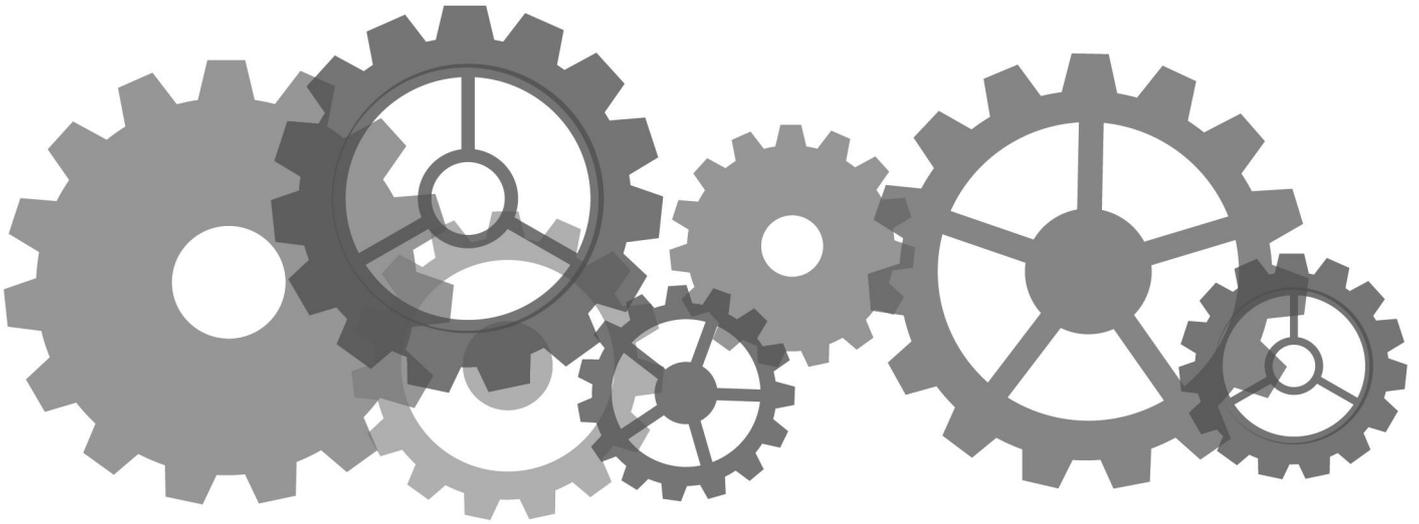




# Health Information Systems Interoperability Maturity Toolkit

## Users' Guide





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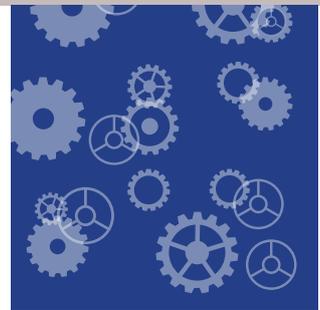
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# ABBREVIATIONS

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DH&I	Digital Health and Interoperability
HDC	Health Data Collaborative
HIMSS	Healthcare Information and Management Systems Society
HIS	health information system(s)
ICT	information and communications technology
LMICs	low- and middle-income countries
MOH	Ministry of Health
UNC	University of North Carolina at Chapel Hill
USAID	United States Agency for International Development
WHO	World Health Organization

# 1

# INTRODUCTION



The Health Information Systems Interoperability Maturity Toolkit consists of a health information systems (HIS) interoperability maturity model, a maturity assessment tool, and this guide for users of the model and the tool.

The term “interoperability” describes the ability of two or more information systems or components to exchange information based on standards, and to use the information that is exchanged. Interoperability enables different HIS to work together in and across organizational boundaries to advance the health status of individuals and communities and the effective delivery of healthcare to them (Healthcare Information and Management Systems Society [HIMSS], 2013).

A maturity model is a set of structured levels that depict the organizational behaviors, practices, and processes that reliably and sustainably produce required outcomes (Hammond, Bailey, Boucher, Spohr, & Whitekar, 2010).

This Health Information Systems Interoperability Maturity Toolkit (hereafter referred to as the HIS Interoperability Maturity Toolkit) was developed in 2017 to address challenges in low- and middle-income countries (LMICs), where digital information systems are largely fragmented. The siloed information systems collect data to support specific health programs or services. These systems include program-specific information systems; health management information systems; laboratory and imaging information systems; and disease surveillance information systems. Additionally, multiple information systems collect the same data and (e.g., different electronic health records systems being used across a country) are unable to exchange data because they do not use the same terminologies. Because of their fragmented nature, these systems cannot effectively exchange data or be harnessed to realize the benefits for which the data were collected. In these conditions, decision-makers inside and outside of government are unable to efficiently and effectively access the data they need to make decisions. Without timely, complete, and accurate data, decision-makers lack important information on which to base their decisions.

The maturity model concept is used to measure the ability of an organization or government entity, such as a ministry of health (MOH), to continuously improve in a specific discipline until it reaches the desired level of development or maturity (Carvalho, Rocha, & Abreu, 2016). The greater the maturity, the stronger the system and the more likely it is to withstand interruptions, such as changes in staff, fluctuation in funds, changing data needs, or the effects of rapidly evolving technology. The HIS interoperability maturity model addresses the components that are critical to interoperability: technology, the broad area of leadership and governance of the HIS, and human resources.

The purpose of the HIS Interoperability Maturity Toolkit is for MOHs, their implementing partners, and other stakeholders to assess the digital HIS’s landscape by identifying their existing capacity, processes, and structures for the key domains for HIS interoperability and the required levels of maturity necessary to achieve HIS interoperability. By using a maturity model approach, we aim to identify the factors that are critical to achieving mature, interoperable HIS, assess them, and create a developmental path toward resilient system(s) (maturity). This toolkit is available to countries as a public good to meet the goals and objectives of strengthening their HIS. Whereas it is possible to create intersectoral interoperable systems, this toolkit focuses on the health ministry’s HIS.

This is Version 1.0 of the toolkit. We published Version 0.5 in late 2017 and updated the toolkit in January 2019 with lessons learned from early adoption by Ghana and Uganda.

The HIS Interoperability Maturity Toolkit is available online at <https://www.measureevaluation.org/resources/tools/health-information-systems-interoperability-toolkit>.

# 2 BACKGROUND



## Need for HIS Interoperability

In the past decade, LMICs have seen rapid growth in digital health solutions. Enthusiasm for the uptake of technology and increased investment in this sector have led to many digital HIS interventions (World Health Organization [WHO], 2011). However, many of these interventions address different health programs such as HIV or Malaria or different aspects of the health system such as disease surveillance and clinical records, resulting in fragmented information systems, both in and across the national and subnational health sectors. HIS interoperability is the extent to which various systems and devices can exchange data, interpret data, and display them in a user-friendly way. Unfortunately, many HIS in LMICs are “digitally walled”: that is, they are architecturally incapable of or have very limited capability to exchange information to keep their meaning. Such systems are not cost- and service-efficient. The same data are collected multiple times, thus increasing the cost of maintaining the systems and causing confusion. Data about the same person or services in different systems sometimes do not match—raising concerns about data integrity. Such systems function contrary to the axioms of interoperability, as described by Hammond, et al. (2010) in their article, “Connecting Information to Improve Health.” These axioms are summarized in Table 1. Such systems are also structurally weak and vulnerable to infiltration for malicious intentions.

Successful interoperability of these digital information systems depends on the presence and use of widely adopted data exchange, security, and messaging standards. A standard is a definition, a set of rules or guidelines, a format, or a document that establishes uniform engineering or technical specifications, criteria, methods, processes, or practices. It should be approved by a recognized standards development organization, or it should have been accepted by the industry (Celi, Fraser, Nikore, Osorio, & Paik, 2017). Interoperability ensures that information flows into and out of digital HIS and is available to users at the right time and in the right place, and contains data that are accurate and complete. At the organizational level, a major challenge to achieving HIS interoperability is the lack of leadership and governance. Leadership and governance are imperative, first, to bring all stakeholders together to organize the information systems, and second, ensure that there is sufficient interorganizational support and commitment to operationalize the information exchange. Bridging the technical and organizational domains ensures that there are appropriate safeguards to maintain the privacy and security of protected information and builds sufficient consensus among all stakeholders that the safeguards are sufficient, practical, and effective (Magnuson & Fu, 2014).

**Table 1. Axioms of interoperability for HIS**

- 1) Data should be entered only once and should be available for multiple purposes, that is, they should be “reusable.”
- 2) Interoperability requires the cooperation of a group of stakeholders to ensure the application of consistent rules across technical domains. It must also be done with sensitivity to legal, ethical, and societal requirements, including security, privacy, and confidentiality.
- 3) A single global set of data elements with attributes must become the building blocks of all such systems. Precise and unambiguous definitions of items are mandatory.
- 4) There will be diverse health information systems, not just one or even several. Yet it is critical to achieve interoperability among all of them.

Source: Hammond, Bailey, Boucher, Spohr, & Whitekar, 2010

At the global level, strong, interoperable digital HIS are critical to achieve the aspirations of WHO's Roadmap for Health Measurement and Accountability goal (Measurement and Accountability for Results in Health, 2015), which is this: by 2030, all LMICs have the necessary information to improve health and health services and achieve national and global health-related Sustainable Development Goals (United Nations, n.d.). Strong HIS are especially critical for tracking progress and enhancing data use for Sustainable Development Goal number three: "Ensure healthy lives and wellbeing for all at all ages (United Nations, n.d.)."

The USAID-funded MEASURE Evaluation project, in collaboration with the Health Data Collaborative (HDC), has developed this toolkit for countries in low-resource settings:

- To identify the domains and subdomains needed for a country's digital HIS to exchange data with other health systems (interoperable) and stages of their development toward maturity
- To assess and understand where they are on the path to interoperable digital HIS and identify actions they can take for course correction, if necessary
- To use the results of the assessment to plan, prioritize, and coordinate resources for the support of a strong, responsive, and sustainable national HIS
- To monitor, evaluate, and report on all or individual components of HIS interoperability

## Why a Maturity Model Approach?

Maturity models have their origin in the field of total quality management. They guide strategically linked continuous improvement processes. They are critical to obtaining a thorough understanding of an organization's current position and where an organization aims to be in the future. A maturity model describes the process components that are believed to lead to better outputs and better outcomes. A low level of maturity implies a lower probability of success in consistently meeting an objective, and a higher level of maturity implies a higher probability of success. Maturity models can be important for diagnosis of and planning for HIS strengthening, especially digital HIS. They can be a reference point for identifying the foundational elements needed to create an enabling environment for digital HIS within a national HIS to become interoperable. If applied regularly, a maturity model can spur improvements in an HIS, from current status to desired status. A maturity model can also serve as a roadmap for how to improve processes from one level to the next by helping to define the attributes of each level.

### **When appropriately designed, maturity models provide:**

- A framework for envisioning the future, the desired state, and the development of improvement plans
- Benchmarks for the organization to compare its processes internally or externally
- A mechanism to provide insight into the improvement path from an immature to a mature process
- A disciplined method that is comparatively easy to understand and implement

Source: Institute of Internal Auditors, 2013

This HIS interoperability maturity model addresses three broad domains that are critical to HIS interoperability: leadership and governance; human resources; and information and communications technology, which we refer to as "technology" in the model. The maturity model is designed to describe the evolutionary path of increasingly organized and systematically more mature processes. One of its strengths is that a country, county, region, or district can use it to determine the status of its digital HIS towards its ability to exchange data through an assessment process, and use the results to determine the desired HIS interoperability status. In other words, even if countries are not in a position to make their systems interoperable yet, the assessment can help them identify what processes, structures, and capacity they should be building within their digital HIS work to enable them to pursue interoperability

in the future. The model contains attributes that allow for the monitoring and measurement of progress along the path to maturity. Using desired goals as the ultimate maturity level, countries can assess the status of their HIS interoperability at any time, and identify how far they are from their goals. The assessment results can be an important input for planning appropriate activities or actions to achieve the desired results.

The maturity model approach is consistent with modern initiatives to help countries determine and track the effective use of digital technology in relation to their key performance indicators, including health outcomes. One example is the Global Digital Health Index. This initiative is an “interactive digital resource that tracks, monitors and evaluates benchmarks, and provides a maturity model for countries to track the effective use of digital technology in relation to health outcomes” (Health Enabled, 2017). Despite the acceptance of maturity models in the fields of organizational development, project management, and process improvement, evidence about the extent of their use and impact is very limited.

## Toolkit Development Stages

The toolkit was developed through a three-pronged strategy, as described in the sections below. The development process was guided by the Principles for Digital Development (Principles for Digital Development, n.d.), especially the principles for designing with the user, understanding the existing ecosystem, and building for sustainability and collaboration.

### Literature Review

In the first stage, we brainstormed and conducted a systematic literature review. The initial brainstorming contributed to the definition of the scope for the literature review. We searched electronic databases (e.g., PubMed, Web of Science, and SCOPUS) and reviewed 60 articles. We also reviewed several maturity models and maturity assessment tools. The preliminary literature review and core team discussions led to the creation of a tentative list of domains, subdomains, and levels of maturity. These formed the foundation for the toolkit. We built on this foundation as new ideas and information became available. The complete list of references reviewed during development of the toolkit is linked here: <https://www.measureevaluation.org/resources/tools/health-information-systems-interoperability-toolkit>.

### Collaboration with the HDC

In December 2016, the DH&I working group of the HDC prioritized the development of an HIS interoperability maturity model as one of its key activities for 2017. Because this activity was already in MEASURE Evaluation’s work plan, the working group worked together with MEASURE Evaluation. The working group made significant contributions to the toolkit during monthly calls in which we discussed progress, reviewed documents, and made plans. The toolkit is therefore a joint deliverable of USAID, HDC, and MEASURE Evaluation.

### Working with Countries

Two of the nine Principles for Digital Development advocate designing digital products jointly with the user and in a collaborative manner. If adhered to, these approaches can increase efficiency in the use of resources and enhance the chances for greater impact and sustainability. Guided by these principles, we worked with two countries, Kenya and Ghana, to develop the toolkit. In Kenya, we worked with an established in-country HDC working group, and with digital health experts from the MOH, local universities, MOH implementing partners, the private sector, and the Kenya Health Informatics Association. This group participated in and contributed to both the design and review of the toolkit. In Ghana, HIS and digital health stakeholders contributed to the toolkit’s development during the review stage only. In both countries, the review was conducted through structured and facilitated discussions. Although several countries are represented in the HDC working group, collaborating with in-country stakeholders during different stages of the toolkit’s development helped to ensure that the format, content, terminologies, and processes reflect the ecosystem in which the toolkit will be used. The toolkit will be pilot-tested in selected countries in 2018. As a global public good, the toolkit will be updated from time to time, guided by new information and lessons from implementers.

# 3

## TOOLKIT DESCRIPTION



The HIS Interoperability Maturity Toolkit has three main components:

1. HIS interoperability maturity model (linked here: <https://www.measureevaluation.org/resources/tools/health-information-systems-interoperability-toolkit>)
2. Assessment tool (linked here: <https://www.measureevaluation.org/resources/tools/health-information-systems-interoperability-toolkit>)
3. This users' guide, which includes the Subdomain Levels Scoring Worksheet (Appendix C) and HIS Interoperability Maturity Model Worksheet (Appendix D)

The toolkit also provides a complete list of the references consulted in the literature review (linked here: <https://www.measureevaluation.org/resources/tools/health-information-systems-interoperability-toolkit>)

### **HIS Interoperability Maturity Model**

#### Interoperability Domains and Subdomains

The HIS interoperability maturity model is a matrix, with domains, their respective subdomains, and maturity levels. The model's three domains are leadership and governance; human resources; and technology. Each domain is divided into subdomains, for a total of 18 subdomains. The three domains and their respective subdomains are illustrated in Figure 1. Appendix B provides the definitions for each subdomain and other terms used in this document.

**Figure 1. HIS interoperability maturity model domains and subdomains**

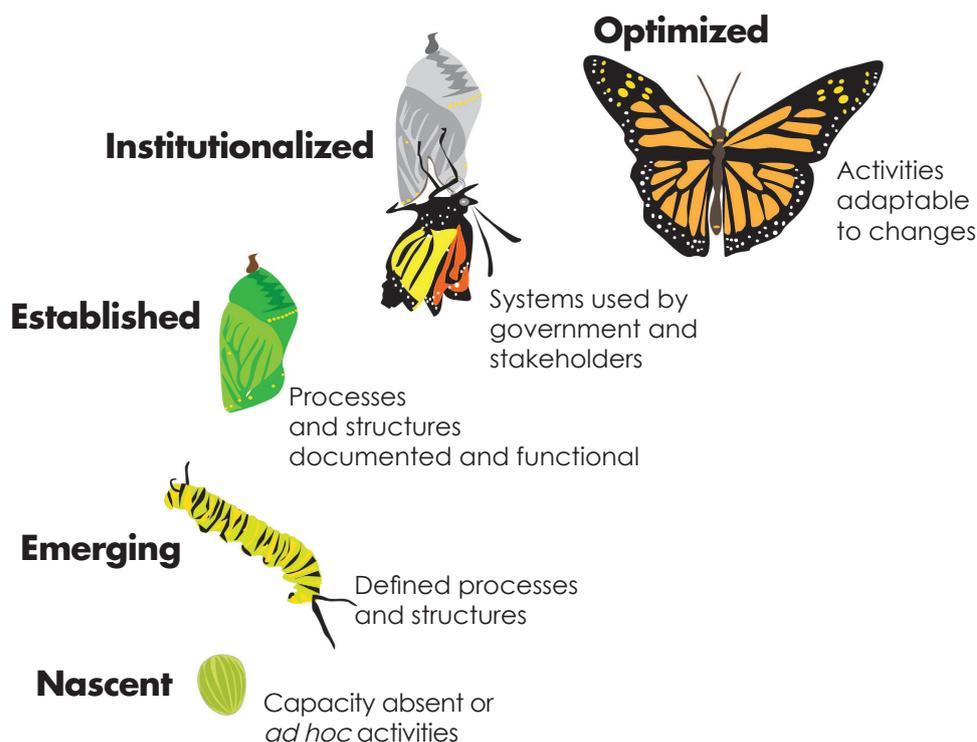


## Maturity Levels

Maturity levels consist of a predefined set of process areas. The maturity levels represent the evolutionary path for the domains and subdomains of an HIS, from the lowest levels to the highest. The levels provide a way to characterize HIS performance and progression from one level to the next. This HIS interoperability maturity model has five levels, labeled nascent, emerging, established, institutionalized, and optimized. Figure 2 describes the five levels of maturity.

**Figure 2. The transitional states in a maturity model**

Typical levels:



1. **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.
2. **Level 2 (Emerging):** The country has defined HIS structures, but they are not systematically documented. No formal or ongoing monitoring or measurement protocol exists.
3. **Level 3 (Established):** The country has documented HIS structures. The structures are functional. Metrics for performance monitoring, quality improvement, and evaluation are used systematically.
4. **Level 4 (Institutionalized):** Government and stakeholders use national HIS system and follow standard practices.
5. **Level 5 (Optimized):** The government and stakeholders routinely review interoperability activities and modify them to adapt to changing conditions.

Figure 3 is an excerpt from the HIS interoperability maturity model showing how the components fit together. It is page one of the multipage maturity model. On the left side are the domains and subdomains. The five levels of maturity are listed and defined across the top of the page. The boxes to the right of each subdomain are the attributes of the subdomains at each level. The complete maturity model—part of the HIS Interoperability Maturity Toolkit—is online here: <https://www.measureevaluation.org/resources/tools/health-information-systems-interoperability-toolkit>.

**Figure 3. Maturity model (Page 1)**

HEALTH INFORMATION SYSTEMS INTEROPERABILITY MATURITY MODEL						
Domain	Subdomain	Level 1: Nascent	Level 2: Emerging	Level 3: Established	Level 4: Institutionalized	Level 5: Optimized
		The country lacks HIS capacity or does not systematically plan, finance or represent. Isolated, ad hoc efforts.	The country has defined HIS processes and an ongoing monitoring or measurement protocol exists.	The country has documented HIS performance monitoring, quality improvement, and evaluation are systematically used.	Government and stakeholders use the	The government and stakeholders routinely view interoperability activities and modify them to adapt to changing conditions.
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 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 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.
	Interoperability guidance documents	HIS interoperability guidance documents are absent. Interoperability is implemented on a case-by-case basis.	Interoperability guidance documents. A governing body for interoperability has 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.

**Levels**

**Domain**

**Subdomains**

**Attributes**

## Assessment Tool

The assessment tool may be used by a country to assess the status of its HIS interoperability. The tool has a set of statements to evaluate each of the 18 subdomains. Each subdomain is preceded by a subdomain definition. Figure 4 provides an excerpt from the assessment tool showing the statements on compliance with the subdomain on data exchange standards. Instructions for how to apply the tool and conduct the assessment are provided in the following section.

**Figure 4. A section of the assessment tool: Compliance with data exchange standards**

<b>C. Subdomain: Compliance with Data Exchange Standards</b>		
<b>Definition:</b> Adherence to organizational policies, procedures, and best practices related to HIS, including standards for data exchange, messaging, and security. It also means adherence to applicable laws, relevant industry standards, and internal policies (e.g., codes of conduct).		
<b>Statements</b>	<b>Check if applicable</b>	<b>Evidence</b>
A1. No structures (working groups, steering committees, or units), processes, and procedures are in place to guide or enforce compliance with data exchange, messaging, and data security standards.	<input type="checkbox"/>	
B1. Structures (working groups, steering committees, or units) are in place to guide or enforce compliance.	<input type="checkbox"/>	
C1. The HIS has developed or adopted and implemented a regulatory framework for compliance.	<input type="checkbox"/>	
D1. The government enforces the regulatory framework for compliance.	<input type="checkbox"/>	
D2. The subsystems in the national HIS are required to meet compliance and certification criteria.	<input type="checkbox"/>	
E1. Compliance with standards for data exchange, messaging, and security is continuously reviewed.	<input type="checkbox"/>	
E2. The regulatory framework is reviewed and updated to reflect best practices for data exchange, messaging, and data security.	<input type="checkbox"/>	

# 4

## ASSESSMENT PROCESS



The assessment process is designed to be self-administered. An MOH can use this method to evaluate the interoperability of its HIS. Using the assessment tool effectively and determining accurately an HIS's level of interoperability maturity requires thoughtful planning to ensure that the right stakeholders participate in the process. Two teams are formed for the assessment process. First, an oversight team is created by the HIS or digital health leadership of the MOH. The oversight team leads the assessment process. Second, the oversight team identifies and establishes an assessment team to participate in the assessment process. The assessment team members come from MOH and HIS stakeholders. Following the self-administration of the assessment tool, the results are mapped to the maturity model and are used to plan improvements in HIS interoperability. A step-by-step description of the assessment process follows. Please note that the process may not be as linear as described here, depending on the context, but should generally follow the flow presented.

### **Step 1. Determine the need for an assessment.**

Planning for the assessment of HIS and interoperability initiates discussions among HIS stakeholders on how to rally people, tools, and technologies to build a strong, interoperable national HIS. It is important for the MOH to work with its HIS technical support partners (e.g., implementing partners, NGOs, donors) to identify the need for and benefits of assessing the level of maturity of HIS interoperability. Engaging HIS leadership in determining the need for an assessment fosters local ownership of the assessment and its results. It also helps to ensure that the right entities participate in the assessment process. One reason for an assessment of HIS interoperability could be an interest in developing or improving an existing eHealth strategy so that it outlines the foundational elements needed for HIS Interoperability. If interoperability is part of the strategy, the assessment would provide additional information on what specific actions need to be undertaken to prepare for and implement interoperability. Once the MOH has identified the need for the assessment, it should decide whether it will lead the assessment or whether it will be led by an external party or a mix of MOH and other stakeholders. Some countries may want to increase the objectivity of the assessment process by having an external party lead the process. To increase buy-in from HIS stakeholders, it is important that the MOH forms an assessment team that is as inclusive as possible (Step 5).

### **Step 2. Determine the scope of the assessment.**

The HIS interoperability maturity model is designed to look at the HIS from a national perspective, which includes subnational units and the many different HIS subsystems that could be part of the national HIS. The scope of the assessment is limited to the HIS in the MOH and implementing partners working with the MOH. Depending on the goals of the assessment, however, the MOH may decide to focus only on certain subnational levels of the HIS, such as the regional, state, district, or county levels. It is therefore important that the assessment oversight team determine the scope of the assessment at the beginning. The scope enables the MOH to identify the people and organizations that should participate in the assessment, and adapt the tools to match the scope, as necessary. For example, some of the subdomains refer to having HIS interoperability functions in place at both the national and subnational levels. If the MOH chooses only to assess the HIS at the national level, references to the subnational level need to be adapted accordingly.

### **Step 3. Establish an assessment oversight team.**

Early in the assessment process, the MOH's HIS leadership selects the stakeholders for the oversight team. This group facilitates the assessment process: identifying the assessment team members, planning the administration of the assessment tool, reaching consensus on the assessment results, mapping the assessment results to the maturity model, and conducting action planning based on the assessment results. At a minimum, oversight team members should have a working understanding and knowledge of HIS, the use of digital technology in HIS, and HIS interoperability. It is also important for the assessment oversight team to have a firm understanding of the HIS context in the country.

### **Step 4. Conduct a desk review.**

The oversight team conducts a desk review to get a better understanding of the HIS context in the country, to know who the key players are, and to collect documents that can verify responses when the assessment tool is administered. Brainstorming can also help to refine the scope of the assessment and inform who should be part of the assessment team (Step 5). The desk review is guided by the assessment tool's domains and subdomains, which require knowledge of the existence or absence of specific documents. For example, in the "data ethics" subdomain, the oversight team may want to investigate the existence of documents that guide health data security and privacy processes in the country and in the MOH.

### **Step 5. Assemble the assessment team.**

One of the tasks of the oversight team is to identify and select the assessment team members. The assessment team's main responsibility is to respond to the assessment tool. Given the wide range of topics in the maturity model and the assessment tool, a variety of stakeholders are needed to complete the assessment tool accurately and fully. The oversight team should ideally work with the MOH to determine which entities need to be represented on the assessment team. The assessment team membership should extend beyond merely the personnel implementing HIS in the MOH to include representatives from other ministries that have a role in HIS interoperability, such as ministries, departments, and agencies including from information and communications technology (ICT), finance, planning, human resources, and education. For example, staff from the MOH's department responsible for human resources may need to be part of the team to respond to issues about the human resources domain. Staff who manage the MOH's funds may be critical to respond to statements about the financial management subdomain. If the scope of the assessment focuses on a subnational HIS, more team members may need to come from the subnational levels. Assessment team members can be identified from existing working groups and committees, such as a technical working group for national monitoring and evaluation, health informatics, HIS, digital health, or interoperability. Members of the assessment team could be MOH officials, representatives from development and implementing partners, donors, private health-sector representatives, civil society organizations focused on health (local and international), academia and research institutions, and health informatics institutions. Examples of whom to select for the assessment team follow, by domain:

## Leadership and governance

Representative(s) for this domain may come from the MOH, preferably those responsible for leadership in digital health, or eHealth, or HIS. This could include representatives from key HIS subsystems and relevant partners supporting the MOH to strengthen its leadership and governance or who are members of the national HIS steering committees or working groups can also participate on the assessment team. Leadership and governance structures in countries vary. Therefore, the country has the final decision on the people who are best placed to play a role in the assessment for this domain.

## Human resources

Representatives for this domain may come from the MOH department responsible for staffing the HIS division; health personnel associations, such as the Nursing Council, medical professional boards, and health informatics associations; and representatives of the civil service and Ministry of Labor. Assessment team members for this domain should have a grasp of the issues articulated in the human resources domain of the maturity model.

## Technology

Representatives for this domain should come from the relevant government ministry: for example, the Ministry of Information and Communications Technology or National IT Authority. This domain may also require representation from implementing partners supporting the MOH with ICT for health and health informatics. Experts in HIS, with knowledge of HIS enterprise architecture, data management processes, and data exchange standards, are likewise critical.

## Step 6. Collect data (as part of the assessment workshop).

It is preferable that the data collection, data analysis, and action planning steps of the assessment are conducted in a workshop setting. As part of the workshop, the oversight team orients the assessment team to the purpose of the assessment, its objectives, and the assessment process.

The assessment process then starts with each member of the assessment team completing the assessment tool individually, responding to as many sections as possible. Some members of the assessment team may not be able to complete the assessment for all subdomains, because they may not have all the information needed. An alternative method to individuals completing the assessment tool is to break the assessment team into smaller groups that discuss and answer the assessment tool questions together. Moreover, if there are assessment team members who cannot attend the assessment workshop, they can fill in the assessment tool and make comments explaining their answers before the workshop. The oversight team can incorporate their responses in the discussions and the results.

Second, assessment team members discuss the individual or small group results and come to a consensus on the responses to each statement in the assessment tool. The oversight team leads the discussion, facilitating dialogue among team members to reach agreement on the final responses for all subdomains. These results are used to determine the level of maturity for each subdomain and domain, and the overall maturity level for HIS interoperability (Step 7). The oversight team records the responses on a master copy of the assessment tool. The oversight team carefully documents the evidence and rationale for the responses for each statement. This information is helpful in developing the action plan (Step 8).

## Step 7. Analyze data (as part of the assessment workshop).

The oversight team leads the assessment team through an analysis of the responses in the assessment tool. The data analysis process steps are the following:

- a. Determine the subdomain levels using the scoring worksheet in Appendix C.
- b. Map the subdomain levels to the maturity model worksheet in Appendix D.
- c. Determine the domain levels.
- d. Determine the overall maturity level for HIS interoperability.

### Determine the subdomain levels.

Using the responses from the consensus discussion (Step 6), the assessment team determines the maturity level for each subdomain. The interoperability maturity level of the HIS is determined by the attainment of the attributes given in each level. The statements in the assessment tool are used to assess the subdomain attributes that an HIS has achieved. The letters next to each statement (A, B, C, D, E) correspond to the attributes associated with the maturity level (Table 2). For example, statements labeled A1 or A2 correspond to Level 1 (nascent); B1, B2, and B3 correspond to Level 2 (emerging) of a subdomain.

**Table 2. Matching levels and assessment statement letters**

**Level 1: "A" statements**

**Level 2: "B" statements**

**Level 3: "C" statements**

**Level 4: "D" statements**

**Level 5: "E" statements**

The assessment team determines each level type by analyzing the assessment responses using the scoring worksheet shown in Appendix C. The worksheet provides instructions to determine each level type. Answers to frequently asked questions about the scoring are provided in Table 3.

### Current level

A subdomain's current level is the level at which all attributes for that level and the preceding levels have been achieved. There are a few exceptions to this rule. In most cases, Level 1 attributes (A statements) indicate that a process is absent or nascent. For that reason, the "A" statements should not be checked off in the assessment tool when an HIS has fulfilled some attributes for Level 2 or beyond. Moreover, a few subdomains have Level 2 attributes that do not necessarily need to be in place to be at Level 3 or higher. Some countries may have attained some attributes for levels higher than their current level. A plus sign (+) is added to the level number to indicate that progress has been made in attributes at levels other than the current level.

### Other levels fully achieved

During the analysis, the assessment team may notice that all attributes of a level or two beyond the “Current level” may have been achieved (meaning the assessment team marked all attributes for a level or two beyond the current level). For example, an HIS might currently be at Level 2 for a specific subdomain, because it has not met any of the attributes for Level 3. However, the HIS may have all attributes for Level 4 of that subdomain. This would mean that the HIS has fully achieved Level 4 even if its current level in the model is 2. If an HIS has all attributes for levels above the current level achieved, put the number of that level in the “other levels fully achieved column.”

### Levels partially achieved

The level for a subdomain might be Level 3, but it has one of the two attributes in Level 4. “Levels partially achieved” are levels beyond the current maturity level in which an HIS has met some of the attributes (meaning the assessment team marked some statements for that level in the assessment tool). For example, the current level for the subdomain might be Level 3, but the HIS has achieved one of the two attributes in Level 4. Level 4 would be considered partially achieved. Therefore put “4” in the “Levels partially achieved” column.

## Map the subdomain levels to the maturity model template.

To visually display the interoperability status of an HIS across the levels of maturity for each subdomain, the results from the worksheet in Appendix C are used. The oversight team facilitates the process of mapping the results to the maturity model worksheet (Appendix D). Mapping is done by shading in the attribute boxes for each subdomain according to the instructions below. The purpose of shading the maturity model is to show the HIS interoperability levels that have been attained, either in full or partially. See the example in the textbox that begins on page 21.

1. Shade in green all attribute boxes up to and including the current level box for each subdomain. For example, if the current level of a subdomain is 3, shade the boxes in green for Levels 1 through 3. All subdomains will at least have Level 1 shaded in green because all countries progress through Level 1 at some point in the process of strengthening HIS interoperability. Countries can shade Level 1 even if they do not have any of the Level 1 attributes.
2. Shade in green all levels **fully** achieved to indicate that all attributes of this level have been achieved (noted in the scoring worksheet).
3. Shade in yellow all levels **partially** achieved to indicate that some attributes of that level have been achieved.
4. Write the current level in the “subdomain level” column. See Figure 7 for an example of shading in the subdomain row, with subdomain score.
5. Repeat these steps for each subdomain. When this is done for all subdomains, the completed maturity model worksheet should have at least one box shaded for each subdomain assessed.

**Table 3. Frequently asked questions about subdomain level scoring and shading**

## Frequently asked questions

**Question: Some levels have more than one statement to assess a subdomain. What do you do when an HIS has attained only some of the attributes of a level?**

Answer: A subdomain level has been reached when the HIS has achieved all attributes for that level and achieved the levels below it (see Appendix C for more detailed instructions). If the assessment team selects some attributes for a subdomain level above its current level, it will put a "+" after the level number, indicating that the HIS has started making progress on other levels. The assessment team notes on the worksheet in Appendix C the levels that have been fully or partially achieved. For example, if the assessment team marks all Level 2 and 3 attributes for a subdomain, and also checks off some of the Level 4 attributes, the subdomain's current level is "3+," and "4" is listed as a partially achieved level. Level 4 is shaded in yellow on the maturity model worksheet to denote partial achievement.

**Question: The assessment team has selected all Level 1 attributes for a subdomain, and all Level 2 attributes. At which level is this subdomain, given that the scoring instructions say that the Level 1 attributes should not be checked off to be Level 2?**

Answer: The oversight team should review the answers with the assessment team to determine whether Level 1 was checked off appropriately. Most likely, the check mark for the Level 1 attribute can be disregarded, meaning that the HIS current level is 2 for that subdomain.

**Question: According to the scoring instructions in Appendix C, the subdomain currently is 2 and the subdomain also has all Level 4 attributes and none of the Level 3 attributes. Why isn't the current level of the subdomain a 4?**

Answer: The path of HIS interoperability through the levels of the maturity model may be nonlinear, meaning that an HIS can accomplish some higher-level attributes before accomplishing the attributes of a lower level. Using the maturity model concept, a system is only at a certain level if it has achieved all levels below it. Therefore, in this example, the HIS is at "2+" for the subdomain, indicating that its current level is 2 but that it has begun achieving attributes in other levels. Level 4 will also be shaded green on the maturity model worksheet, showing that the HIS has achieved this level.

**Question: Why is a subdomain shaded green for Level 1 when it does not have any of the Level 1 attributes?**

Answer: The premise of a maturity model is that it describes the evolutionary process a system or an entire organization goes through in maturing its processes. Some attributes of some levels continue through to other levels, while some processes do not continue as the system or organization matures. In the HIS Interoperability Maturity Model, most attributes of Level 1 for each subdomain indicate a lack of formal processes or ad hoc processes. Therefore, an HIS may not have any Level 1 attributes, but will still have passed through that level at some point. The purpose of shading the maturity model is to show the levels the HIS has attained or is currently working on.

**Question: How should the assessment team mark the assessment if one of the statements is partially applicable in the assessment tool?**

Answer: The assessment team would not mark that statement as applicable but should note what has already been achieved in the "Evidence" column in the assessment tool so this information can be used in action planning.

## Example of how to score and shade a subdomain

This is an example of how to score a subdomain based on the assessment responses and shade the subdomain in the maturity model worksheet. Figure 5 is an example of the assessment tool filled out for the governance structure subdomain.

**Figure 5. Example of the assessment tool with the governance structure subdomain filled out**

Statements	Check if applicable	Evidence
A1. Evolving governing body for health information systems (HIS) is constituted on a case-by-case basis OR no governing body exists.	<input type="checkbox"/>	B1: Minutes of meeting are available.
B1. An HIS governing body is formally constituted.	<input checked="" type="checkbox"/>	B2: A document containing SOW for data governance was presented.
B2. The governing body has a scope of work that includes the people responsible for data governance oversight.	<input checked="" type="checkbox"/>	B3: Terms of reference technical working group are available.
B3. The governing body oversees interoperability directly or through a separate technical working group (TWG).	<input checked="" type="checkbox"/>	C1: Minutes of data governance technical committee presented
C1. The HIS governing body conducts regular meetings with stakeholder participation.	<input checked="" type="checkbox"/>	D2: The Assessment team was unanimous that HIS is government lead.
D1. The HIS governing body uses a work plan (or another tool) to monitor the implementation of HIS interoperability.	<input type="checkbox"/>	E1: The technical oversight committee is protected by an Act of Parliament.
D2. The HIS governing body is government-led. <sup>1</sup>	<input checked="" type="checkbox"/>	E3: The Assessment Team was in agreement that HIS Oversight Committee works with Eastern Africa Digital Health.
D3. The HIS governing body mobilizes resources (financial, human resources, and political) to accomplish its goals.	<input type="checkbox"/>	
E1. The HIS governing body is legally protected from interference or organizational changes.	<input checked="" type="checkbox"/>	
E2. The HIS governing body and its TWGs are nationally recognized as the lead for HIS interoperability.	<input checked="" type="checkbox"/>	
E3. The governing body works in liaison with other similar working groups regionally and/or around the world.	<input checked="" type="checkbox"/>	

<sup>1</sup> Government-led: When one or more government agencies manage the calendar of events, exercise leadership by chairing meetings, maintaining records of meetings, and following up on the implementation of actions.

Using the responses in the assessment tool (Figure 5), Figure 6 shows how to fill out the worksheet for the governance structure subdomain. The current level is 3+, because—according to the scoring instructions for this subdomain—the HIS needs all Level 2 and 3 attributes (B1, B2, B3, and C1) to be at Level 3. Some of the attributes for Levels 4 and 5 have also been achieved. For Level 5, all attributes (E1, E2, E3) have been checked off, so Level 5 is listed in the “other levels fully achieved” column. The HIS has achieved one of the three attributes for Level 4 (D2), so Level 4 is listed in the “levels partially achieved” column.

**Figure 6. Sample worksheet filled out for the governance structure for HIS**

Subdomain	Current level scoring instructions	Current level	Other levels fully achieved	Levels partially achieved
Governance structure for HIS	Level 1: Checked all "A" statements only Level 2: Checked all "B" statements and did not check "A" statements	3+	5	4
Interoperability guidance documents				
Compliance with data exchange standards				
Data ethics				

The completed worksheet is used to shade the maturity model template. Figure 7 shows the shaded attribute boxes for the governance structure for HIS subdomain using the completed worksheet. The attribute boxes 1, 2, and 3 are shaded green, because the current level of the HIS is 3. The attribute box for Level 5 is shaded green, because the HIS has achieved all attributes for Level 5. The attribute box for Level 4 is shaded yellow, because one attribute for this level has been achieved. "3+" is written in the right-hand column, because it is the current level for the subdomain.

**Figure 7. Example of shading in the subdomain row, with subdomain score**

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	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 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+

Determine the domain levels.

A domain's maturity level is determined using the scores of respective subdomains. For a domain to be at a certain maturity level, all of its subdomains must be at or above that level. Figure 8 provides an example from the human resources domain. This domain's level is 2, because the subdomains are Level 2 or higher. The score is written in the last row of the domain.

**Figure 8. Sample human resources subdomains and domain level**

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.	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.	3
	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.	2
<b>Maturity level of Human Resources domain:</b>							<b>2</b>

Determine the overall maturity level for HIS interoperability.

The domain levels are used to determine the overall maturity level for HIS interoperability. The interoperability maturity level of an HIS means that all domains are at or above that level. Appendix E provides an example. The overall maturity level for the HIS is 2, because all domains are at Level 2 or higher.

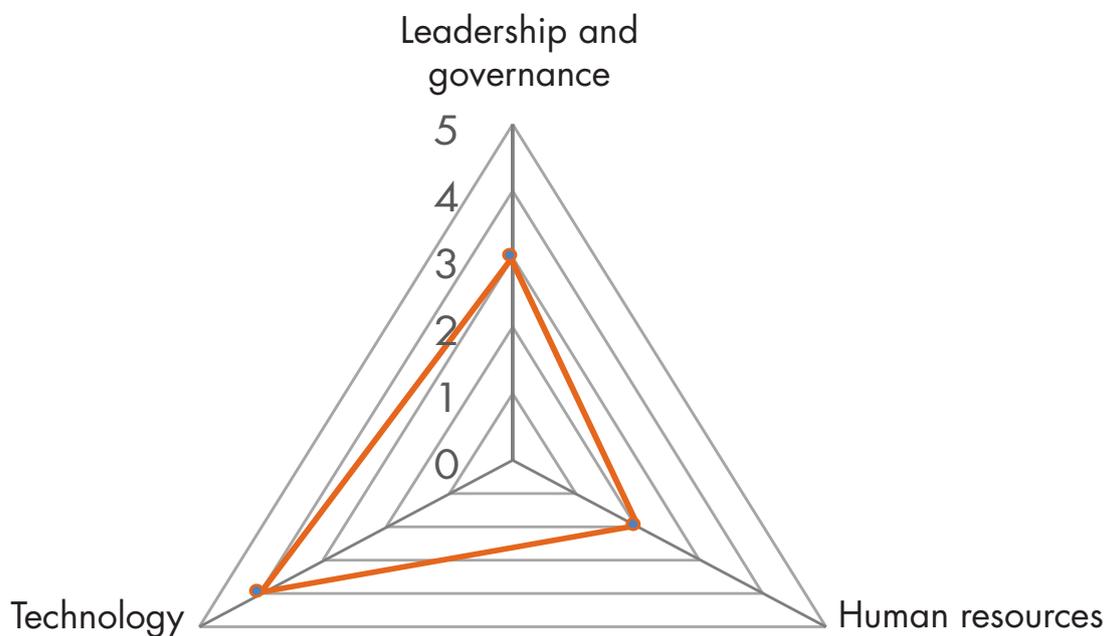
## Validate the subdomain and domain levels.

The oversight team reviews the levels with the assessment team as part of the assessment workshop. The purpose is to validate the assessment results and ensure that they reflect the status of HIS interoperability.

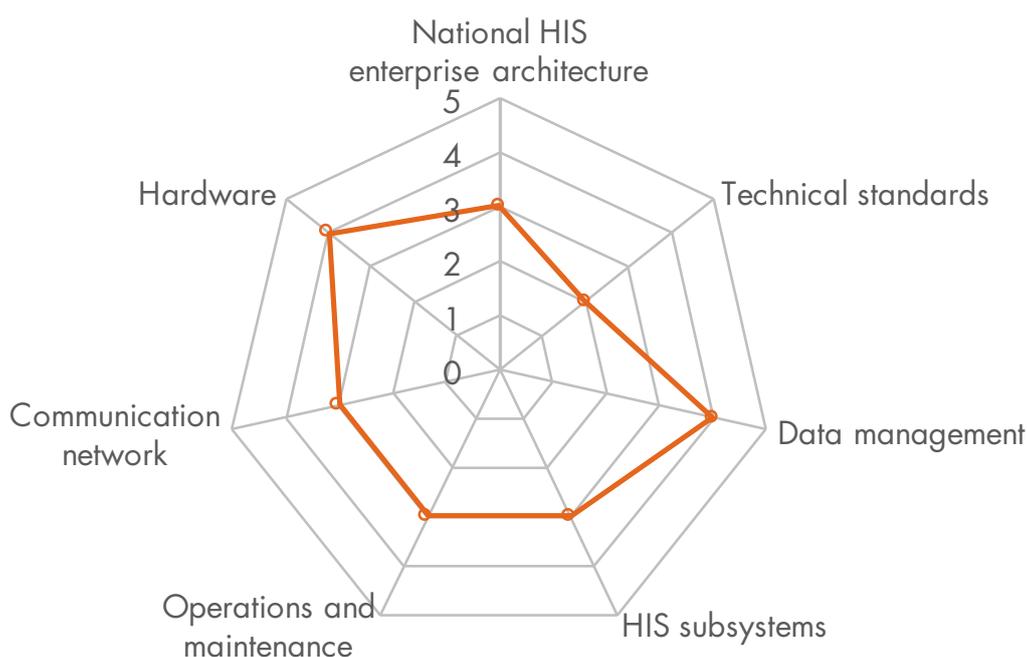
### Other presentation options

In addition to the completed maturity model template with its green and yellow shading, the oversight and assessment teams may choose to illustrate the results for all subdomain and domain levels using different types of graphs. In Figures 9 and 10, we present an example of how radar or spider graphs can be used. A radar graph can be used to show the overall results at the three domains (Figure 9) and for all subdomains in each domain (Figure 10). The radar graphs provide a visual aid to show areas of strength and weakness in HIS interoperability. Points closer to the center of the graph show the areas in need of improvement, whereas points further away from the center indicate areas of strength.

**Figure 9. Sample radar graph for domains**



**Figure 10. Sample radar graph for the technology domain**



## Step 8. Action planning (as part of assessment workshop)

After the assessment has been completed and the results mapped to the maturity model worksheet and validated by the assessment team, the processes of interpretation and translation of results can begin.

The effective use of the findings requires identifying the right individual or institution, the right people or office, and the right stakeholders to implement the action. The action planning process includes discussion of the meaning of the results, especially the areas that should be improved, and allocating responsibilities to individuals and or institutions with clear implementation timelines. Although involving the assessment team is a good start for action planning, there may be other stakeholders who may not have been part of the assessment, such as donors and other implementing partners working in eHealth or HIS, who could be engaged. Some questions to guide the discussion could be:

- In which subdomains are we particularly strong?
- In which subdomains do we need to improve?
- Which subdomains would we like to improve? How do these subdomains align with existing strategies and frameworks for digital health or eHealth in the country? In which attributes of the subdomain do we need to plan interventions?
- Looking at the overall dimension spider graphs, how did we perform in each domain?
- What resources (e.g., human, political, financial) do we need to progress to higher levels for our target subdomains?
- What action steps can we take to address the priority areas for improvement?
- If we are using data from two time points, which subdomains and domains have shown improvement? Which have declined? Where do we still need improvement?

In designing the action plan, the oversight team, assessment team, and other stakeholders can use the maturity model as the roadmap for strengthening HIS interoperability, because it lays out the path for progressing through the subdomains. For example, if an HIS is at Level 2 for the human resource policy subdomain and the goal is to progress to Level 4, its action plan should include means of achieving attributes of Levels 3 and 4. Prioritization of items for inclusion in the action plan should be done through consensus and should contain, at a minimum, the action/activity(ies), the timeframe for completion, resources needed to implement the action/activity(ies), and responsible person(s) or organization(s).

The MOH can use the identified gaps and respective actions to advocate allocation of resources in several ways. The MOH can solicit resources to develop certain components of the HIS, modify existing work plans with implementing partners, or advocate that the government provide additional resources needed to address identified gaps.

Many resources are available to guide the implementation of HIS and digital health. The HDC DH&I Working Group developed mapping tool that maps existing tools and resources in HIS and digital health to the subdomains of the HIS Interoperability Maturity Model. This resource was created so that countries looking for interventions to strengthen specific subdomains within the maturity model could refer to existing resources for information and guidance. This resource is available on the toolkit's webpage and can also be found at this link: <https://www.measureevaluation.org/resources/publications/tl-18-17>. MEASURE Evaluation has also collated a searchable database of assessment tools that evaluate the components of the HIS in its Health Information Systems Strengthening Resource Center here: <https://www.measureevaluation.org/his-strengthening-resource-center>. The HIS Assessment Tool database is available here: <https://www.measureevaluation.org/his-strengthening-resource-center/his-assessment-tools>. Another resource to supplement this toolkit is under development: an HIS assessment tools reference guide. This resource maps the HIS tools to the domains of this maturity model. The guide will be useful to countries looking for ways to move certain subdomains forward.

After developing the action plan, the oversight team and assessment team can decide whether and when they will repeat the HIS interoperability maturity assessment to monitor changes.

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# APPENDIX A

## PARTICIPANTS IN THE TOOLKIT DEVELOPMENT AND REVIEW MEETINGS



### Kenya

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Dr. Anthony Ofofu	Ghana Health Service
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Gordon Yowaa	Infotech Systems
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# APPENDIX B GLOSSARY



Domain	Subdomain	Contextual Definition	References
Leadership and Governance	<b>Governance structure for the health information system (HIS)</b>	The exercise of technical, political, and administrative authority to manage national HIS affairs at all levels of a country's health system. The governance structure consists of the mechanisms, processes, and institutions through which actors and stakeholders articulate their interests, exercise their rights, meet their obligations, mediate their differences, and oversee the functioning of the HIS.	Adapted from the United Nations definition of governance <a href="http://unpan1.un.org/intradoc/groups/public/documents/un/unpan022332.pdf">http://unpan1.un.org/intradoc/groups/public/documents/un/unpan022332.pdf</a>
	<b>Interoperability guiding documents</b>	The documents (policies, strategies, and frameworks) that guide decisions, implementation, and the course of action for HIS interoperability. They are important reference materials for stakeholders who are developing the HIS from its current status to a mature status.	Definition from Kenya stakeholders who participated in toolkit development
	<b>Compliance</b>	Adherence to organizational policies, procedures, and best practices related to HIS, including standards for data exchange, messaging, and security. It also means adherence to applicable laws, relevant industry standards, and internal policies (e.g., codes of conduct).	Adapted from the ISO definition <a href="https://www.iso.org/news/2014/12/Ref1919.html">https://www.iso.org/news/2014/12/Ref1919.html</a>
	<b>Data ethics</b>	Data ethics addresses the moral dimensions of data management. This includes ensuring adherence to ethical principles throughout data generation, recording, curation, processing, dissemination, sharing, and use. Ethical practices should strive to ensure respect for the people behind the data; use of data in accordance with the intentions of the disclosing party; matching privacy and security safeguards to the expectation of individuals and populations from whom data are drawn; and following the law regarding personal health data privacy and security. These practices are also sometimes referred to as responsible data practices.	Definition adapted and modified from <a href="https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5124072/">https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5124072/</a>  Additional insights from <a href="https://www.accenture.com/us-en/insight-data-ethics">https://www.accenture.com/us-en/insight-data-ethics</a>
	<b>HIS interoperability monitoring and evaluation</b>	Use of indicators/attributes from the maturity model to facilitate the tracking of inputs, processes, and outputs against desired results of HIS interoperability implementation, and using these data to make decisions.	Authors' definition
	<b>Business continuity</b>	Business continuity is the capability of the organization to continue the delivery of products or services at acceptable predefined levels following a disruptive incident. Business continuity is about devising plans and strategies that enable an organization to continue business operations, and enable it to recover quickly and effectively from any type of disruption, whatever its size or cause. Interoperability will not function as intended if the HIS and all its components do not function correctly. Therefore, business continuity of the national HIS is imperative for continuity of strong interoperability services of HIS. This includes putting in place systems for data recovery, continuity of healthcare, continuous flow of funding, staff transition plans, etc.	Source: ISO Standard 22301:2012 <a href="https://www.iso.org/standard/50038.html">https://www.iso.org/standard/50038.html</a>
	<b>Financial management</b>	The legal and administrative systems and procedures put in place permitting a government ministry and its agencies and organizations to conduct activities that ensure the correct use of public funds, and which meet defined standards of probity and regularity. Activities include management and control of public expenditures, financial accounting, reporting, and asset management, in some cases.	Adapted from OECD <a href="https://stats.oecd.org/glossary/detail.asp?ID=4782">https://stats.oecd.org/glossary/detail.asp?ID=4782</a>
	<b>Financial resource mobilization</b>	All activities involved in securing new and additional financial resources for an organization (in this case, the HIS). It also involves making better use of and maximizing existing financial resources.	Health Communication Capacity Collaborative <a href="https://healthcommcapacity.org/resource-mobilization-important/">https://healthcommcapacity.org/resource-mobilization-important/</a>

Domain	Subdomain	Contextual Definition	References
Human Resources	<b>Human resources policy</b>	A set of principles, guidelines, and norms that an organization adopts to help manage its employees.	Human Resources Professionals Association <a href="https://www.hrpa.ca/Pages/SearchResults.aspx?k=Human%20Resource%20Policy">https://www.hrpa.ca/Pages/SearchResults.aspx?k=Human%20Resource%20Policy</a>
	<b>Human resources capacity (skill set and numbers)</b>	Availability of adequate personnel with characteristics, attributes, and capabilities to perform a task/set of tasks to achieve clearly defined results.	Human Resources Professionals Association <a href="https://www.hrpa.ca/Pages/SearchResults.aspx?k=Human%20Resource%20Policy">https://www.hrpa.ca/Pages/SearchResults.aspx?k=Human%20Resource%20Policy</a>
	<b>Human resource capacity development</b>	An organized activity with clear learning outcomes that aims to impart knowledge and skills, shape attitudes, and develop specific competencies and capabilities in personnel.	Human Resources Professionals Association <a href="https://www.hrpa.ca/Pages/SearchResults.aspx?k=Human%20Resource%20Policy">https://www.hrpa.ca/Pages/SearchResults.aspx?k=Human%20Resource%20Policy</a>

Domain	Subdomain	Contextual Definition	References
Technology	<b>National HIS enterprise architecture</b>	Enterprise architecture is a method and an organizing principle that aligns functional business objectives and strategies with an information technology (IT) strategy and execution plan. A national enterprise architecture for an HIS defines how HIS subsystems interact and exchange data, and shows the necessary services for that data exchange, such as an interoperability services layer.	Oracle Technology Network <a href="http://www.oracle.com/technetwork/topics/entarch/whatsnew/index.html">http://www.oracle.com/technetwork/topics/entarch/whatsnew/index.html</a>
	<b>Technical standards</b>	An established norm based on a set of requirements, specifications, guidelines, or characteristics that can be used consistently to ensure that digital health systems, health information services, and processes are appropriate for their purpose. Standards provide a common language and set of expectations that enable interoperability among systems and/or devices. The technical standards include standards for data exchange, transmission, messaging, security, privacy, and hardware.	Adapted from ISO.org and <a href="http://www.himss.org/library/interoperability-standards/standards-101">http://www.himss.org/library/interoperability-standards/standards-101</a>
	<b>Data management</b>	Data management consists of the development, execution, and supervision of plans, policies, programs, and practices that control, protect, deliver, and enhance the value of data and information assets for decision making. Data management includes procedures on how data are captured, stored, analyzed, transmitted, and packaged for use across the data supply chain.	MEASURE Evaluation <a href="https://www.measureevaluation.org/resources/publications/ms-15-99">https://www.measureevaluation.org/resources/publications/ms-15-99</a>
	<b>HIS subsystem</b>	A system that collects one or more of the data sources in a national HIS. Examples include routine HIS, health management information systems, civil registration and vital statistics systems, logistics management information systems, and human resource information systems.	MEASURE Evaluation <a href="https://www.measureevaluation.org/his-strengthening-resource-center/his-definitions">https://www.measureevaluation.org/his-strengthening-resource-center/his-definitions</a>
	<b>Operations and maintenance (for computer technology)</b>	A set of procedures to ensure a high uptime for computer hardware, software, and network resources.	Authors' definition
	<b>Communication network (LAN/WAN)</b>	A communication network is several computers linked together to allow them to share resources. Networked computers can share hardware, software, and data. Most computer networks have at least one server. A local area network (LAN) and a wide area network (WAN) are typically distinguished by the geographical coverage of the network, with a LAN usually covering and offering services to a relatively small geographical area as compared to a WAN.	Cisco Press.com <a href="http://www.ciscopress.com/articles/article.asp?p=2158215&amp;seqNum=6">http://www.ciscopress.com/articles/article.asp?p=2158215&amp;seqNum=6</a>
	<b>Hardware</b>	An assembly of tangible physical parts of a system of computers, including servers and virtual private networks that provide services to a user in the HIS.	Cisco Press.com <a href="http://www.ciscopress.com/articles/article.asp?p=2158215&amp;seqNum=6">http://www.ciscopress.com/articles/article.asp?p=2158215&amp;seqNum=6</a>

## OTHER DEFINITIONS

Term	Definition	References
<b>Health Information System</b>	Encompasses all health data sources required by a country to plan and implement its national health strategy. An HIS combines vital and health statistical data from multiple sources to derive information and make decisions about the health needs, health resources, costs, uses, and outcomes of healthcare. Examples of data sources are electronic health records for patient care, health facility data, surveillance data, census data, population surveys, vital event records, human resource records, financial data, infrastructure data, and logistics and supply data.	Adapted from MEASURE Evaluation, Defining Health Information Systems <a href="https://www.measureevaluation.org/his-strengthening-resource-center/his-definitions">https://www.measureevaluation.org/his-strengthening-resource-center/his-definitions</a>
<b>Data Stewardship</b>	Health data stewardship is a responsibility that is guided by principles and practices. It assures the knowledgeable and appropriate use of data derived from individuals' personal health information. The uses include (but are not limited to) data collection, viewing, storage, exchange, aggregation, and analysis. A central concept of data stewardship is accountability, which resides in a named data steward who has formal responsibility for assuring the appropriate use of health data, and with liability for inappropriate use.	<a href="https://www.ncvhs.hhs.gov/wp-content/uploads/2014/05/090930lt.pdf">National Committee on Vital and Health Statistics. https://www.ncvhs.hhs.gov/wp-content/uploads/2014/05/090930lt.pdf</a>
<b>Governance</b>	Determining who makes decisions about what issues, who has input into decisions, and how to hold entities accountable. Data governance is a system of decision on rights and accountabilities for information-related processes, executed according to agreed-upon models that describe who can take what actions with what information and when, under what circumstances, and using what methods.	Adapted from Healthcare Information and Management Systems Society <a href="http://www HIMSS.org/news/effective-it-governance-needed-successful-clinical-informatics-implementations">http://www HIMSS.org/news/effective-it-governance-needed-successful-clinical-informatics-implementations</a> and The Data Governance Institute <a href="http://www.datagovernance.com/">http://www.datagovernance.com/</a>
<b>Interoperability</b>	The ability of two or more information systems or components to exchange information based on standards and to use the information that has been exchanged. Interoperability enables the HIS to work together within and across organizational boundaries and to advance the health status and the effective delivery of healthcare for individuals and communities.	HIMSS. (2013, April 5). Definition of Interoperability. Retrieved from: <a href="http://www HIMSS.org/sites/HIMSSorg/files/FileDownloads/HIMSS%20Interoperability%20Definition%20FINAL.pdf">http://www HIMSS.org/sites/HIMSSorg/files/FileDownloads/HIMSS%20Interoperability%20Definition%20FINAL.pdf</a> .
<b>Maturity Model</b>	Measures the "as is" status of a process or set of processes, and describes the critical components of a process believed to lead to improved outcomes. The model usually has a certain number of levels that describe the evolution of these processes.	Adapted from: Institute of Internal Auditors. (2013). <i>Selecting, using, and creating maturity models: a tool for assurance and consulting engagements</i> . Altamonte Springs, Fla.: Institute of Internal Auditors. <a href="https://www.iaa.org.uk/media/358857/selecting_using_and_creating_maturity_models_-_a_tool_for_assurance_and_consulting_engagements.pdf">https://www.iaa.org.uk/media/358857/selecting_using_and_creating_maturity_models_-_a_tool_for_assurance_and_consulting_engagements.pdf</a>
<b>Digital Health and Digital HIS</b>	Digital health is the use of digital, mobile, and wireless technologies to support the achievement of health objectives. Digital health describes the general use of information and communication technologies for health. It includes both mHealth and eHealth. Digital HIS is an electronic information system for the management of health information.	WHO. (2016). <i>Monitoring and evaluating digital health interventions: a practical guide to conducting research and assessment</i> . Geneva: WHO. Retrieved from <a href="http://apps.who.int/iris/bitstream/10665/252183/1/9789241511766-eng.pdf">http://apps.who.int/iris/bitstream/10665/252183/1/9789241511766-eng.pdf</a> .
<b>Interoperability Services Layer</b>	An interoperability layer is a system that enables easier interoperability between disparate information systems by connecting all of the infrastructure services and client applications together. In the HIS enterprise architecture context, these systems are HIS subsystems such as a client registry, provider registry, facility registry, shared health record, and terminology service. An interoperability layer receives transactions from client systems, coordinates interaction between components of the HIE, and provides common core functions to simplify the interoperability between systems.	Adapted from OpenHIE Interoperability Layer Community <a href="https://wiki.ohie.org/display/SUB/Interoperability+Layer+Community">https://wiki.ohie.org/display/SUB/Interoperability+Layer+Community</a>

# APPENDIX C SUBDOMAIN LEVELS SCORING WORKSHEET



Use this worksheet to conduct Step 7 (data analysis) for the HIS interoperability maturity assessment process. The worksheet analyzes the data (responses) in the assessment tool.

## Instructions

Complete the information in the three tables below using the following instructions. Each table has three columns on the right-hand side to fill in. These columns are labeled “Current level,” “Other levels fully achieved,” and “Levels partially achieved.” The instructions in this worksheet refer to the lettered statements in the assessment tool. The letters next to the statements (A, B, C, D, E) correspond to the attributes associated with the maturity level (Table 4). Statements labeled A1 or A2 correspond to Level 1; B1, B2, and B3 correspond to Level 2 of a subdomain; and so forth. Therefore, when the instructions refer to “attributes” of a level, they are referring to the statements for that level in the assessment tool. For an example of how to fill in the worksheet using the assessment responses, see the text box that begins on page 21.

**Table 4. Matching levels and assessment statement letters**

- Level 1: “A” statements**
- Level 2: “B” statements**
- Level 3: “C” statements**
- Level 4: “D” statements**
- Level 5: “E” statements**

## Current Level

A subdomain's current level is the level at which all attributes for that level and the preceding levels have been achieved. There are a few exceptions to this rule. In most cases, Level 1 attributes (A statements) indicate that a process is absent or nascent. For that reason, the "A" statements should not be checked off in the assessment tool when a country has fulfilled some attributes for Level 2 or beyond. There are a few other exceptions that create the three scoring scenarios below. For example, a few subdomains have Level 2 attributes that do not need to be in place to be at Level 3 or higher. The scoring for these scenarios is described below in each of the tables. To determine the level of HIS interoperability for each subdomain, do the following:

1. Use the instructions in the "Current level scoring" column to determine which levels have been achieved. There are three scoring scenarios for the subdomains represented by the three tables in the worksheet. **Please read the instructions for each scenario, because they differ among the subdomains and do not all follow the same pattern.**
2. For some of the subdomains, it is possible to fulfill some attributes (indicated by checking some but not all statements for that level in the assessment) for levels higher than the current level. If an HIS has achieved some attributes for levels above the current level, place a "+" after the level number, indicating that it is in progress on other levels.
3. Write the current level in the "current level" column for each subdomain.
4. If you have questions about scoring, please refer to Table 3 (frequently asked questions) in this users' guide.

## Other Levels Fully Achieved

During the analysis, the assessment team may notice that the HIS has achieved all attributes of a level or two beyond the "Current level" (meaning the assessment team marked all the attributes for a level or two beyond the current level). For example, HIS interoperability may currently be at Level 2 because it has not met any of the attributes for Level 3. However, the HIS does have all the attributes for Level 4. This would mean that the HIS has fully achieved Level 4 even if its current level in the model is 2+. If an HIS has all attributes for levels above the current level achieved, put the number of that level in the "other levels fully achieved" column. See the text box that begins on page 21 for an example.

## Levels Partially Achieved

"Levels partially achieved" are levels beyond the current maturity level in which an HIS has met some of the attributes (meaning the assessment team marked some statements for that level in the assessment tool). For example, the current level for a subdomain might be Level 3, but the HIS has achieved one of the two attributes in Level 4. Level 4 would be considered partially achieved. Therefore put "4" in the "Levels partially achieved" column. See the text box that begins on page 21 for an example.

After completing this worksheet, use the instructions in this users' guide on how to map the results to the HIS interoperability maturity model and use the results in action planning.

**Table 5. Scoring Scenario 1**

Subdomain	Current level scoring instructions	Current level	Other levels fully achieved	Levels partially achieved
Governance structure for HIS	Level 1: Checked all "A" statements only  Level 2: Checked all "B" statements and did not check "A" statements  Level 3: Checked all "B" and "C" statements and did not check "A" statements  Level 4: Checked all "B," "C," and "D" statements and did not check "A" statements  Level 5: Checked all "B," "C," "D," and "E" statements and did not check "A" statements			
Interoperability guidance documents				
Compliance with data exchange standards				
Data ethics				
HIS interoperability monitoring and evaluation				
Business continuity				
Financial management				
Human resources policy				
Human resource capacity development				
Technical standards				
Data management				
Communication network				

**Table 6. Scoring Scenario 2**

Subdomain	Current level scoring instructions	Current level	Other levels fully achieved	Levels partially achieved
Financial resource mobilization	Level 1: Checked all "A" statements only  Level 2: Checked all "B" statements and did not check "A" statements  Level 3: Checked all "C" statements and did not check "A" and "B" statements  Level 4: Checked all "C," and "D" statements and did not check "A" and "B" statements  Level 5: Checked all "C," "D," and "E" statements and did not check "A" and "B" statements			
Human resources capacity				
HIS subsystems				
Operations and maintenance				
Hardware				

**Table 7. Scoring Scenario 3**

Subdomain	Current level scoring instructions	Current level	Other levels fully achieved	Levels partially achieved
National HIS enterprise architecture	Level 1: Checked all "A" statements only  Level 2: Checked all "B" statements and did not check "A" statements  Level 3: Checked all "C" statements and "B1" and did not check "A" and "B2" statements  Level 4: Checked all "C," and "D" statements and "B1" and did not check "A" and "B2" statements  Level 5: Checked all "C," "D," and "E" statements and "B1" and did not check "A" and "B2" statements			

# APPENDIX D

## HEALTH INFORMATION SYSTEMS INTEROPERABILITY MATURITY MODEL WORKSHEET



HEALTH INFORMATION SYSTEMS INTEROPERABILITY MATURITY MODEL WORKSHEET							
Domain	Subdomain	Level 1: Nascent	Level 2: Emerging	Level 3: Established	Level 4: Institutionalized	Level 5: Optimized	Subdomain Level
Leadership and Governance	Governance structure for HIS	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.	
	Interoperability guidance documents <sup>1</sup>	Evolving governing body for health information systems (HIS) is constituted on a case-by-case basis OR no governing body exists.	His interoperability guidance documents are absent, and HIS interoperability is implemented on a case-by-case basis.	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 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.

<sup>1</sup> The approved documents (policies, strategies, and frameworks) that guide HIS and digital health/eHealth work in a country

Domain	Subdomain	Level 1: Nascent	Level 2: Emerging	Level 3: Established	Level 4: Institutionalized	Level 5: Optimized	Subdomain Level
Leadership and Governance	<b>Compliance with data exchange standards</b>	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.	
	<b>Data ethics</b>	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.	
	<b>HIS interoperability monitoring and evaluation</b>	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.	
	<b>Business continuity</b>	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.	

Domain	Subdomain	Level 1: Nascent	Level 2: Emerging	Level 3: Established	Level 4: Institutionalized	Level 5: Optimized	Subdomain Level
<b>Leadership and Governance</b>	<b>Financial management</b>	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.	
	<b>Financial resource mobilization</b>	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.	
<b>Maturity level of Leadership and Governance domain:</b>							

Domain	Subdomain	Level 1: Nascent	Level 2: Emerging	Level 3: Established	Level 4: Institutionalized	Level 5: Optimized	Subdomain Level
<b>Human Resources</b>	<b>Human resources policy</b>	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.	
	<b>Human resources capacity (skills and numbers)</b>	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.	
	<b>Human resource capacity development</b>	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.	
<b>Maturity level of Human Resources domain:</b>							

Domain	Subdomain	Level 1: Nascent	Level 2: Emerging	Level 3: Established	Level 4: Institutionalized	Level 5: Optimized	Subdomain Level
Technology	<b>National HIS enterprise architecture</b>	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.	
	<b>Technical standards<sup>2</sup></b>	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 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.	

<sup>2</sup> 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	<b>Data management<sup>3</sup></b>	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.	
	<b>HIS subsystems</b>	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.	
	<b>Operations and maintenance (for computer technology)</b>	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.	

<sup>3</sup> 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	<b>Communication network: local area network (LAN) and wide area network (WAN)</b>	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.	
	<b>Hardware</b>	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.	
<b>Maturity level of Technology domain:</b>							

# APPENDIX E

## EXAMPLE OF A COMPLETED HIS INTEROPERABILITY MATURITY MODEL WORKSHEET



HEALTH INFORMATION SYSTEMS INTEROPERABILITY MATURITY MODEL WORKSHEET							
Domain	Subdomain	Level 1: Nascent	Level 2: Emerging	Level 3: Established	Level 4: Institutionalized	Level 5: Optimized	Subdomain Level
Leadership and Governance	Governance structure for HIS	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.	3+
	Interoperability guidance documents <sup>1</sup>	Evolving governing body for health information systems (HIS) is constituted on a case-by-case basis OR no governing body exists.	His interoperability guidance documents are absent, and HIS interoperability is implemented on a case-by-case basis.	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 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.

<sup>1</sup> The approved documents (policies, strategies, and frameworks) that guide HIS and digital health/eHealth work in a country

Domain	Subdomain	Level 1: Nascent	Level 2: Emerging	Level 3: Established	Level 4: Institutionalized	Level 5: Optimized	Subdomain Level
Leadership and Governance	<b>Compliance with data exchange standards</b>	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.	3
	<b>Data ethics</b>	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.	4
	<b>HIS interoperability monitoring and evaluation</b>	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.	3
	<b>Business continuity</b>	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.	3

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.	3+
	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 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
<b>Maturity level of Leadership and Governance domain:</b>							<b>3</b>

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.	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.	3
	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.	2
<b>Maturity level of Human Resources domain:</b>							<b>2</b>

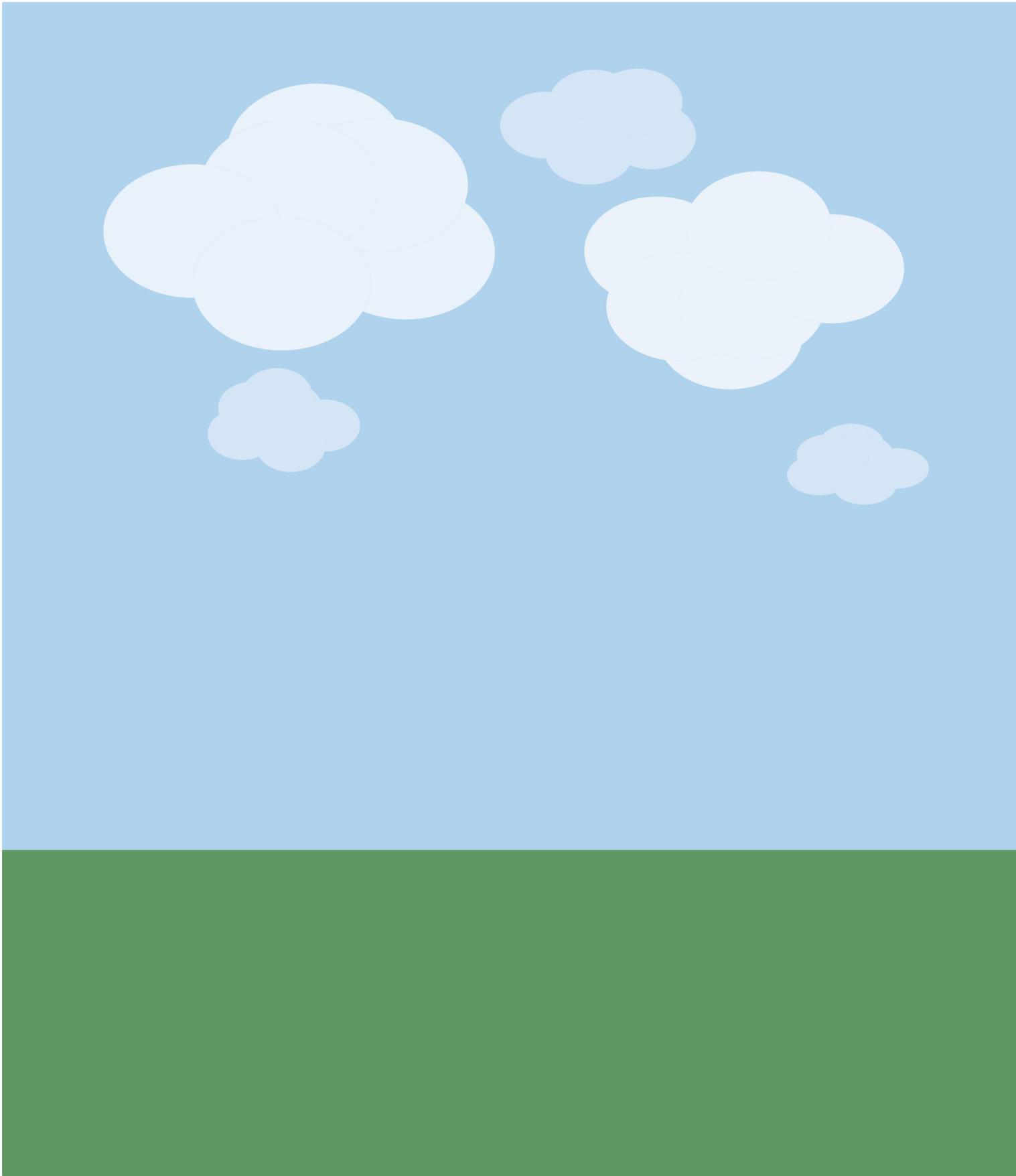
Domain	Subdomain	Level 1: Nascent	Level 2: Emerging	Level 3: Established	Level 4: Institutionalized	Level 5: Optimized	Subdomain Level
Technology	<b>National HIS enterprise architecture</b>	A national HIS enterprise architecture document defining technology requirements and data exchange formats for 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.	3
	<b>Technical standards<sup>2</sup></b>	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 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.	3+

<sup>2</sup> 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	<b>Data management<sup>3</sup></b>	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.	3+
	<b>HIS subsystems</b>	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.	3
	<b>Operations and maintenance (for computer technology)</b>	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

<sup>3</sup> 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	<b>Communication network: local area network (LAN) and wide area network (WAN)</b>	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.	3+
	<b>Hardware</b>	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
<b>Maturity level of Technology domain:</b>							<b>3</b>



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