July 2022

DIPC

Report:

DPPA

Digital Pandemic Preparedness Assessment

Sierra Leone

german cooperation
DEUTSCHE ZUSAMMENARBEIT

Implemented by
giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Published by:
Deutsche Gesellschaft für
Internationale Zusammenarbeit
(GIZ) GmbH

Registered offices:
Bonn and Eschborn
Friedrich-Ebert-Allee 32 + 36,
53113 Bonn, Germany
T +49 228 44 60-0
F +49 228 44 60-17 66

E: digital-health@giz.de
I: www.giz.de

Regional Programme Support to Pandemic Prevention (RPPP)
Damien Bishop; Amadou Traore

Sector Initiative Global Health (Health Data and Digital Health)
Division Economic and Social Development / Sectoral and Global Programmes
digital-health@giz.de / Barakissa Tien-Wahser

DIPC - Digital Innovation in Pandemic Control:
dipc@giz.de / Tessa Lennemann; Max Schumann; Julia Niklewski

Consultants GFA
Magnus Mordu Conteh; Dr. Peter Drury; Virginia Barberis

Special thanks:
Our thanks go to all stakeholders for their availability and their multifaceted contributions to the success of this evaluation.

Design and layout:
Diego Narrea Sheen

URL links
This publication contains links to external websites. Responsibility for the content of the listed external sites always lies with their respective publishers.

Cover photo:
Photo by Joshua Sortino on Unsplash

Maps:
freevectormaps.com

On behalf of
German Federal Ministry for Economic Cooperation and Development (BMZ)

GIZ is responsible for the content of this publication.

Disclaimer: The data in the publication has been collected, analysed and compiled with due care; and has been prepared in good faith based on information available at the date of publication without any independent verification. However, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH does not guarantee the accuracy, reliability, completeness or currency of the information in this publication. GIZ shall not be held liable for any loss, damage, cost or expense incurred or arising by reason of any person using or relying on information in this publication.

Bonn and Eschborn, Germany
22.07.2022

Acknowledgements

This report on the assessment of Digital Pandemic Preparedness in Sierra Leone reflects the joint effort of the expert team, and national and international partners. We would like to thank all stakeholders for their availability and their multifaceted contributions to the success of this evaluation.

In particular, our thanks go to the Ministry of Health and development partners for their guidance and input, as well as their support in conducting interview sessions and stakeholder consultation, GIZ Regional and bilateral Programmes and their development partners.

We would also like to thank all the interviewees; Dr Francis Smart (Min of Health), Dr Edward Magbinty (Min of Health), Mr Gerald Thomas (Min of Health), Mr Emile Sesay (Min of Health), Mr Mohamed Feika (Min of Health), Mr A B Rahim (Min of Health), Mr Mohamed B Swaray (Min of Health), Ms Hawanatu Dora Mansaray (Min of Health), Ms Zainab Conteh (Min of Health), Ms Gladys S Jusu (Min of Health), Dr Mugaga Malimbo (WHO), Ms Bridget Magoba (AFENET), Mr Royston Wright (UNICEF), Dr Amadou Traore (GIZ) and Mr Christian Boombu-Johnson (World Vision).

The Authors apologize to any individuals or organizations inadvertently omitted from this list.

TABLE OF CONTENTS

Figures and Tables 5
Acronyms 6
How to read this report 8
Executive summary 9
Recommendations 11

01. BACKGROUND AND OBJECTIVES 12
1.1 DPPA 13
1.2 Sierra Leone as pilot country 13

02. DPPA TOOLKIT AND METHODS 16
2.1 WP1: Preliminary Work and Stakeholders 16
2.2 WP2: Digital Health Ecosystem Analysis and EDIT tool 17
2.3 WP3: Map and Match Data and Existing digital Tools 17
2.4 WP4. DPPA Uses Cases and Mapping Process 19
2.5 WP5: Recommendations 21
2.5.1 Towards the digital health ecosystem 21
2.5.2 Concerning Pandemic Preparedness 21

03. DPPA RESULTS FOR SIERRA LEONE 22
3.1 WP1: Preliminary Works and Stakeholders 22
3.2 WP2: Analysis of the digital health ecosystem and EDIT tool 27
3.3 WP3: Opportunities 31
3.4 WP4: Gaps 33
3.5 WP5: Recommendations 35
3.5.1 Improving the digital ecosystem 35
3.5.2 Digital pandemic preparedness 37

04. SUMMARY 39
ANNEX 1: List of Primary and Secondary Stakeholders 39
ANNEX 2: Qualitative EDIT interviews 42
ANNEX 3: Detailed view of digital tool opportunities 46
ANNEX 4: Overview of gaps and opportunities of existing digital tools in Sierra Leone 56

Figures and Tables

Figure 1: Map of Sierra Leone showing the 5 regions and 16 districts
Figure 2: Functionalities of digital DPPA systems to be assessed

Table 1: Important information on the digital tools evaluated
Table 2: EDIT assessment of critical indicators for digital health
Table 3: High-level assessment of existing opportunities before the validation process
Table 4: Opportunities for the number of existing software packages to meet DPPA functionality
Table 5: List of DPPA Functionalities not available in Sierra Leone
Table 6: Stakeholder Mapping
Table 7: EDIT results
Table 8: List of Digital Tools and functional opportunities
Table 9: Overview of digital gaps and opportunities

Acronyms

AI	Artificial Intelligence
API	Application Programming Interface
ACE	Africa Coast to Europe
AFENET	African Field Epidemiology Network
BMZ	Federal Ministry for Economic Cooperation and Development
CDC	Centre for Disease Control and Prevention
DHIS2	District Health Information System version 2
DICE	Digital Centre of Excellence
DHSE	Directorate of Health Security and Emergencies
DM&EO	District Monitoring and Evaluation Officers
DPP	Digital Pandemic Preparedness
DPPA	Digital Pandemic Preparedness Assessment
EPI	Expanded Programme for Immunisation
ECOWAS	Economic Community of West African States
EDIT	Early-Stage Digital Health Investment Tool
EPRRG	Emergency Preparedness Response and Resilience Group
GFA	GFA Consulting Group
GHS	Ghana Health Service
GFA	GFA Consulting Group
GIZ	German Agency for International Development Cooperation
HIE	Health Information Exchange
HL7 FHIR	Health Level Seven Fast Healthcare Interoperability Resources
HIS	Health Information System
HISP WCA	Health information system program for West and Central Africa
HSS	Health Strengthening System
H1N1	Swine Flu
HMIS	Health Management Information System
GILMIS	Ghana Integrated Logistics Management Information System
iHRIS	Human Resources Information System
ICD-10	International Classification of Diseases version 10
ICT	Information Communication Technology
LMIS	Logistics Management Information Systems
ML	Machine Learning
MIC	Ministry of Information and Sanitation

M&E	Monitoring and Evaluation
M&M	Map and Match
MoHS	Ministry of Health and Sanitation
NGO	Non-Governmental Organisation
RPPP	Regional Programme Support to Pandemic Prevention
RH	Ressources humaines
RHS	Ressources humaines en santé
RSIMD	Research Statistics Information Management Directorate
PHC	Primary Health Care
UNICEF	United Nations International Children's Emergency Fund
UiO	University of Oslo
UN	United Nations
WHO	World Health Organisation
USAID	United States Agency for International Development
WP	Work Package

How to read this report

This report aims to provide an overview of the digital landscape of Sierra Leone, a narrative and recommendations on the country's digital preparedness level in the event of an epidemic.

The executive summary provides an overview of the report's key findings and statements.

The **methodology section explains** the setup of the prototype of the DPPA Toolkit and the processes the key actors must undergo to generate the results.

The **results of the evaluation** are elaborated in the country-specific results sections, which are subdivided into five (5) sections:

- The section **WP1 preliminary work** gives an overview of the key actors involved in this evaluation and to whom the report might be of interest.
- The **WP2 Digital Health Ecosystem** section provides an overview of the digital health ecosystem in Sierra Leone.
- The **WP3 opportunities** section represents all the potential digital tools, including digital global public goods, that could be relevant to prepare the country for a pandemic at national and rural level.
- The **WP4 gaps** section is the result of the mapping of DPPA use cases. It provides an overview of the functionalities that could be implemented in the country, with a comment on the importance of these functionalities in the country context.
- The **WP5 recommendation** section is a set of preliminary recommendations regarding the digital health ecosystem, pandemic preparedness and selected global goods that could be considered a priority by some stakeholders.

The last section is the conclusion, which summarizes the evaluation and gives a first overview of how the results have been adapted by the stakeholders.

Executive Summary

A digital pandemic preparedness assessment was conducted from November 2021 to January 2022 in Sierra Leone on a set of forty-four identified software packages.

Objective
The objective was to identify the need for digital tools that fit into Sierra Leone's existing digital health ecosystem that can modernise overall pandemic preparedness. More specifically, it was to i) assess the different functionalities of the digital health ecosystem in the country's health system; ii) identify gaps and opportunities by functionality and iii) make recommendations for action based on the analysis of each identified gap/opportunity.

Methodology
Data collection was undertaken through a literature review, a stakeholder survey and interviews, conducted according to the DPPA assessment tool.

A purposeful selection approach was adopted in selecting seven districts [out of a total of sixteen] to presumptively get a representative sample of epidemiological factors, terrain/access, stage of deployment of digital solutions and experience. This selection was made by the ICT Manager at the MoHS, who oversees all digital health deployments in the country. The Monitoring and Evaluation Officers at the districts were designated as the participants to provide the necessary input into the study survey. These officers were each then sent an email explaining the purpose of the study with the DPPA Tool attached, together with clear instructions on how to complete the relevant sections i.e., tabs A3 and A4 of the tool. These emails were then followed up with phone calls to provide further explanation/clarification for each of the participants and ensuring their understanding of how to complete the exercise. Additional follow up phone calls were also made to some participants requesting additional support.

Results
The Ministry of Health and Sanitation has DPPA functionality gaps related to the Proximity Tracing and the One Health approach. There were also some gaps in five other categories: Interoperability, Contact Tracing, Vaccine Delivery, Laboratory Systems and Health Facility Administration. In view of these identified gaps as well as opportunities, several recommendations have been made.

Recommendations
Recommendations concerning the major gaps include strengthening mobile phone communication for contact tracing and digital tracking, improved monitoring and management of animal, environment and human disease outbreaks (One Health).

Conclusion
The assessment of Sierra Leone's digital pandemic preparedness provided findings and insights into gaps and opportunities for functionality deployment and implementation resulting in relevant and realistic recommendations being made for consideration to help optimize digital pandemic preparedness in Sierra Leone.

Recommendations

Improving the Digital Health Ecosystem

R1.1 Invest in the Digital Health Sector
R1.2 Build Capacity for Leadership and Governance
R1.3 Strengthen Supportive Supervision
R1.4. Improve Information Sharing
R1.5. Improve Standardisation and Use of Applications and Registers
R1.6 Build Capacity for Data Capture and Use

Digital Pandemic Preparedness

R2.1. Strengthen Lab Test Results Sharing
R2.2. Strengthen Traveller Enrolment Schemes
R2.3. Strengthen Mobile Phone Communication with Contacts
R2.4 Develop Proximity Tracing for Contract Tracing
R2.5 Strengthen Fiscal Management Solutions
R2.6. Improve Health Worker Training
R2.7. Strengthen the Digital Tracking, Monitoring and Management of Animal, Environment and Human Disease Outbreaks (One Health)

01 BACKGROUND AND OBJECTIVES

Digital Pandemic Preparedness (DPP) is becoming crucial not only because paper-based methods have shown their limitations in the face of increasing numbers of cases, but also because epidemics require adequate national, regional and international control measures, strategies and optimal allocation of available resources. Digital tools allow the generation of granular data to identify and model trends in disease evolution and guide policy changes and response strategies. This is becoming increasingly important, especially since the advent of COVID-19, which has highlighted the usefulness of digital tools in public health and epidemiology.

However, there has been an explosion in the digitalisation of the health sector in countries, leading to an uncoordinated multiplication of digital tools, sometimes on a very small scale. This phenomenon hinders the consistency of the data collected and reveals major gaps in the capacity of these many developed systems to manage and guide informed decision-making in pandemic prevention. Good governance and a shared strategy are therefore needed to enable the alignment of multilateral partners and integration of digital tools. This in turn will support public health administration and effectively help partner countries to better manage the current COVID-19 pandemic, as well as potential future outbreaks.

It is in this context that the GIZ Global Health and Digitalisation Programme and other international stakeholders have sought to identify and map the gaps in the digital health ecosystem of partner countries. By mid-2020, the Programme had successfully defined a DPPA context and a prototype digital tool for conducting local assessments. Meanwhile, USAID, in collaboration with Digital Square, had also succeeded in establishing the Map & Match database which provides a good illustration of the digital tools implemented by a large number of stakeholders in the field of public health.

The objective of the Digital Pandemic Preparedness Assessment (DPPA) is to identify the current digital health landscape for pandemic preparedness and response, to identify opportunities to further develop this landscape and to propose activities to explore these opportunities.

1.1 DPPA

The development of the prototype DPPA tool was commissioned by GIZ to GFA Consulting Group (GFA). The concept was developed on the basis of a 2019 framework that provides a digital tool and a systematic methodology to identify gaps and opportunities in existing digital tools in a given country to enable the national health system to be prepared to respond to a pandemic.

The DPPA digital tool integrates and builds on the important work of other partners, including US-AID's Map and Match (M&M) database, feedback from various stakeholders such as the Centres for Disease Control and Prevention (CDC), the World Bank, and the UNICEF/WHO-led Digital Centre of Excellence (DICE). In addition, the DPPA digital tool has integrated the Early-Stage Digital Health Investment Tool (EDIT), a digital global asset developed by the Kati Collective.

The results of the DPPA digital tool are assessed and interpreted to formulate scenarios for integrating or increasing interoperability within an existing digital health ecosystem. With the DPPA reports, partner countries and Multilateral Organisations have relevant insights on how to fill these gaps or opportunities through digital applications and appropriate measures to modernise public health pandemic preparedness and decision making.

The first version of the DPPA was finalised in October 2021 and piloted in five Economic Community of West African State (ECOWAS) member countries, namely Cote d'Ivoire, Ghana, Nigeria, Togo and Sierra Leone.

1.2 Sierra Leone as a pilot country

Sierra Leone (officially the Republic of Sierra Leone, informally Salone), is a country on the southwest coast of West Africa. It is bordered by Liberia to the southeast and Guinea surrounds the northern half of the nation. Sierra Leone has a tropical climate with a diverse environment ranging from savanna to rainforests, a total area of 71,740 km2 (27,699 sq mi) and a population of 7,092,113 as of the 2015 census. The capital and largest city is Freetown. Sierra Leone is a constitutional republic with a unicameral parliament and a directly elected president serving a five-year term with a maximum of two terms. Sierra Leone is a secular nation with the constitution providing for the separation of state and religion and freedom of conscience (which includes freedom of thoughts and religion). Muslims make up about three-quarters of the population, though with an influential Christian minority. Religious tolerance in the West African nation is very high and is generally considered a norm and part of Sierra Leone's cultural identity.

Figure 1 *Map of Sierra Leone showing the 5 regions and 16 districts*[1]

Sierra Leone is divided into the five (5) main regions which are Northern, North-West, Southern and Eastern and the area around the capital Freetown called Western Area. The regions are in turn divided into a total of 16 districts which have their own powers regarding police authority and jurisdiction.

Over the past 15 (fifteen) to 20 (twenty) years, the country has experienced a number of public health-related emergencies from cholera in 2012, to the Ebola outbreak of 2014-2016 in West Africa, and other environmental disasters such a flooding and mudslides, and more recently the Wellington Fire Incident (October 2020), that have presented significant challenges and over-stretched the national health services.

Sierra Leone regions (5)

Sierra Leone districts (16)

[1]Sierra Leone - Wikipedia

This is coming on the back of an eleven-year civil war (1991-2002) that devastated the health system with significant loss of health infrastructure and qualified health personnel (doctors, nurses, midwives and other paramedics). The international community's coordinated response to the unprecedented Ebola outbreak saw a sharp increase in the use of digital tools across the health sector, in a country that had been slow in fully embracing digital transformation. The policy and regulatory environment was weak and the deployment of multiple applications resulted in duplication and pilots that were not interoperable, thereby creating data silos and hindered evidence-based and/or timely decision making. The need for the deployment of appropriate digital technologies as part of the public health practitioners tool kit cannot be overstated considering the COVID-19 pandemic's epidemiology with its high rate of infection, rapid transmission and high mortality rates (in the early part of the outbreak). Lessons learnt from the Ebola outbreak could have been used for a better digital pandemic preparedness in Sierra Leone.

02 DPPA TOOLKIT AND METHODS

The DPPA data collection process can be described in five (5) steps or work packages (WP). After preliminary work (1) and a qualitative assessment of the digital health ecosystem (2), using the Map and Match data as a starting point and validating it in the local context (3), the landscape of existing digital tools has to be mapped (4) and interpreted according to opportunities, gaps and recommendations (5).

2.1 WP1: Preliminary Work with Stakeholders

Before starting the DPPA process, it is crucial to obtain the support and approval of the country's Ministry of Health and key stakeholders in the health sector. To do this, a few meetings are necessary to present the DPPA concept, its objectives and, most importantly, the benefits that the results could bring to digital health strategies and donor-supported activities during the different phases of an epidemic.

For the stakeholder mapping, a simple coding was defined. The aim is to represent key actors who can contribute to decision-making processes that are very important for the collection of information and the implementation of recommendations.

Primary: key actors for information gathering and support with the assessment process or decision making: For example, national governmental stakeholders

Secondary: key actors for information dissemination. For example, multilateral stakeholders who might be interested in funding some of the recommendations as part of their programme.

2.2 WP2: Digital Health Ecosystem Analysis and EDIT tool

An important part of the DPPA is to analyse the status and digital health ecosystem in countries. This should identify key elements of the system that can be reused, exploited, and built upon to improve a country's health system before, during and after a pandemic. The tool captures basic epidemiological data, qualitative information on the country's level of digital health preparedness, and data sources collected and monitored centrally by the country's health authorities.

To complement this aspect of the DPPA, the EDIT tool was integrated as an essential part of the process of assessing the country's readiness (infrastructure, strategy) for digital health. It is a digital public good developed by the Kati collective . The tool defines a set of 79 indicators that help describe the digital health landscape at the DPP national level and identify areas that require specific improvements or digital tools. The EDIT indicators are divided into six (6) key blocks: 1) human capacity, 2) investment and financing, 3) data capture and use, 4) infrastructure, 5) standards and interoperability, and 6) governance and policy. EDIT has labelled each indicator as either informative, enabling or critical. In a further process, EDIT allows indicators to be scored according to the country context with a number between 1 (non-existent) and 5 (functional at master level). A minimum score of three (3) as the final score in the overall EDIT assessment should be a good indicator of the readiness of a country's digital health capacity to conduct activities at the national level.

2.3 WP3: Map and Match Data and existing digital tools

M&M is a USAID-funded project that provides a landscape of existing and adaptable digital tools used at the country level[3]. These digital tools were then mapped to use cases for COVID-19 and broader pandemic management.

In this context, the M&M database is used as a starting point to obtain a set of existing digital tools per country. Therefore, the first step is to validate the M&M data locally in the country's context.

The second step is to use other sources of knowledge of other digital tools in the health sector in Sierra Leone, to consider expanding the list of available digital tools before starting the assessment.

With this existing landscape/tool list, the DPPA digital tool automatically generates a table with all the available DPP functional opportunities in the country. The following information is the minimum information that the DPPA requires to be validated locally in the country before starting the assessment.

[3]https://digitalsquare.org/covid19-map-match

Name of Column in DPPA Tool	Description
Project/Tool	The software or project name under which the software was implemented.
Software Name (incl. package, module etc)	The given name to the software, to be used to identify and describe the solution.
Primary purpose of tool	A short description of the tool and the status in the country. In case this information is not available, a comment on the efforts to get this information will suffice.
Funder	Organization(s) involved in tool funding
Implementer	Organization(s) involved in tool implementation
Government Contributions	(1) Yes (2) Yes, MOH is fully funding the project (3) Yes, there is a financial contribution through MOH budget (4) Yes, they are contributing in-kind people or time (5) No, they have not yet contributed (6) Unknown In case this status is unknown, a simple text describing what effort has been done to get this information will suffice.
Tool proprietary /Open source	(1) Freemium (2) Non protective free and open-source software (e.g., Apache) (3) Open source (4) Proprietary (5) Protective free and open-source software (6) Public domain (7) Unknown In case this status is unknown, a simple text describing what effort has been done to get this information will suffice.
Scale: National or Sub-National	(1) National (2) Sub-National (3) Unknown In case this status is unknown, a simple text describing what effort has been done to get this information will suffice.
Scale: Scope	A description of the scale at which the tool is being used
Link	Website, GitHub, or Developer - Organization(s) involved in tool development
Scale: Regions	# of regions the tool is being used in

GIZ DPP Categories	This refers to the 14 DPP use cases. In case a tool is added to the list, the corresponding and validated DPP use case(s) if existing need to be listed: 1. Surveillance 2. Laboratory systems 3. Case management 4. Contact tracing 5. Proximity tracing 6. Coordination & operations 7. Supply chain & health facility logistics 8. Health facility administration 9. Health worker training 10. Risk communication & community engagement 11. One Health 12. Interoperability 13. Vaccine delivery 14. Data analytics, visualization & use

Table 1 *Important information on the digital tools evaluated*

2.4 WP4: DPPA use cases and mapping process

The use cases and functionalities of the DPPA were developed in coordination with the USAID M&M use cases that were defined in a framework describing how digital tools can be adapted and used during the different phases of an epidemic (Digital Applications and Tools Across an Epidemiological Curve). The use cases of the DPPA were further defined in 64 sub-features.

For the pilot phase of the DPPA, the mapping process consists of validating locally with national key stakeholders the use cases of the DPPA against the existing landscape. The process has been documented in an e-learning format to enable stakeholders to understand the process.

For the evaluation, a simple coding was defined:

- **(1) Deployed:** If a digital tool is deployed and the functionality is used in the country.
- **(2) Existing functionality in the software package, but NOT deployed:** If not used.
- **( ) Unknown / NA:** Empty choices indicate that the status is unknown or not available.

DPP CATEGORIES
1. SURVEILLANCE
2. LABORATORY SYSTEMS
3. CASE MANAGEMENT
4. CONTACT TRACING
5. PROXIMITY TRACING
6. CORDINATION & OPERATIONS
7. SUPPLE CHAIN & HEATH FACILITY LOGISTICS
8. HEALTH FACILITY ADMINISTRATION
9. HEALTH WORKER TRAINING
10. RISK COMMUNICATION & COMMUNITY ENGAGEMENT
11. ONE HEALTH
12. INTEROPERABILITY
13. VACCINE DELIVERY
14. DATA ANALYTICS, VISUALIZATION & USE

14 DPP Categories — Broken down into 64 DPP functionalitites

2.0 LABORATORY SYSTEMS	
2.1	Link patient and healthcare workers to the patient sample sent to the laboratory for testing
2.2	Guidance (to health workers) on the methos to collect a sample
2.3	Notifications when results are available (to patient, to healthcare facility for contact tracing etc.)
2.4	Integration with case management application and surveillance tools (to confirm suspected cases are positive or not)

Figure 2: *List of use cases and functionalities of digital tools assesed by the DPPA*

2.5 WP5: Recommendations

The DPPA assessment develops three types of recommendations:

2.5.1 Recommendations towards the digital health ecosystem

Based on the analysis of the Digital Health Ecosystem and the EDIT assessment, a set of recommendations should be formulated to support coordinated donor activities targeted towards country-level Digital Health strategies and to improve basic Digital Health infrastructure and country-specific digital readiness.

2.5.2 Concerning pandemic preparedness

Based on the available DPPA's assessment of opportunities, which ideally display all existing digital tools in the country, and the validated table of DPPA functionalities deployed (or not) in the country context, an assessment can be made to provide an analysis-based recommendation for each gap based on use cases, opportunities and the digital health ecosystem.

- Leverage existing software: Existing software is available as an opportunity identified in the context of the partner country's DPPA. Based on the opportunities and the contextual viability analysis, we recommend exploring the use of specific software currently operated by government stakeholders to meet this functionality requirement.
- Recommendation for new software: if no existing software is available for an identified gap in the partner country's DPPA context. Based on the stakeholders and the analysis of the digital landscape, we recommend exploring options for new software to meet this functionality requirement.

03 DPPA RESULTS IN SIERRA LEONE

3.1 WP1: Preliminary Work and Stakeholders

At the start of this assessment in Sierra Leone, approval was sought from the Ministry of Health and Sanitation, and the Director of Health Security and Emergencies (DHSE) was designated as the lead official for the study team to liaise with at the Ministry. This was followed by a presentation at the Emergency Preparedness Response and Resilience Group (EPRRG) weekly meeting to brief key stakeholders on the proposed study and provide answers to any questions they may have about the study. Training was then provided for the consultant on the use of the tools and interpretation of the results.

The assessment methodology is based on a linear approach organized in three phases:

1. Training on the DPPA tool and initial stakeholder engagement.

2. Data collection, this involved:

- Literature Review
- Qualitative assessments of digital readiness
- Application of a digital health readiness assessment tool (EDIT)
- Selection of the software to review
- Interviews and data collection

3. Analysis to formulate recommendations and write the report.

Data collection was undertaken through a literature review, a stakeholder survey and interviews, conducted according to the DPPA assessment tool.

A purposeful selection approach was adopted in selecting seven districts [out of a total of sixteen] to get a presumptively representative sample of epidemiological factors, terrain/access, stage of deployment of digital solutions and experience. This selection was made by the ICT Manager at the MoHS, who oversees all digital health deployments in the country. The Monitoring and Evaluation (M&E) Officers at the districts were designated as primary respondents to provide the necessary input into the study survey. These officers were each then sent an email explaining the purpose of the study with the DPPA tool attached together with clear instructions on how to complete the relevant sections i.e., tabs A3 and A4 of the tool. These emails were then followed up with phone calls to provide further explanation/clarification for each of the respondents and ensuring their understanding of how to complete the exercise. Additional follow up phone calls were also made to some of the respondents that requested additional support.

The literature review focused on the following aspects:

Contextual data including:

- The current epidemiological situation on the Covid-19 pandemic.
- The general qualitative assessment on digital readiness including internet accessibility and infrastructure, digital skills and use by the target population, technology adoption, trust, and policy, legal/regulatory aspects.
- The overall qualitative assessment of the digital health system through the national priorities, the national architectural framework for digital health and/or health information exchange (HIE) in place, the National Health Information System (HMIS) in place in the country and the existing health information standards.
- The identification of existing DPP software packages.

Data collection for EDIT (see Chapter 2 WP2) was also done remotely via email. Six health systems leaders from the MoHS, UNICEF, WHO, HISP South Africa and AFENET were sent the DPPA Tool and asked specifically to focus on Tab AO.1 for EDIT, with clear instructions on how to complete the tool. Follow up phone calls were offered and all but one respondent completed and returned the assessment

Stakeholder mapping was undertaken according to the methodology described in chapter 2 WP1 (see **ANNEX 1**).

Most of the
PRIMARY ACTORS
identified were from the district and national levels of the Ministry of Health and Sanitation (MoHS). These were:

District Health Management Team (DHMT)
with the respondents being the District Monitoring and Evaluation Officers (DM&EO). These are multi-disciplinary teams at the district with responsibility for disease surveillance, immunization, and health services delivery in general. The DM&EOs are responsible for leading data collection, analysis, management, and reporting across their district and overseeing the deployment and use of digital applications under the MoHS' purview.

Directorate of Policy, Planning and Information:
This directorate is responsible for leading the development of health policies, planning health care delivery and the collection, analysis, management, and dissemination of data. It also houses the eHealth Hub, an entity responsible for coordinating and overseeing the review and approval of digital applications in the health sector.

World Health Organization (WHO):
provides technical and financial support for the implementation of digital tools through expert consultations.

World Bank:
is a financial partner that could support the country in implementing the recommendations of the evaluation.

United Nations International Children's Emergency Fund (UNICEF):
is supporting digital health initiatives as part of its programme of work.

SECONDARY ACTORS
were drawn from the MoHS, UN and multilateral agencies as well as Non-Governmental Organizations (NGOs). These were:

Office of the Minister of Health:
this serves as the political head of the MoHS.

Office of the Chief Medical Officer:
this serves as the professional head of MoHS.

Directorate of Health Security and Emergencies:
This serves as the operational branch of the MoHS for public health emergency preparedness and response and is the anchorage point for the International Health Regulations (2005).

Directorate of Policy, Planning and Information:
This directorate is responsible for leading the development of health policies, planning health care delivery and the collection, analysis, management of data and dissemination. It also houses the eHealth Hub, an entity responsible for coordinating and overseeing the review and approval of digital applications in the health sector.

World Health Organization (WHO):
provides technical and financial support for the implementation of digital tools through expert consultations.

United Nations International Children's Emergency Fund (UNICEF):
is supporting digital health initiatives as part of its programme of work.

African Field Epidemiology Network (AFENET):
AFENET is a non-profit networking and service alliance of Field Epidemiology (and Laboratory) Training Programs and other applied epidemiology training programs.

Global Fund:
plays the same role as the World Bank, but with the difference that its support is focused on the three killer diseases HIV/AIDS, malaria, and TB.

GIZ:
is a technical partner to the MoHS in Sierra Leone. The Regional Programme Support to Pandemic Prevention in the ECOWAS Region (RPPP) aims to support local organisations in the establishment of a transnational pandemic prevention and control system.

World Vision Sierra Leone:
This local (Non-Governmental Organisation) NGO is part the network of implementing partners that deploy digital applications within health programs plays an active role in supporting the MoHS. They are also part of an international federation (World Vision International) and could help in dissemination of the results

3.2 WP2: Analysis of the digital health ecosystem and EDIT tool

Based on the critical indicators of the EDIT tool and additional qualitative information, the country was assessed with respect to overall pandemic preparedness, digital preparedness and the state of the digital health system, including infrastructure, governance and regulation, data quality and use, and human resources as well as technology adoption, the national architectural framework for digital health and/or health information exchange (HIE) and existing health information standards.

With an **overall average score of 3.0 out of 5 across the 17 critical indicators of the EDIT,** Sierra Leone demonstrates very high political interest and support in investing in ICT for service improvement. It has put in place strong governance and policy frameworks to create the enabling environment for the ecosystem to thrive. This is evidenced by the existence of an approved and costed National Digital Health Strategy , community health worker registries, availability of health facility registries, standardized immunization registries, geographic and demographic data for the country. However, the country falls short of the minimum score of level 3 in a few critical areas such as: the proportion of institutions with functional and accessible computers (2), proportion of establishments with functional and accessible mobile phones (2), national level capacity of maintaining servers (2) and the ability to maintain and troubleshoot hardware and software at the district level (2).

Table 2** shows a summary of the results, and the details of the evaluation are in **ANNEX 2.
***Table 2:** EDIT assessment of critical indicators for digital health*

Subcategory	Indicator	Goal
Human Capabilities	Mechanisms for capacity development and information sharing	3
	Specialized knowledge to support and maintain system	4
	Regular supportive staff supervision	3
Standards and Interoperability	Master facility list	3
	Ability to unambiguously identify an individual	3
Governance and Policy	Leadership and political will	3
	Existence of institutionalized digital health governance structures	3
	Existence of a digital health strategy	3
	Geographic data for the country	5
	Standardized Logistics Management Information System (LMIS)	2
	Community Health Worker Registry	4
	Standardized Immunization Registers	4
	Demographic Data Availability	4
	Data entry workload	2
	Data improvement plan	3

Investments and Funding	Costed, long-term plan to operate, maintain and support digital health systems	2
	Political interest and support in investing in ICT for service improvement	4
	Existence of sufficient funding to support infrastructure strengthening	2
Infrastructure	Proportion of facilities with functionable and accessible computers	2
	Proportion of facilities with functionable and accessible mobile devices	3
	National level capacity of maintaining hardware in the data storage centers	2
	Ability to maintain and troubleshoot both hardware and software at district level	2
Overall Average Score:		**3.0**

Human Capabilities
The use of ICTs is widespread amongst the health workforce in Sierra Leone. There is an organized information sharing mechanism in place with a MoHS website and portal, DHIS2 (the health information management system), as well as social media platforms both official and unofficial, such as Facebook, Twitter, WhatsApp etc. While most health workers are comfortable using digital applications, there is a cohort of users who are somewhat resistant to technology adoption. This notwithstanding, there is an increase in use of digital applications and solutions across all levels of the health system.

Standards and Interoperability
The Ministry of Information and Communication (MIC) has overall responsibility for overseeing standards setting in ICT across government (including the MoHS) and has over the years made efforts in this direction. The community health worker, master facility lists, standardized immunization registries are some of the standards that have been set by the MoHS across the health sector.

Efforts are also being made to align with international standards of best practice. In 2019, the Electronic Transactions Act[5] was enacted and provided an initial legal and regulatory framework for conducing secure transactions using devices etc. In 2021, following stakeholder consultations, the country's first Cybersecurity Policy[6] was approved by Cabinet. These two developments are contributing to building confidence in both the public and private sectors in terms of the handling of digital transactions and sensitive and personal data.

There is an ability to unambiguously identify an individual. This, however, is with a client matching algorithm of limited reliability. There is, therefore, a need for the reliability of this important functionality to be addressed, through appropriate technical review and supportive actions.

[5]https://old.sierralii.org/sl/legislation/act/2019/89-0
[6]https://old.sierralii.org/sl/legislation/act/2021/2yes

Systems interoperability remains a challenge in a context where deployment of new digital applications in the health sector sometimes bypasses the eHealth Hub, setup by the MoHS (and development partners) to address duplications and interoperability issues. There is, therefore, a need to establish a framework or guidelines for interoperability and incentivize stakeholders to adopt such a framework.

Governance and Policy
The MIC has the overarching responsibility for representing the government in oversight and governance on all ICT related matters. It has the mandate for providing policy and technical leadership, implementing, monitoring and reviewing the national ICT strategy. In addition to the MIC, in 2018 the President appointed a Chief Innovation Officer to lead the Directorate of Science, Technology and Innovation under his Office at State House, to support the governments' agenda for human capital development.

Other Ministries, Departments and Agencies had developed internal strategies for ICT in the absence of a national ICT Strategy, thus making coordination difficult. However, the MIC has now taken bold steps, (with support from development partners/donor institutions) to develop a National Digital Development Strategy (2021), following on from the development of its National Digital Policy (2021) [both documents are not yet publicly available].

Though there is a costed National Digital Health Strategy, 2018 – 2023, it is not yet fully funded and/or operationalized. This presents an investment opportunity for the donor community to strengthen digital transformation across the health sector guided by the strategy. Strengthening the eHealth Hub could also go a long way in improving coordination of the deployment of digital applications and solutions, thereby reducing duplication, redundancies and data silos, and improving interoperability.

There is a core group of people across government departments who are committed to advancing digital health and ICT both within the public and private sectors. However, supportive workshops, seminars, conferences, and other capacity building interventions are needed to strengthen and support digital health governance structures in the country.

Data Capture and Use
Over the last 5 - 10 years, significant efforts have been made by the MoHS to develop standards and processes in data capture, storage, analysis, and transfer. Working with development partners, the ministry embarked on formulating and agreeing minimum datasets, definitions, and categorization to effectively aggregate, interpret and report information for decision making. This, however, remains work in progress as the challenges of data silos and interoperability persist.

Several standardized records exist in areas such as CHW Registries, Health Facility Registries, Immunization Registries Geographic and Demographic Data for the Country, albert there is inconsistent use of such records. This presents an opportunity for investment by the donor community to strengthen these systems, updating and improving their accuracy, availability and use for decision making. This could build on the existing data improvement plan that is already in place, is funded and prioritizes registries. However, a monitoring system needs to be put in place to track implementation of this plan to ensure consistent progress and delivery.

Data entry workload is a recuring theme across all districts and impacts the ability to have access to the data required for making real-time/timely decisions. Human resource availability is impacted by lack of timely (and sometimes non-payment) of salaries to critical data collection and entry staff at the frontlines Development partners and donors need to work together with government to put arrangements in place to ensure salaries are always fully and promptly paid.

Investments and financing
Digital investment is a priority for the government and the MoHS, and efforts are being made to secure funding through multiple sources to support realisation of the digital transformation that Sierra Leone is yet to fully realise.

The country's Mid-Term National Development Plan, 2019 – 23[7], the National Innovation and Digital Strategy [Digitization for All: Identity, Economy and Governance] (2019 – 2029)[8], the development of its National Digital Policy (2021) and the National Digital Development Strategy (2021) and the MoHS' Digital Health Strategy, are all clear statements of intent showing that the country is embracing digital transformation and its dream. However, all the efforts that have gone into the development of these policies, strategies and plans will come to nothing if the government and its development partners do not make the appropriate investments. It is, therefore, imperative that financial support is provided to fully fund the development and implementation of the long-term plan being developed to support digital health systems in the country, together with the requisite technical support for investments in ICT for service delivery.

Infrastructure
In the past two decades, great strides have been made to improve the digital core infrastructure in Sierra Leone. Key amongst these improvements, is the landing of the Africa Coast to Europe (ACE) fiber submarine cable, which connects Sierra Leone to the internet thereby securing improved international connectivity.

Furthermore, the country has seen the implementation of a National Fiber Terrestrial Backbone and the ECOWAS Regional Backbone infrastructure, resulting in the construction of a 660-kilometer terrestrial fiber optic backbone link, funded by the Islamic Development Bank. This link stretches from Freetown to Zimmi at the Liberia border and onwards to Gbalamuya at the border with Guinea, connecting 28 cities along the way. Additional funding from a bank in China has also now extended this to 1,010 km of in-country fiber network connecting major cities and towns and about 50% of the country is covered for potential broadband and other electronic services for end-users.

Despite the purposeful strides that have been made by the country towards digital transformation of its economy and health services in particular, the overall infrastructure for last mile connectivity remains poor. The DPPA Assessment results indicate that less than 50% of health facilities in the country have functionable and accessible computers with less than 75% having functionable and accessible mobile devices. National level capacity of maintaining servers is at EDIT level 2 out of 5 and the ability to maintain and troubleshoot both hardware and software at district level is also at

[5]https://www.imf.org/en/Publications/CR/Issues/2019/07/09/Sierra-Leone-Economic-Development-Documents-National-Development-Plan-2019-23-47099
[6]https://www.dsti.gov.sl/wp-content/uploads/2019/11/Sierra-Leone-National-Innovation-and-Digital-Strategy.pdf#

level 2 out of 5. There is a huge opportunity for development partners/donor institutions to invest in building the infrastructure capacity of health facilities and the health system through financial, technical, and human resources capacity building.

3.3 WP3: Opportunities

Initially, an assessment was made of the Map and Match data against the 14 DPPA categories. For Sierra Leone a total of 29 Tools were in the Map and Match database. These tools are:

1. 117 Alert System
2. 3-2-1 Services
3. 468 SMS Service COVID Self-Check
4. Child Health and Mortality Prevention Surveillance (CHAMPS)
5. CommCare
6. Computer Aided Detection for COVID-19 (CAD4COVID)
7. Country HMIS (DHIS2+Tracker+COVID)
8. COVID Triage Tool
9. HealthAlert
10. RECOBVR (ODK)
11. Timed and Targeted Counselling mHealth Application (mTTC) (CommCare)
12. World Continuing Education Alliance (WCEA)
13. Bahmni/OpenMRS
14. Breakthrough ACTION Interactive Voice Response (IVR)
15. Ebola Vaccine Deployment, Acceptance and Compliance (EBODAC) Mobile Training and Support (MOTS)
16. Ebola Vaccine Deployment, Acceptance and Compliance (EBODAC) Mobile Technology for Community Health (MOTECH)
17. Fionet
18. Fistula Hotline
19. Global Open Facility Registry (GOFR) Reconciliation Tool (DHIS2)
20. iHRIS
21. mHero
22. mSupply (ColdChain and Mobile Vaccine Module)
23. Open Data Kit (ODK)
24. OpenHIE
25. OpenMRS
26. Safe Delivery App
27. U-Report
28. Vantage
29. VaxTrac (CommCare, DHIS2)

The first process was to validate the existence and functionalities of these tools in the country context. All digital tools have been piloted in at least one district in real time. However, some have been abandoned due to maladjustment or lack of funding. The figure below shown the results of the first validation process.

Table 3 *High-level assessment of existing opportunities before the validation process*

Tool Name	117 Alerts System	3-2-1 Service	468 SMS Service	AVADAR: Auto	Bahmni/OpenMRS	Breakthrough	CAD4COVID	CAD4TB	CHAMPS	Citizen Engage	CommCare	Country HMS	COVID-19 Triag...	cStock	EBODAC Biom..	EBODAC MOT...	EBODAC MOT...	EbolaTxt	EOC Logistics	Extract, Transf...	Fionet	Fistula Hotline	Global Open F...	GxAlert	HealthAlert	iHRIS	mHero (mHero)	mSupply (cold...	ODK	OpenHIE	OpenMRS	Quantimed	RapidPro	RECOVR (ODK...	Safe Delivery	Sense Followu...	Sense ID	Timed and Target	U-Report	Ushandi	Vantage	VaxTrac (Com..	VigiFlow	World Continu...
DPP CATEGORIES (1) Currently deployed under listed function-ality category (ref. A1 column AW; GIZ DPP Categories)	Custom Bu	Viamo	Unknown	ODK, SMS	Bahmni		CADATBCOVID	CAD4TB	SMS	Citizen Eng	CommCare	DHIS2, DHIS	Wellvis approach	Bamboo		MOTECH		Vusion	LoMIS Suite	DHIS2	Deki, Spiri,	Unknow	DHIS2, HA...	Xpert, Aspe..	HealthAlert	iHRIS	iHRIS, mHealth	mSupply	ODK	OpenHIE	OpenMRS		RapidPro	SurveyCTC	Cloud service	Cordova-b...	Sense ID	CommCare	RapidPro	Ushahidi	Vantage, A..	CommCare		Other, WCE
1. SURVEILLANCE		1				1																		1						1	1				1	1	1					
2. LABORATORY SYSTEMS																		1													1		1										
3. CASE MANAGE-MENT	1					1	1		1					1										1		1	1	1				1	1			1		1				
4. CONTACT TRACING																1																											
5. PROXIMITY TRACING																1																											
6. CORDINATION & OPERATIONS									1	1		1	1															1				1		1									
7. SUPPLY CHAIN & HEATH FACILITY LOGISTICS			1												1		1												1	1	1	1											
8. HEALTH FACILITY ADMINISTRATION																			1		1	1																					
9. HEALTH WORKER TRAINING																							1																	1			
10. RISK COMMUNI-CATION & COMMUNI-TY ENGAGEMENT				1		1		1								1																		1								
11. ONE HEALTH																																											
12. INTEROPERA-BILITY																																											
13. VACCINE DE-LIVERY			1		1																												1									
14. DATA ANALYTICS, VISUALIZATION & USE											1									1															1	1	1				1		

Focusing on the DPP Categories, figure 3 below summarizes the number of available digital tools opportunities that can be adapted very fast or are currently in use in the country. At the first view, only 2 categories are not served. For all other categories there are at least three (3) to sixteen (16) opportunities that could be rolled out nationally.

Table 4
Opportunities for the number of existing software packages to meet DPPA functionality

DPP CATEGORIES	Matching Software packages deployed
1. SURVEILLANCE	16
2. LABORATORY SYSTEMS	6
3. CASE MANAGEMENT	16
4. CONTACT TRACING	5
5. PROXIMITY TRACING	
6. CORDINATION & OPERATIONS	14
7. SUPPLY CHAIN & HEATH FACILITY LOGISTICS	13
8. HEALTH FACILITY ADMINISTRATION	5
9. HEALTH WORKER TRAINING	7
10. RISK COMMUNICATION & COMMUNITY ENGAGEMENT	14
11. ONE HEALTH	
12. INTEROPERABILITY	3
13. VACCINE DELIVERY	6
14. DATA ANALYTICS, VISUALIZATION & USE	9

A more detailed assessment of the tools currently available for meeting the 14 Categories of DPPA functionality is provided in **ANNEX 3.**

3.4 WP4: Gaps

This section presents the validation of opportunities against actual implementations of the digital tools found at the national level. For this purpose, email responses and individual interviews with key informants and stakeholders were collected and evaluated according to the methodology for evaluating the **14 DPPA Categories and 64 Functionalities described in Chapter 2 DPPA Toolkit and Methods.**

A comprehensive overview of the gaps based on how the existing tools match against the categories and functionalities is in **ANNEX 4.** In summary, as shown in Table 4 below, there are gaps in **15 functionalities in 7 DPPA categories,** but there are some opportunities for redeployment.

S/N	DPP FUNCTIONALITIES	Software packages: DEPLOYED	Software packages: Existing but NOT DEPLOYED
CATEGORIES			
	SURVEILLANCE		
2.3	Notifications when results are available (to client, to healthcare facility for contact tracing, etc)	0	1
	CASE MANAGEMENT		
3.12	Enrolment of travellers who have visited high-risk locations at ports of entry for monitoring and follow-up (Port of Entry Screening and Follow-Up)	0	1
	CONTACT TRACING		
4.4	Communication with contact via phone call (through app)	0	1
4.6	Bidirectional communication with contact via messaging (e.g. SMS, social media, in-app. WhatsApp)	0	1
	PROXIMITY TRACING		
5.1	Automated mass contact tracing of anonymous contacts via smartphone (or bracelet) Bluetooth signals	0	0
5.2	Optional notification of positive infection diagnosis with high-risk contacts via user's smartphone app	0	0
5.3	Functionality adapted to generalised epidemic response (not stricktly COVID-19)	0	0
	HEALTH FACILITY ADMINISTRATION		
8.1	Fiscal managment	0	0
8.2	Donor compliance reporting (Fraud prevention, transparent monitoring, etc)	0	0
	HEALTH WORKER TRAINING		
9.1	Epidemic-specific symptoms monitoring	0	0
9.2	Use of personal protective equipment (PPE), delivering vaccination, etc.	0	0
9.3	Safety protocols for facilities	0	0
	ONE HEALTH		
11.1	Tracking of infectious disease outbreaks in domesticated animals (livestock etc)	0	0
11.2	Tracking of infectious disease outbreaks in wildlife	0	0
11.3	Ecological surveillance of environment for changes that could increase risk of zoonotic infection	0	0

Table 4 *List of DPPA Functionalities not available in Sierra Leone*

It is worth noting that the digital ecosystem in Sierra Leone still lacks the necessary level of enabling policy and regulatory frameworks to facilitate full deployment of some of these functionalities. Where such frameworks exist, adherence to their implementation, and accountability to the MoHS is less than adequate.

The gaps in the categories of Proximity Tracing and One Health are not surprising, since these are relatively new concepts introduced as a result of COVID-19 and the health service is yet to catch-up on the use of digital tools and their related functionalities.

3.5 WP5: Recommendations

The main objective of this assessment was to gain an overview of the digital ecosystem in public health in Sierra Leone and to formulate recommendations and action plans that could contribute to modernising overall digital pandemic preparedness in the country.

3.5.1 Improving the Digital Ecosystem

Qualitative analysis of Digital Health Ecosystem and the EDIT assessment has highlighted several opportunities for improvement that could help strengthen the ecosystem and transform health service delivery for the achievement of the Sustainable Development Goals (SDGs). The following recommendations are intended to support donor activities targeted towards country-level Digital Health Strategies and to improve Health Infrastructure and Country-Specific Readiness.

R1.1 Invest in the Digital Health Sector
Sierra Leone's MoHS is in the process of developing a costed, long-term plan (on the back of its existing Digital Health Strategy, 2019) to operate, maintain and support digital health systems. This is a priority for the country. The MoHS is currently exploring funding sources with some funding already secured. If this plan is to be fully implemented, government with support from the donor community must invest in the implementation plan as well as engender an enabling environment through the development of the requisite policies and regulatory frameworks. Financial support could be provided to fully fund the implementation of the plan for infrastructure strengthening.

Whilst there appears to be political will for supporting the digital health ecosystem, this needs to be translated to action through resource allocation, capacity building and enhanced coordination at all levels, and being part of a whole of government approach towards a digital economy.

R1.2 Capacity Building for Leadership and Governance
While there is a core group of individuals across departments committed to advancing digital health and the use of ICT, there are supportive workshops, seminars, conferences, and other capacity building interventions that need to be provided to support and strengthen digital governance structures in the country. This is critical for better coordination, alignment, oversight, and leadership

R1.3 Strengthen Supportive Supervision
Action should be taken to monitor and strengthen this oversight mechanism as there is a tendency for frequency of supervision to fluctuate due to challenges pertaining to logistics and human resources for health. Funding support particularly for logistics will go a long way in facilitating access to remote and hard to reach places, where supervision is often not available albeit being highly needed.

R1.4 Improved Coordination on Interoperability
The challenges and lack of interoperability of a number of digital tools deployed by development partners and funded by international donors, must be addressed by all parties i.e., donors, implementing partners, software developers and governmental institutions through better coordination and harmonization.

R1.5 Improve Information Sharing
Support is needed to foster the frequent use of the available information sharing approach that already exists to strengthen information use and exchange, aided by an increase in the availability of technicians to strengthen the availability of technical support at the relevant locations.

R1.6 Improve Standardisation and Use of Applications and Registries
A mechanism needs to be put in place for the standardisation and use of LMIS, CHW registries, immunization registries, master facility lists etc. This will go a long way in improving service provision and access to better care.

R1.7 Build Capacity for Data Capture and Use
Support is needed to assess and build the necessary human resources for health capacity required to provide real time data entry for real time decision making. This is necessary not only for building the digital health ecosystem but for pandemic preparedness too.

Support should be provided to update and foster the consistent use of geographical data as well as updating the available demographic data.

R1.8 Improve Data Quality
There is a costed quality improvement plan in place that prioritizes registries. However, a monitoring system should be put in place to tackle implementation of this plan to ensure consistent progress and delivery.

R1.9 Improve Infrastructure
The proportion of facilities with functional and accessible computers is less than 50%. There is potential here for donor support both to improve the availability of functional and accessible computers and also mobile devices to accrue the requisite benefits on health service provision.
The national level capacity of maintaining servers and the ability to maintain and troubleshoot both hardware and software at district level are both very low. Whilst it is reported that there exists a plan on both fronts for the development of capacity in these areas, there is potential here for donor support to provide the technical and human resources capacity to fully implement the plan.

Power outages and lack of connectivity have featured prominently in the respondents' identification

of challenges. Investments in solar power and other renewable energy solutions must be prioritized to support the digital health ecosystem.

3.5.2 Digital Pandemic Preparedness

R2.1 Strengthen Lab Test Results Notification
It is important and sometimes critical that notification of lab test results happens as soon as it becomes available for appropriate actions to be taken where necessary, particularly in disease surveillance and contact tracing during emergencies/pandemics. It would give relief to the individual if the result is negative and on the other hand, health professionals can take prompt and appropriate action in circumstances where the results are positive e.g., quarantine/isolate the individual and report the case, provide advice and/or treatment etc.

R2.2 Strengthen Traveller Enrolment Schemes
It is good practice to have a system in place for enrolling travellers who have visited high risk locations at ports of entry for monitoring and follow up as part of contact tracing schemes. This functionality within digital applications needs to be operationalized when deployed.

R2.3 Strengthen Mobile Phone Communication with Contacts
The use of mobile phones to communicate with contacts in the execution of contact tracing schemes is a fast and efficient way of passing on information and notifications. Considering the ubiquitous nature [there were 8.07 million mobile connections in Sierra Leone in January 2021 equivalent to 100.1% of the total population] of the use of these devices, apps and social media, health workers could take advantage of these functionalities and strengthen effective and timely communication with contacts.

R2.4 Develop Appropriate Proximity Tracing Solutions
Proximity tracing is a sophisticated technological approach that has great benefits but predominantly where there is high penetration of smartphones and strong network connectivity. However, in circumstances where this is not the case, Bluetooth technology could be used. Sierra Leone is one such context where the establishment of proximity tracing functionality must carefully take into consideration the local conditions for the development of appropriate proximity tracing solutions.

R2.5 Strengthen Fiscal Management Solutions
Efficient management and accountability for financial resources within the health services is critical for optimal service delivery at all levels. At health facilities, this is even more critical considering the limited financial allocations they sometimes get against the demands for service provision. An opportunity, therefore, exists for investment to be made in improving the availability of digital tools that could strengthen fiscal management and accountability at these facilities.

[9]https://datareportal.com/reports/digital-2021-sierra-leone

R2.6 Improve Health Worker Training

Online and eLearning platforms now play a major part in health worker capacity building for both pre-registration and refresher training using blended learning. These platforms and applications should, however, consider user-centred design approaches and learning needs assessments in both their design to enhance user experience, as well as the provision of relevant content.
In pandemic preparedness, training content such as epidemic-specific symptoms monitoring, use of personal protective equipment (PPE), vaccine delivery and safety protocol for health facilities are a must for health worker training. Consideration should therefore be given to the prioritization of these modules in the curriculum on the platforms.

R2.7 Strengthen the Digital Tracking, Monitoring and Management of Animal, Environment and Human Disease Outbreaks (One Health)

The One Health approach in epidemiology is increasingly gaining significance and traction in public health surveillance and practice. Outbreaks like Ebola in West Africa, COVID-19 pandemic and previously the H1N1 bird flu are painful reminders of the significant risks that zoonotic infections pose to humans as populations increase and human settlements encroach into habitats once reserved for animals. The gap therefore in DPPA functionality for digital solutions for tracking infectious disease outbreaks in domesticated animals (livestock), wildlife and ecological surveillance of environmental changes that could increase risk of zoonotic infections needs to be closed. Digital tools for the performance of these functions will make a welcome addition in the public health arsenal for public health practitioners.

04 SUMMARY

ANNEX 1: List of Primary and Secondary Stakeholders

Name stakeholder by affiliation (institutional)	Name of stakeholder (individual): focal point, key contact, potential informant - if any	Sector	Level of involvement	Role in (Digital) Health System/exposure to tools/level of technical engagement	Primary or secondary stakeholder	Comments & Observations
Ministry of Health and Sanitarion	Dr Austin Demby	Public Sector	national	strategic/decision-making	Secondary	Dr Demby is the Minister of Health and Sanitation and was responsible for giving approval for the evaluation to be undertaken and designated the Director of Health Security and Emergency as the Focal Person
	Dr Kandeh	Public Sector	regional		Secondary	Dr Kandeh is the Chief Medical Officer and the professional head of the MoHS and necessary for the acceptance and dissemination of the results of the evaluation
	Dr Vandi	Public Sector	national	strategic/decision-making	Secondary	Dr Vandi is the Director of the Directorate of Policy, Planning and Information in the MoHS and relevant for dissemination of the results of the evaluation
	Dr Francis Smart	Public Sector	national	strategic/decision-making	Secondary	Dr Smart is the Director og Health Security and Emergency in the MoHS and the ministry's designated Focal Person for the evaluation and relevant for dissemination of the results of the evaluation
	Dr Magbinty	Public Sector	national	technical advisor - Public Health	Secondary	Dr Magbinty is the Monitoring and Evaluation Speacialist in the MoHS and key informant for this evaluation and contributed to completing the EDIT assessment

	Mr Eddie Foday	Public Sector	national	technical advisor - Public Health	Secondary	Mr Foday is the Research and Publications Specialist in the Mohs and Co-Chair of the eHealth Hub (a national coordinating body for the deployment of digital solutions in the MoHS) He is relevant for the dissemination of the results of the evaluation
	Mr Gerald Thomas	Private Sector	national	technical advisor - IT	Primary	Mr Thomas is the national ICT Manager at the Mohs, a key informant for both EDIT and the DPPA assessment. he is relevant for the dissemination of the results of the evaluation
	Mr Mohamed Feika	Public Sector	regional	Operator / user	Primary	Mr Feika is a District M&E Specialist in the MoHS, and operator / user of the applications and a primary informant. he is relevant for the dissemination of the results of the evaluation
	Mr A B Rahim	Public Sector	regional	Operator / user	Primary	Mr Rahim is a District M&E Specialist in the MoHS, and operator / user of the applications and a primary informant. he is relevant for the dissemination of the results of the evaluation
	Mr Mohamed B Swaray	Public Sector	regional	Operator / user	Primary	Mr Swaray is a District M&E Specialist in the MoHS, and operator / user of the applications and a primary informant. he is relevant for the dissemination of the results of the evaluation
	Mr Mohamed Kanu	Public Sector	regional	Operator / user	Primary	Mr Kanu is a District M&E Specialist in the MoHS, and operator / user of the applications and a primary informant. he is relevant for the dissemination of the results of the evaluation
	Ms Hawanatu Dora Mansaray	Public Sector	regional	Operator / user	Primary	Ms Mansaray is a District M&E Specialist in the MoHS, and operator / user of the applications and a primary informant. he is relevant for the dissemination of the results of the evaluation
	Ms Zainab Conteh	Public Sector	regional	Operator / user	Primary	Ms Conteh is a District M&E Specialist in the MoHS, and operator / user of the applications and a primary informant. he is relevant for the dissemination of the results of the evaluation

	Ms Gladys S Jusu	Public Sector	regional	Operator / user	Primary	Ms Jusu is a District M&E Specialist in the MoHS, and operator / user of the applications and a primary informant. he is relevant for the dissemination of the results of the evaluation
World Health Organization	Dr Mugagga Malimbo	International Organization	national	medical specialist/epi	Primary	Dr Malimbo is a Technical Officer with WHO
AFENET	Ms Bridget Magoba	Implementing Partner	national	tool/software development	Primary	Ms Magoba is a Technical Adviser with African Field Epidemiology Network
UNICEF	Mr Royston Wright	International Organization	national	Technical advisor - IT	Secondary	Mr Wright is M&E Officer with UNICEF.
GIZ	Dr Amadou Traore	Donor	international	technical advisor - Public Health	Secondary	Dr Traore is a Technical Adviser with GIZ in Sierra Leone. He is relevant for funding support as well as dissemination of the results of the evaluation
World Vision Sierra Leone	Mr Christian Boombu-Johnson	Implementing Partner	national	technical advisor - IT	Secondary	Mr Bloombu-Johnson is Director of ICT with World Vision, and implementing partner organization. He is relevant for dissemination of the results of the evaluation

ANNEX 2: Qualitative EDIT interviews

SUB CATEGORY	INDICATOR	SCORE	POTENTIAL ACTION
HUMAN CAPITAL			
What is the human capacity for digital health?	Mechanisms for information sharing within the health system	**3** - An organized information sharing approach exists and is occasionally used	Support should be provided to foster the frequent use of the available information sharing approach that exists to strengthen information use and exchange.
What opportunities does the ICT workforce have for development?	Specialized knowledge to support and maintain system	**4** -Technicians are regularly available at some, but not all, locations, and levels either as staff or contractors	The availability of technicians could be increased to strengthen the availability of technical support at the relevant locations.
What oversight is provided for staff?	Regular supportive staff supervision	**3** - Supervision schedule is established, and most facilities are visited annually	There is a tendency for frequency of supervision to fluctuate due to logistics and human resources for health challenges. Action should be taken to monitor and strengthen this oversight mechanism.
STANDARDS AND INTEROPERABILITY			
What digital identity management is in place?	Master facility list	**3** - A list with public, NGO and private health facilities is available, but may not be up to date	The master facility list should be revised and updated periodically.
	Ability to unambiguously identify an individual	**2** - Ability available, but with limited reliability and client matching algorithm	The reliability of this important functionality should be addressed through appropriate technical review and supportive action

GOVERNMENT AND POLICY			
What is the digital health governance structure in country?	Leadership and political will	**3** - There is a core group of people across departments committed to advancing digital health and ICT.	Supportive workshops, seminars, conferences, and other capacity building interventions could be put in place to strengthen and support digital health governance structure/s in the country.
	Existence of institutionalized digital health governance structures	**3** - There is a core group of people and other stakeholders responsible, and they give guidance and support to digital health programmes on an ad-hoc basis	Supportive workshops, seminars, conferences, and other capacity building interventions could be put in place to strengthen and support digital health governance structure/s in the country.
Is there a digital health strategy in place?	Existence of a digital health strategy	**3** - A costed national digital health plan has been developed and approved, but implementation has not started.	Financial and human resources could be provided to support full implementation of the digital health strategy.
DATA CAPTURE AND USAGE			
"What data is captured/available?"	Geographic data for the country	**5** - Geographic data exists, and is available for all relevant points of interest including health facilities and are used consistently	Support could be provided to update and foster the consistent use of geographical data.
	Standardized Logistics Management Information System (LMIS)	**2** - LMIS exists, but is not standardized across the country	Support could be provided to standardize LMIS across the country.
	Community Health worker registry	4 - Standardized CHW registers exist and are available at the health facilities, but are used inconsistently	Support could be provided to promote standardization and use of CHW registers.

	Standardized Immunization Registers	4 - Standardized registers exist and are available at the health facilities, but are used inconsistently	Support could be provided to promote standardization and use of immunization registers.
	Demographic Data Availability	4 - Demographic data exists at all administrative levels but is not up to date	Support could be provided to update the available demographic data
	Data entry workload	2 - There are sufficient staff to record the majority of entries, but not in real time	Support could be provided to assess and build the necessary human resources for health capacity required to provide real time data entry for real time decision making
What quality improvement processes are in place?	Data improvement plan	3 - A plan exists, is funded and prioritizes registries	A monitoring system could be put in place to tack implementation of this plan to ensure consistent progress and delivery
INVESTMENTS AND FUNDING			
What long-term funding is secured for sustainability, operations and maintenance?	Costed, long-term plan to operate, maintain and support digital health systems	2 - The plan is being developed	Support could be provided to ensure full development and funding of the costed plan to ensure operationalization, maintenance and support for digital health systems.
	Political interest and support in investing in ICT for service improvement	4 - It is a country priority, and the country is exploring funding sources with some funding already secured	Financial and technical support could be provided to support investments in ICT for service delivery.
	Existence of sufficient funding to support infrastructure strengthening	2 - A budgeted plan contains funding for less than 25% of infrastructure investments	Financial support could be provided to fully fund the implementation of the plan for infrastructure strengthening.

INFRASTRUCTURE			
What hardware and software is available and maintained?	Proportion of facilities with functionable and accessible computers	2) <50%	There is potential here for donor support the availability of functional and accessible computers to accrue the requisite benefits on health service provision.
	Proportion of facilities with functionable and accessible mobile devices	3) <75%	There is potential here for donor support the availability of functional and accessible mobile devices to accrue the requisite benefits on health service provision.
What is the country implementation, operations and maintenance capacity?	National level capacity of maintaining servers	2 - A plan exists to develop national-level maintenance capacity	There is potential here for donor support to provide technical and human resources capacity building to support maintenance of servers.
	Ability to maintain and troubleshoot both hardware and software at district level	2 - A plan exists to develop district-level maintenance capacity	There is potential here for donor support to provide technical and human resources capacity building to support implementation of this plan.

ANNEX 3: Detailed View of Digital Tool Opportunities

No.	TOOL	SOFTWARE	DESCRIPTION
1.	117 Alert System	Custom Built from eHA	24-hour hotline built as a syndromic and mortality surveillance tool for early detection of disease outbreaks. Receive alerts from public, trigger burial / survey teams. A toll-free, nationwide phone alert system was established for rapid notification and response during the 2014–2015 Ebola epidemic in Sierra Leone. The system remained in place after the end of the epidemic under a policy of mandatory reporting and Ebola testing for all deaths, and, from June 2016, testing only in case of suspected Ebola. Recently, the 117 Call Centre has seen major transformation-from extending the facility and giving it a facelift, to upgrading software for a more efficient system that the peoples of Sierra Leone can trust and utilize.
2.	3-2-1 Services	Viamo	Viamo's 3-2-1 Service is a toll-free, automated information hotline available in 18 countries. Subscribers can access information hosted on this hotline by dialling a toll-free, shortcode (such as 3-2-1) and then easily navigating a menu of topics with various options, such as "Press 1 to learn about the symptoms of COVID-19" or "Press 2 to learn how to prevent the spread of COVID-19." Messages are distributed on mobile telephones (i.e., smart or feature), and made available for free on the service as part of Viamo's pre-negotiated agreements with MNOs. The 3-2-1 Service communicates information through audio using IVR technology, which allows anyone, regardless of literacy level, to access the information. The service can host both static and dynamic content, which is recorded by native speakers in local languages, validated by experts and approved by the relevant government stakeholders. For COVID-19, Viamo worked with outbreak experts and relevant local stakeholders to identify key messages to increase awareness of health services relating to COVID-19 and share those messages to almost anyone, on-demand. In 2020, 6.8 million people across the world called the 3-2-1 Service to learn more about COVID-19. In Sierra Leone, Grameen Foundation's Mobile Technology for Community Health platform integrated with Viamo to mobilize communities and enhance uptake of an Ebola vaccine in Sierra Leone,

			Grameen Foundation's Mobile Technology for Community Health platform integrated with Viamo to mobilize communities and enhance uptake of an Ebola vaccine in Sierra Leone. As a result of the success, clinics continue to use the service to track number of vaccinations and promote awareness.
3.	468 SMS Service COVID Self-Check	Unknown	The existing *468# (*GOV#) Government Unstructured Supplementary Service Data (USSD) platform was expanded to allow citizens to conduct a self-check against their symptoms; learn prevention tips; and get updates on Sierra Leone's COVID-19 situation, including the number of cases, deaths, and the quarantine status. A complimentary SMS mobile application that offers users the same functionalities was also developed.
4.	Child Health and Mortality Prevention Surveillance (CHAMPS)	SMS	CHAMPS is a global surveillance network that generates and shares accurate cause of death data on child mortality. We aim to ensure that all deaths are reported to the 117 system, both from the hospital and communities. This way, mortality surveillance will be improved and causes of deaths in under fives identified. Starting on April 4, 2020, until October 31, 2020, CHAMPS pivoted to support the COVID19 response in Bombali district. During that period, CHAMPS had suspended MITS sampling, but continued to remotely respond to death.
5.	CommCare	CommCare	CommCare is an offline-capable mobile data collection and service delivery platform used in more than 80 countries. CommCare is popular for its offline case management capabilities proven to be effective at scale. It is designed for everything from simple surveys to comprehensive longitudinal data tracking. It allows for easy digitization of surveys, has forms that are intuitive for end users, utilizes simple device deployment, and includes translation features.
6.	Computer Aided Detection for COVID-19 (CAD4COVID)	CAD-4COVID	CAD4COVID is a free solution that uses artificial intelligence on chest X-rays to triage COVID-19 suspects to support triaging in resource-constrained settings and high-prevalence areas.
7.	Country HMIS (DHIS2 + Tracker + COVID)	DHIS2, DHIS 2 Tracker (individual-level) data packages, DHIS2 Android	District Health Information Software 2 (DHIS2) is an open source, web based HMIS platform. DHIS2 supports the collection, analysis, visualization, and sharing of both aggregate and individual-level data, including mobile and offline data collection using the DHIS2 Android app. The core DHIS2 software development is managed by the HISP at the University of Oslo. HISP is a global network that provides day-in, day-out direct support to ministries of health and local implementers of DHIS2.

			DHIS2 Tracker allows the user to define a particular kind of thing (person, commodity, lab sample, catchment area, etc.) that they want to follow over time (a tracked entity), define the data that they want to collect about this entity (data elements), place the data elements in a specific order and with any accompanying conditions or logic (program, program rules), and determine the analytics that should be produced (program indicators, event reports, data visualizations, etc.) in Sierra Leone, DHIS 2 is used to accelerate case detection, situation reporting, active surveillance and response for COVID-19
8.	COVID Triage Tool	WellvisApp	Wellvis app is an application that allows users to self-assess their corona virus risk category based on their symptoms and exposure history in a freeway. The application also allows digital health care appointments that can be paid online.
9.	HealthAlert	Health Alert	Praekelt has developed Health Connect which enables effective health communication with patients, health providers and health system. For Covid - During the pandemic, Praekelt adapted the platform to provide national messaging services on behalf of WHO and several other country governments on COVID-19 related information via individual modules such as HealthAlert, HealthCheck and HealthWorkerAlert
10.	RECOBVR (ODK)	SurveyCTO, ODK	Tracking how people's lives are affected by the COVID-19 pandemic can enable policymakers to better understand the situation in their countries and make data-driven policy decisions. To respond to this need, IPA has developed the RECOVR survey—a panel survey that will facilitate comparisons, document real-time trends of policy concern, and inform decision-makers about the communities that are hardest-hit by the economic toll of the pandemic
11.	Timed and Targeted Counselling mHealth Application (mTTC) (CommCare)	CommCare, MOTECH	The mTTC app is built in the common MOTECH Suite (CommCare), allowing easy adaptation and alignment to national data systems. The app collects real-time household-level data on practices, which can easily be assimilated and used in data-based feedback and supervision. The app ensures CHWs time home visits correctly by gestation/age of child, sending reminders on missed visits and follow-up, and improving workload management. It includes audio-visuals with multiple language settings, and press-play messages to give accurate information to caregivers. CHWs are prompted to conduct post-referral assessment of care including essential newborn care practices, stock-outs and case handling. In two countries it also includes accurate diagnostics of childhood illnesses. TTC App is used by CHWs conducting TTC home visits to communicate and track health practices for maternal newborn and child health at the household level.

12.	World Continuing Education Alliance (WCEA)	Other, WCEA	LMS for multi-field e-learning & mhealth, supports virtual and blended learning linked to CPD and lifelong learning (All areas of nursing & midwifery, COVID, - both clinical and nonclinical, etc) with various components including customized CPD certifications and access to research journals, healthcare community. Reporting tools that provide 360 view of study habits and data of users i.e., age, gender, location, qualification, role, employments status, etc
13.	Bahmni/ OpenMRS	Bahmi	Bahmni is an opensource, electronic medical records (EMR) and hospital information system that is currently deployed in over 50 countries. Bahmni is a distribution of the OpenMRS medical record platform that is designed to help health care providers to improve the efficiency and quality of patient care, reduce the margin of error in clinical diagnosis, and advocate for policies related to public health in rural areas. It manages patient information in a flexible fashion throughout the care cycle, including registration, various points of care, investigations, laboratory orders and results management, picture archiving and communication systems, and billing. While not being used in Sierra Leone for COVID, Bahmni released a COVID-19 kit that uses an OpenMRS module initializer to install forms that capture travel history and contract tracing, enable patient screening, and track information on home quarantining. Nepal adapted Bahmni for COVID-19 response as a case management tool in government hospitals by creating a COVID-19 screening template and syncing data in near real-time to dashboards.
14.	Breakthrough ACTION Interactive Voice Response (IVR)		Breakthrough ACTION Sierra Leone and its partner Viamo collaborated with the Government of Sierra Leone's COVID-19 response to develop a training for health workers caring for individuals who have or may have coronavirus. The training aims to help address the psychosocial needs of these health workers and their patients, and also covers some basics around coronavirus prevention, PPE, patient care, and rumour management. The training is delivered in Krio over the phone (basic phones are fine) through a series of phone calls using an IVR platform. IVR means the health worker can interact with the recording by selecting answers to quiz questions and receiving the appropriate response. There are six lessons in the entire training, each 5-6 minutes in length, delivered over a two-week period in December 2020. The training also includes a pre- and post-training survey to assess knowledge. After the training is completed, Breakthrough ACTION is coordinating with Last Mile Health to include the trainings on its COVID-19 classroom app which features existing

			COVID-19 tools and resources. Technically it could be adapted and scaled for COVID use nationally, however, until Viamo or the government is able to put in place an in-country server, its deployment requires international rates for mobile airtime which is very expensive for widespread use. The tool could be adapted for multiple purposes as many people in Sierra Leone have access to at least a basic cell phone. The content communicated via the tool could be changed for many purposes. The interactive feature allows for it to also be used as a survey for data collection if you wanted to use it for surveillance or reporting purposes. As long as you can gather the phone numbers for the intended audience, you can reach them with whatever information you produce. Because it is audio, individuals who are illiterate or with poor eyesight can participate. By delivering content to people's phones wherever they are, it is a COVID-19-safe way to reach people, it avoids bringing people together in large groups for trainings, and it allows for the implementer to reach more people more quickly and for perhaps less costs (especially with an in-country server which would greatly reduce airtime costs) than perhaps could be reached by organizing in-person trainings. Additionally, with an in-country server, the tool could include a call-back option where the user "flashes" a number for free and triggers a call-back. This feature would help the tool be useful as a reporting mechanism.
15.	Ebola Vaccine Deployment, Acceptance and Compliance (EBODAC) Mobile Training and Support (MOTS)	MOTECH	The EBODAC project (Ebola Vaccine Deployment, Acceptance and Compliance) is developing strategies and tools to promote the acceptance and uptake of new Ebola vaccines, to help the right person receive the right vaccine at the right time. Tools designed to promote acceptance and uptake of new Ebola vaccines. The MOTS platform aims to strengthen the training provided to Community Health Workers. Interactive training modules were developed in line with the national health curriculum to provide community health workers with refresher training on vaccines and emergency response practices through an interactive voice response (IVR) system. Training materials are delivered to the mobile phones of remote workers as audio files in local languages, in order to make the training as effective as possible and accessible even to those with limited literacy. CHW's can listen to the training materials in their own time, giving them greater flexibility in their learning and reducing the burden on the Ministry of Health to organize physical trainings.

16.	Ebola Vaccine Deployment, Acceptance and Compliance (EBODAC) Mobile Technology for Community Health (MOTECH)	MOTECH	The EBODAC project (Ebola Vaccine Deployment, Acceptance and Compliance) is developing strategies and tools to promote the acceptance and uptake of new Ebola vaccines, to help the right person receive the right vaccine at the right time. Tools designed to promote acceptance and uptake of new Ebola vaccines. The MOTECH platform supports clinical trial teams to effectively recall participants to receive the second dose of the prime-boost vaccine regimen or attend scheduled clinic visits. It has been successfully deployed and adapted to the needs of a multilingual population with a high rate of illiteracy and a lack of familiarity with clinical trials
17.	Fionet	Deki, Spiri, airFio	Deki mobile software applications and companion devices for health care workers integrate clinical workflow guidance and digital data capture at the point of care, then transmit records of patient encounters to airFio.
18.	Fistula Hotline	Unknown	In Sierra Leone the Fistula Hotline links women to experts to discuss concerns of fistula, an all-too common side-effect of prolonged labour in developing countries. The hotline nurses determine whether women are eligible for fistula treatment, and then connect them with more resources
19.	Global Open Facility Registry (GOFR) Reconciliation Tool (DHIS2)	DHIS2, HAPI FHIR	The Facility Reconciliation Tool is an open source and open standards-based product to help anyone match lists of facilities from different data sources. The tools support uploading data from CSV, FHIR servers and DHIS2 instances.
20.	iHRIS	iHRIS	iHRIS is used at the national level MOH for workforce panning and management. iHRIS is a free and open-source software solution that forms an integrated human resources information system, enabling countries to more easily collect, maintain, and analyse health workforce data and manage health workforce resources at a ministry of health (MOH), district health offices, and health care facilities. This implementation includes Manage, the health workforce management application allows tracking and management of health workers actively engaged in service delivery. While iHRIS is not currently being used for COVID-19 in Sierra Leone, it could be adapted for COVID management/tracking of health workers vaccinations and workforce planning for COVID hotspots/ staffing needs.

21.	mHero	iHRIS, mHero, Rapid pro	mHero is a two-way, mobile phone-based communication system that connects ministries of health and health workers. mHero brings together existing health information systems with locally popular communication platforms to facilitate important health sector communication. IntraHealth International and UNICEF created mHero in 2014 to support health sector communication during the Ebola outbreak in West Africa, and the platform has since been adapted for general health sector communication, disease surveillance, and for COVID-19 response, however it has not been deployed for COVID in Sierra Leone yet.
22.	mSupply (ColdChain and Mobile Vaccine Module)	mSupply	In Sierra Leone, there are four systems (mSupply, Channel, Pharmaceutical Dashboard and DHIS2) in use that collect HMIS and LMIS data, which DDMS and other programs use to inform quantification, procurement, distribution, and reverse logistics across supply chains. Since the HMIS-LMIS integration meeting in January 2018 significant progress has been made to move forward LMIS systems and HMIS-LMIS integration in Sierra Leone including: Central level rollout of mSupply – an electronic logistics information systems (eLMIS) used to manage government inventory, Rollout of mSupply in 8 districts at hospital and 5 district stores, and Pilot of RRIV integration into DHIS2. mSupply can be used for any combination of inventory management, display of aggregated data on dashboards, per patient recording of dispensing of vaccines, including calculating vaccination rates, producing a list of people to send SMS reminders to for their 2nd dose, etc, cold chain equipment monitoring using Bluetooth sensors, adverse drug reaction recording. While not deployed for COVID in Sierra Leone yet, it can be used for any combination of inventory management per patient recording of dispensing of vaccines, including calculating vaccination rates, producing a list of people to send SMS reminders to for their 2nd dose, etc cold chain equipment monitoring using Bluetooth sensors adverse drug reaction recording It does not need adapting- it is already available.

23.	Open Data Kit (ODK)	ODK	Open Data Kit (ODK) is free and opensource software that helps millions of people collect data quickly, accurately, offline, and at scale. ODK has two tool suites (ODK, ODK-X) and created a strong community of users, implementers, and developers. ODK is switching its name to a new brand, Data Software for Social Good (DSFSG). ODK's lead developer, Nafundi, is offering support to COVID-19 response efforts, specifically to address contact tracing, decision support, community education, strategic mapping, and case management. In Sierra Leone, ODK has been used to create a Master Bed list, map schools to use as treatment centres, surveillance.
24.	OpenHIE	OpenHIE	"Health information exchange (HIE) is the electronic transmission of healthcare-related data among medical facilities, health information organizations -- companies that oversee and govern the exchange of this data -- and government agencies according to national standards. The purpose of HIE is to promote the appropriate and secure access and retrieval of a patient's health information to improve the cost, quality, safety and speed of patient care,"" and to inform planning and policymaking."
25.	OpenMRS	OpenMRS	OpenMRS is a software platform and a reference application that enables design of a customized medical records system. OpenMRS has adapted it software to make it easier for 5,500 existing implementations to screen, test, and manage patients (diagnostic tools) and to report data out efficiently to DHIS2 for public health surveillance. While not currently in use for COVID in Sierra Leone, OpenMRS has deployed an active COVID-19 Response Squad that s working to identify existing work within the OpenMRS community that can be rapidly adapted by implementers and packaged as a suite of COVID-19 Public Health Response Tools. Kenya is utilizing OpenMRS for patient care and reporting on COVID-19. Nepal is utilizing OpenMRS to screen patients for COVID-19. OpenMRS is also adapted for COVID-19 response in Chile, Colombia, Guatemala, Haiti, Mexico, and Peru.

26.	Safe Delivery App	Cloud Services + Mobile App	The Safe Delivery App is a free, evidence-based mobile application that uses simple, intuitive animated instruction videos, drug lists, and quizzes to guide health workers in how to handle the most common childbirth emergencies. In light of the Covid-19 pandemic, Maternity Foundation collaborated with University of Copenhagen, Laerdal Global Health, International Confederation of Midwives (ICM), and UNFPA to create a module within the App to help equip midwives in low-resource settings with up-to-date information to protect themselves, mothers and newborns from Covid-19 and to ensure that women continue to receive quality services during pregnancy and childbirth. Health care workers can now get key information, animated video instructions, and checklists to support them to limit the spread of COVID-19 in the health facilities, including information on infection prevention, breastfeeding and vertical transmission. The App is currently implemented by a variety of government, UN, and NGO partners, and is now used by skilled birth attendants in over 40 countries. Once downloaded, the App works offline, making it easy to use in remote settings without a stable internet connection. The content of the Safe Delivery App is regularly updated according to WHO standards and guidelines. Maternity Foundation offers services to support partner implementation of the App in three main areas: App adaptation to language or national directives, implementation support (e.g., program planning, curriculum integration, virtual or in-person training), and monitoring, data analytics & insights. Due to the pandemic, the coalition behind the Covid-19 module has emphasized virtual trainings integrating the App, including remote BEmONC trainings and standalone trainings on the Safe Delivery App. While we are unsure as to whether the tool has been used for COVID, it could be used for Virtual or in-person trainings on the Covid-19 module and protocol, including national guidance.
27.	U-Report	RapidPRO	UNICEF has been supporting MOHS to deploy RapidPro use cases for informed decision makings. U-Report has been used as a focused mHealth application, specifically providing real-time mobile counselling and conducting coordinated polls on HIV/AIDS among adolescents and young people.

28.	Vantage	Vantage, Azure	Vantage is an AI-enabled cloud platform that empowers healthcare workers to make decisions. he cloud-based platform is able to instantaneously analyse data and communicate findings and direct meaningful actions through automatically generated dashboards and targeted push notifications
29.	VaxTrac (CommCare, DHIS2)	CommCare, DHIS2	Electronic Vaccination Record and Tracking System Implementation Project (VaxTrac) is a clinic-based vaccine registry tool to record vaccine data at the time and place of vaccine administration. The backbone of the system is a mobile, clinic-based immunization registry. The mobile app includes: Clinical decision support to improve the quality of services delivered, Methods for defaulter tracing, Automated reporting that can reduce the administrative burden on front line health workers, and improve the quality of data.

ANNEX 4: Overview of Gaps and Opportunities of Existing Digital Tools in Sierra Leone

S/N	Categories/Functions of the DPPA	Software Packages Deployed	Existing Software Packages Not Deployed
1.0 MONITORING			
1.1	Real-time reporting of aggregated data on individuals with symptoms, laboratory confirmation, etc. (ref. Coordination & Operations)	1. ODK, SMS/AVADAR: Auto-Visual AFP, 2. SMS/CHAMPS, 3. ODK, Cordova-based hybrid mobile app built for Android / Sense Follow-up + Dashboard...	Survey CTO/RECOVR (ODK)
1.2	Specification of a subset of minimum critical data points for reporting to facilitate rapid analysis and planning	1. ODK, SMS/AVADAR: Auto-Visual AFP, 2. SMS/CHAMPS, 3. ODK, Cordova-based hybrid mobile app built for Android / Sense Follow-up + Dashboard...	Survey CTO/RECOVR (ODK)
1.3	Early warning monitoring based on data from web searches of common symptoms or social media sentiment analysis (or keywords)	1. ODK, Cordova-based hybrid mobile app built for Android / Sense Follow-up + Dashboard...	
2.0 LABORATORY SYSTEMS			
2.1	Link between the patient and the health care staff and the patient's sample sent to the laboratory for analysis	1. DHIS2, DHIS 2 Tracker (individual-level) data packages, DHIS2 Android/Country HMIS (DHIS2 + Tracker + COVID), 2. Xpert, Aspect/Gxpert	
2.2	Advice (to health staff) on how to take a sample	1. DHIS2, DHIS 2 Tracker (individual-level) data packages, 2. DHIS2 Android/Country HMIS (DHIS2 + Tracker + COVID)	

2.3	Notifications when results are available (to the patient, to the health facility to conduct contact tracing, etc.)		1. DHIS2, DHIS 2 Tracker (individual-level) data packages, 2. DHIS2 Android/ Country HMIS (DHIS2 + Tracker + COVID),
2.4	Integration with case management application and digital surveillance tools (to confirm whether suspected cases are positive or not)	1. DHIS2, DHIS 2 Tracker (individual-level) data packages, 2. DHIS2 Android/Country HMIS (DHIS2 + Tracker + COVID)	
3.0 CASE MANAGEMENT			
3.1	Registration of patients in the system with a unique identifier	1. DHIS2, DHIS 2 Tracker (individual-level) data packages, 2. DHIS2 Android/Country HMIS (DHIS2 + Tracker + COVID), 3. ODK, 4. CommCare/Time and Targeted mHealth	
3.2	Patient health history available in the system	1. DHIS2, DHIS 2 Tracker (individual-level) data packages, 2. DHIS2 Android/Country HMIS (DHIS2 + Tracker + COVID), 3. ODK, 4. CommCare/Time and Targeted mHealth CommCare/Time and Targeted mHealth	
3.3	Entering patient details	1. DHIS2, DHIS 2 Tracker (individual-level) data packages, 2. DHIS2 Android/Country HMIS (DHIS2 + Tracker + COVID), 3. ODK, 4. CommCare/Time and Targeted mHealth	
3.4	Recording of patient demographics, vital signs, risk factors and symptoms	1. DHIS2, DHIS 2 Tracker (individual-level) data packages, 2. DHIS2 Android/Country HMIS (DHIS2 + Tracker + COVID), 3. ODK, 4. CommCare/Time and Targeted mHealth	

3.5	Creation of laboratory requests	1. DHIS2, DHIS 2 Tracker (individual-level) data packages, 2. DHIS2 Android/ Country HMIS (DHIS2 + Tracker + COVID), 3. CommCare/Time and Targeted mHealth	
3.6	Communication with the patient by phone (via the application)	1. CommCare/Time and Targeted mHealth	DHIS2, DHIS 2 Tracker (individual-level) data packages, DHIS2 Android/Country HMIS (DHIS2 + Tracker + COVID),
3.7	One-way communication with the patient via messaging (e.g. SMS, social media, in-app, WhatsApp)	1. CommCare/Time and Targeted mHealth	DHIS2, DHIS 2 Tracker (individual-level) data packages, DHIS2 Android/Country HMIS (DHIS2 + Tracker + COVID),
3.8	Two-way communication with the patient via messaging (e.g., SMS, social media, in-app, WhatsApp)	1. DHIS2, DHIS 2 Tracker (individual-level) data packages, 2. DHIS2 Android/Country HMIS (DHIS2 + Tracker + COVID), 3. CommCare/Time and Targeted mHealth	
3.9	Monitoring and updating of further client interactions and outcomes	1. DHIS2, DHIS 2 Tracker (individual-level) data packages, 2. DHIS2 Android/Country HMIS (DHIS2 + Tracker + COVID), 3. CommCare/Time and Targeted mHealth	
3.10	View a summary record and services provided for a client per encounter	1. DHIS2, DHIS 2 Tracker (individual-level) data packages, 2. DHIS2 Android/Country HMIS (DHIS2 + Tracker + COVID), 3. ODK	
3.11	Editing of record in case of errors	1. DHIS2, DHIS 2 Tracker (individual-level) data packages, 2. DHIS2 Android/Country HMIS (DHIS2 + Tracker + COVID), 3. ODK, 4. CommCare/Time and Targeted mHealth	

3.12	Enrolment of travellers who have visited high-risk locations at ports of entry for monitoring and follow-up (Port of Entry Screening and Follow-Up)		1. DHIS2, DHIS 2 Tracker (individual-level) data packages, 2. DHIS2 Android/ Country HMIS (DHIS2 + Tracker + COVID),
4.0 CONTACT TRACING			
4.1	Documentation of detailed contact history about the time, place, and person for each high-risk encounter	1. DHIS2, DHIS 2 Tracker (individual-level) data packages, 2. DHIS2 Android/Country HMIS (DHIS2 + Tracker + COVID),	
4.2	Creation of a listing of high-risk contacts linked to suspected and existing cases	1. DHIS2, DHIS 2 Tracker (individual-level) data packages, 2. DHIS2 Android/Country HMIS (DHIS2 + Tracker + COVID),	
4.3	Creation of record to input demographics and risk factors og high-risk contact	1. DHIS2, DHIS 2 Tracker (individual-level) data packages, 2. DHIS2 Android/Country HMIS (DHIS2 + Tracker + COVID),	
4.4	Communication with the patient by phone (via the application)		1. DHIS2, DHIS 2 Tracker (individual-level) data packages, 2. DHIS2 Android/ Country HMIS (DHIS2 + Tracker + COVID),
4.5	Undirectional communication with contact via messaging (e.g. SMS, social media, in-app. WhatsApp)	1. DHIS2, DHIS 2 Tracker (individual-level) data packages, 2. DHIS2 Android/Country HMIS (DHIS2 + Tracker + COVID),	
4.6	Two-way communication with the patient via messaging (e.g., SMS, social media, in-app, WhatsApp)		1. DHIS2, DHIS 2 Tracker (individual-level) data packages, 2. DHIS2 Android/ Country HMIS (DHIS2 + Tracker + COVID),

4.7	Update contact records with new changes / symptoms	1. DHIS2, DHIS 2 Tracker (individual-level) data packages, 2. DHIS2 Android/Country HMIS (DHIS2 + Tracker + COVID),	
4.8	Editing of contact record in case of errors	1. DHIS2, DHIS 2 Tracker (individual-level) data packages, 2. DHIS2 Android/Country HMIS (DHIS2 + Tracker + COVID),	
4.9	Functionality adapted to generalised epidemic response (not strictly COVID-19)	1. DHIS2, DHIS 2 Tracker (individual-level) data packages, 2. DHIS2 Android/Country HMIS (DHIS2 + Tracker + COVID),	
4.10	Allows simultaneous management of multiple epidemic types	1. DHIS2, DHIS 2 Tracker (individual-level) data packages, 2. DHIS2 Android/Country HMIS (DHIS2 + Tracker + COVID),	
4.11	Compatibility with country public health management information system (HMIS)	1. DHIS2, DHIS 2 Tracker (individual-level) data packages, 2. DHIS2 Android/Country HMIS (DHIS2 + Tracker + COVID),	
5.0	**PROXIMITY TRACING**		
5.1	Automated mass contact tracing of anonymous contacts via smartphone (or bracelet) Bluetooth signals		
5.2	Optional notification of positive infection diagnosis with high-risk contacts via user's smartphone app		
5.3	Functionality adapted to generalised epidemic response (not stricktly COVID-19)		
6.0	**CORDINATION & OPERATIONS**		
6.1	Easy access to real time aggregated to inform response	1. DHIS2/ Extract, Transform, Load (ETL) Application (DHIS2)	
6.2	Clear visualisations of key indicators	1. HIS2/ Extract, Transform, Load (ETL) Application (DHIS2), 2. DHIS2 IMA..., DHIS2 SUM...	

6.3	Efficient and effective communications with health facilities and field staff	1. DHIS2/ Extract, Transform Load (ETL) Application (DHIS2), 2. HealthAlert	
6.4	Modelling of epidemic impact scenarios to prepare response (simulations)	1. DHIS2/ Extract, Transform, Load (ETL) Application (DHIS2), 2. HealthAlert, 3. DHIS2 IMA..., DHIS2 SUM	
6.5	Clear visualisation of risk factors (risk index) at subnational level	1. DHIS2/ Extract, Transform, Load (ETL) Application (DHIS2), 2. HealthAlert, DHIS2 IMA..., DHIS2 SUM	
6.6	Monitoring of response capacities (relevant health personnel, hospital beds, equipment, national or internal Emergency Medical Teams)	1. DHIS2/ Extract, Transform, Load (ETL) Application (DHIS2), 2. ODK	
6.7	Big Data analysis (e.g. mobility monitoring based on mobile phone data, rumour monitoring based on social media analysis)	1. ODK	
7.0	**SUPPLY CHAIN & HEALTH FACILITY LOGISTICS**		
7.1	Registration of healthcare facilities	1. DHIS2, DHIS 2 Tracker (individual-level) data packages, 2. DHIS2 Android/Country HMIS (DHIS2 + Tracker + COVID), 3. LoMIS Suite/EOC Logistics System, 4. mSupply/mSupply (Cold Chain + mSupply mobile vaccines, 5. Rapid Pro	RapidPro
7.2	Collection and reporting of data on epidemic-specific consumables (vacciones, PPE etc.), e.g. stocking and stock forecasting, cold chain monitoring (for vaccines)	1. DHIS2, DHIS 2 Tracker (individual-level) data packages, 2. DHIS2 Android/Country HMIS (DHIS2 + Tracker + COVID), 3. LoMIS Suite/EOC Logistics System, 4. mSupply/mSupply (Cold Chain + mSupply mobile vaccines), 5. Rapid Pro	

7.3	Collection and reporting of data on epidemic-specific equipment(x-ray machines, critical care beds, ventilators, etc)	1. DHIS2, DHIS 2 Tracker (individual-level) data packages, 2. DHIS2 Android/Country HMIS (DHIS2 + Tracker + COVID), 3. LoMIS Suite/EOC Logistics System, 4. mSupply/mSupply (Cold Chain + mSupply mobile vaccines)	
7.4	Collection and reporting of data on epidemic-specific operational metrics (e.g. available ICU capacity, current staffing levels etc)	1. DHIS2, DHIS 2 Tracker (individual-level) data packages, 2. DHIS2 Android/Country HMIS (DHIS2 + Tracker + COVID), 3. LoMIS Suite/EOC Logistics System	
8.0	**HEALTH FACILITY ADMINISTRATION**		
8.1	Fiscal managment		
8.2	Donor compliance reporting (Fraud prevention, transparent monitoring, etc)		
8.3	Human resource management	1. iHRIS/iHRIS mHero	
9.0	**HEALTHCARE WORKER TRAINING**		
9.1	Epidemic-specific symptoms monitoring		
9.2	Use of personal protective equipment (PPE), delivering vaccination, etc.		
9.3	Safety protocols for facilities		
10.0	**RISK COMMUNICATION & COMMUNITY ENGAGEMENT**		
10.1	Point of care communications tools (videos through app, atc)		

10.2	Integrated mass communications tools (web, social media, SMS, robocalls, etc)		
11.0	**ONE HEALTH**		
11.1	Tracking of infectious disease outbreaks in domesticated animals (livestock etc)		
11.2	Tracking of infectious disease outbreaks in wildlife		
11.3	Ecological surveillance of environment for changes that could increase risk of zoonotic infection		
12.0	**INTEROPERABILITY**		
12.1	Standardised interface (IHE, OpenHIE, REST, API, HL7, HL7-FHIR, supporting the OpenHIE architecture and workflows)	1. OpenHIE	
12.2	Support for healthcare Coding Standars (e.g. ICD-9, ICD-10, LOINC, SNOMED)	1. OpenHIE	
13.0	**VACCINE DELIVERY**		
13.1	Integration with immunization registry	1. DHIS2, DHIS 2 Tracker (individual-level) data packages, 2. DHIS2 Android/Country HMIS (DHIS2 + Tracker + COVID),	
13.2	Vaccine scheduling (immunisation schedule)	1. DHIS2, DHIS 2 Tracker (individual-level) data packages, 2. DHIS2 Android/Country HMIS (DHIS2 + Tracker + COVID),	
13.3	Vaccination/immunization delivery monitoring, tracking and follow-up at client-level	1. DHIS2, DHIS 2 Tracker (individual-level) data packages, 2. DHIS2 Android/Country HMIS (DHIS2 + Tracker + COVID),	

13.4	Reporting on adverse effects	1. CommCare/VaxTrac (CommCare, DHIS2)	DHIS2, DHIS 2 Tracker (individual-level) data packages, DHIS2 Android/Country HMIS (DHIS2 + Tracker + COVID),
13.5	Digital vaccine certificicate support		DHIS2, DHIS 2 Tracker (individual-level) data packages, DHIS2 Android/Country HMIS (DHIS2 + Tracker + COVID),
13.6	Microplanning	1. DHIS2, DHIS 2 Tracker (individual-level) data packages, 2. DHIS2 Android/Country HMIS (DHIS2 + Tracker + COVID),	
14.0	**DATA ANALYTICS, VISUALIZATION & USE**		
14.1	Inbuilt data visualisation features	1. DHIS2, DHIS 2 Tracker (individual-level) data packages, 2. DHIS2 Android/Country HMIS (DHIS2 + Tracker + COVID), 3. Survey CTO/RECOVR (ODK)	
14.2	Multi-level data aggregation and user acess to inform decision-making	1. DHIS2, DHIS 2 Tracker (individual-level) data packages, 2. DHIS2 Android/Country HMIS (DHIS2 + Tracker + COVID), 3. Survey CTO/RECOVR (ODK)	

DIPC