	UNICEF
Peter Miiro	Global Health Supply Chain (PSM)
Adelite Murindangwe	EASTECO
Dr. Zuberi Muvunyi	MOH-Clinical Services
Candide Tran Ngoc	World Health Organization
Moses Nhadiro	EASTECO
Samson Radeny	IntraHealth International
Janise Richards	CDC
Vincent Sabagiqiqwa	Global Health Supply Chain (PSM)

Dr. Albert Tuyishime	Rwanda Biomedical Center
Elisabeth Uwanyiligira	USAID Rwanda
Randy Wilson	Management Sciences for Health

Table C. Assessment workshop participants

Name	Organization
Aime Theophile Abizeyimama	RBC
Erick Gaju	MOH
Michele Kayiganwa	MOH
Faustin Maniragena	ENABEL
Peter Miiro	Global Health Supply Chain (PSM)
Sylvere Mugumya	RISA
Dr. Zuberi Muvunyi	MOH
Candide Tran Ngoc	WHO
Moses Nhadiro	EASTECO
Jasper Pamela Nlivugurugua	MOH
Alain Thephile Nyomugabo	RSSB
Janise Richards	CDC
Degratia Rutebuka	IntraHealth International
Aphrodice Rwagaju	CHAI
Alex Tumwesigye	MEASURE Evaluation (facilitator)
Elisabeth Uwanyiligira	USAID Rwanda
Christina Villella	MEASURE Evaluation (facilitator)
Steven Wanyee	MEASURE Evaluation (facilitator)
Amizero Willy	Hopital La Croix Du Sud

APPENDIX B. WORKSHOP AGENDAS

East African Community & Republic of Rwanda Ministry of Health
Health Information Systems Interoperability Assessment Workshop
Chez Lando Hotel
Assessment Workshop: May 29, 2019

Session topic	Time	Facilitator(s)
Registration	8:00-9:00	Ministry of Health, MEASURE Evaluation
Opening prayer, remarks, and introductions	9:00-9:20	Dr. Zuberi Muvunyi, Ministry of Health
Opening remarks by East African Community	9:20-9:25	Moses Nhadiro, EASTECO
Overview of Digital Health and Interoperability in Rwanda	9:25-9:40	Erick Gaju, Ministry of Health
Overview of the Assessment	9:40-10:10	Steven Wanyee, MEASURE Evaluation
Tea break	10:10-10:30	Hotel
Review subdomains of maturity model	10:30-11:15	Christina Villella, MEASURE Evaluation
Small groups assessment	11:15-13:00	All
Lunch	13:00-14:00	Hotel
Consensus on assessment answers	14:00-16:30	Erick Gaju, Ministry of Health
Next steps & Closing remarks	16:30-16:45	Erick Gaju, Ministry of Health
Tea break and departure	16:45-17:00	Hotel

East African Community & Republic of Rwanda Ministry of Health
Health Information Systems Interoperability Consensus Workshop
Chez Lando Hotel
Workshop: May 31, 2019

Session topic	Time	Facilitator(s)
Registration	8:00-9:00	MOH, MEASURE Evaluation
Introductions and opening prayer	9:00-9:15	Dr. Zuberi Muvunyi, MOH
Summary of assessment workshop & Assessment results review and validation	9:15-10:00	MEASURE Evaluation
Prioritization discussion and voting What subdomains should be prioritized? What criteria should we use to prioritize?	10:00-10:30	Erick Gaju, MOH
Tea break	10:30-10:45	Hotel
Breakout groups to determine action plans	10:45-11:45	All
Plenary sharing	11:45-12:45	Erick Gaju, MOH
Next steps and wrap up	12:45-13:00	Erick Gaju, MOH
Lunch	13:00-14:00	

APPENDIX C. HIS INTEROPERABILITY MATURITY MODEL 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.	**Subdomain Level**
Leadership and Governance 5	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 technical working group (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 esources—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.	5
2+	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 some attributes achieved: Level above current subdomain level with some attributes of that level achieved

Level with all attributes achieved: Level above the current subdomain level with all attributes in 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.	4+
	Data ethics	The country has no healthcare-specific data laws, regulatory frameworks, or ethics provisions to guide data security, privacy, and confidentiality.	The country has drafted laws, policies, or a regulatory framework for data security and privacy that address issues related to health data.	The country has an approved health data regulatory framework.	The health data security and privacy laws have been implemented, and there are guidelines on how to operationalize the laws in the HIS. HIS users have been sensitized on the data security and privacy laws. The government and stakeholders consistently enforce the data security and privacy laws.	The country has a recognized mechanism (e.g., committee or working group) for reviewing data ethics issues in the national HIS, and for updating policies, procedures, and laws, as needed. This mechanism reflects industry best practices.	3+
	HIS interoperability monitoring and evaluation	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.	2
	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.	5

Domain	Subdomain	Level 1: Nascent	Level 2: Emerging	Level 3: Established	Level 4: Institutionalized	Level 5: Optimized	Subdomain Level
Leadership and Governance	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-supported.	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.	2
					Maturity level of Leadership and Governance domain [average]:		2 [3.5]

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 human resources (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 and/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.	2+
	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.	There is growing capacity within the public sector support digital HIS. The country also receives 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.	3+
					Maturity level of Human Resources domain [average]:		2+ [2.3]

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, and 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.	2+
	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 Ministry of Health.	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 pplications 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.	3

[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 are clearly 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 to decision makers.	4+
	HIS subsystems	The country's HIS mainly consists of stand-alone program- specific subsystems working in silos, and addressing only the basic 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 are web- 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.	2+
	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.	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.	4+

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 a national 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 Ministry of Health 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 Ministry of Health'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.	4+
	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 Ministry of Health's national and subnational offices have the required hardware (computers, printers, connecting devices, etc.).	50% or more of the Ministry of Health's national and subnational offices have the required hardware, including back-up hardware.	Seventy-five percent (75%) of the Ministry of Health'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.	3+
Maturity level of Technology domain [average]:							2+ [3.1]