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DIPC

Report:

DPPA

Digital Pandemic Preparedness Assessment

Ghana

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Acronyms

API	Application Programming Interface
PHC	Primary Health Care
AI	Artificial Intelligence
BMZ	Federal Ministry for Economic Cooperation and Development
CHIM	Centre for Health Information Management
CHPs	Community-based Health Planning Services
DHIS2	District Health Information System version 2
DPP	Digital Pandemic Preparedness
DPPA	Digital Pandemic Preparedness Assessment
DSNISI	Director Of the National Health Information System and Informatics
EDIT	Initial Stage Digital Health Investment Tool
EPI	Expanded Programme for Immunisation
GAVI	Global Alliance for Vaccine and Immunisation
GFA	GFA Consulting Group
GHS	Ghana Health Service
GILMIS	Ghana Integrated Logistics Management Information System
GIZ	Agence allemande de coopération internationale pour le développement
HIS	Health Information System
HISP WCA	Health information system program for West and Central Africa
HSS	Health Strengthening System
ICD-10	International Classification of Diseases version 10
ICT	Information Communication Technology
RSIMD	Research Statistics Information Management Directorate
iHRIS	Human Resources Information System
ML	Machine Learning
MoH	Ministry of Health
RH	Ressources humaines
RHS	Ressources humaines en santé
UiO	University of Oslo
UN	United Nations
WHO	World Health Organisation

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How to read this report

This report provides an overview of the digital landscape, a narration on the digital tools landscape and recommendations on the country digital health preparedness towards an outbreak.

The executive summary gives an overview of the finding and key statements of the report.
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 outcome of the assessment is elaborated in the country specific results sections which is subdivided in five sections:

- The WP1 preliminary work section gives an overview of the relevant key actors involved in this assessment and to who the report could be of interest.
- The WP2 ecosystem analysis provide a details overview of the digital eco-system in Ghana.
- The WP3 opportunities represents all potential solutions including digital public goods, which could be of relevant to implement specific DPP use cases at national or subnational level.
- The WP4 gaps section is a result of the DPP use case mapping. It gives an overview of functionalities which could be implemented in the country with a narration about the importance of the implementation in the country context.
- The WP5 recommendation is a set of preliminary recommendations towards the basic ecosystem, the pandemic preparedness and some selected global goods which could be prioritise by multilateral stakeholders.

The last section summarizes the assessment and gives a first outlook on how the outcome has been adapted by the stakeholders.

Executive Summary

A digital pandemic preparedness assessment was conducted from October to February 2022 in Ghana on a set of sixty-two (62) software identified. A total of 17 software packages were assessed for this exercise and another 21 were identified to be decommissioned or not in use. The assessment also revealed that 11 software were not relevant to pandemic preparedness and 12 were deemed to be useful for pandemic preparedness but relevant stakeholders for interviews could not be identified.

Objectives
The objective was to identify the need for digital tools that integrate into Ghana's existing digital ecosystem that can modernize general pandemic preparedness. More specifically, it was a question of (i) appreciating the different functionalities of the digital 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
A literature review and stakeholder interviews based on the Digital Pandemic Preparedness Assessment Tool (DPPA) were conducted. The approach used Map and Match data as a starting point, validating it in the local context. This assessment process included focus group meetings, face-to-face interviews, virtual calls and review of technical documents. Also used in the digital health landscape assessment was the EDIT tool.

Results
SORMAS and DHIS2 applications are the most widely used software nationally for pandemic management. There are several tools and applications that were used locally that could be extended to cover the whole country. But the assessment revealed that Ghana's digital health ecosystem has gaps in functionality related to the management of Early Warning Surveillance, bi-directional communication guidance (to health workers) on the method to collect a sample; vaccination/immunisation delivery monitoring, tracking and follow-up at client-level and One Health (including tracking

of wildlife and domesticated infections). The assessment also revealed opportunities in areas such as proximity tracing and Interoperability. In view of these identified gaps and opportunities, the following recommendations were made.

Recommendations

For future pandemic preparedness, the recommendation is for the Ministry of Health to update the current eHealth strategy in the light of pandemic preparedness and recent innovations in the digital health ecosystem. In addition, a new data warehouse is required to support collection, transformation, analysis of (pandemic-related) data and dissemination of evidence-based reports. Development partners should support MoH to develop a costed roadmap with key priorities for implementation in the short to medium term (1-5yrs). There is also an opportunity for MoH to partner GIZ to support identification of key areas for an accelerator program to develop an innovative application to enhance the country's preparedness for future pandemic. Further recommendations are that the MoH needs to invest in the development of data science skills and cloud infrastructure, as well as developing a new business model and infrastructure for telemedicine and build a new gateway for managing social media platforms to support bidirectional communication. MoH should be encouraged to support the development of the Master Patient Index platform using the National ID number and integrate the national data warehouse with the lab information system.

Conclusion

The assessment of digital pandemic preparedness in Ghana has yielded results in terms of functional gaps and opportunities and generated relevant and realistic recommendations that the country will need to implement to ensure optimal digital pandemic preparedness.

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

Recommendations

Improve the Digital Health Ecosystem

R1.1 Update eHealth Strategy
R1.2 Build New Data Warehouse Infrastructure
R1.3 Update Telemedicine Infrastructure and Develop New Business Model
R1.4 Integrated National Data Warehouse with Lab Information System
R1.5 Mirror SORMAS Functionalities in National Information System
R1.6 Develop/Integrate Immunisation Management System in HMIS Ghana
R1.7 Develop Data Science Skills Capabilities
R1.8 Port Health Declaration Form with Case Management System
R1.9 Develop Master Patient Index
R1.10 Establish eHealth Secretariat
R1.11 Use Existing Social Media Networks

Digital Pandemic Preparedness

R2.1 Consolidate and Use Surveillance and Case Management Dataset
R2.2 Development of digital tools for self-declaration and anonymous self-declaration of proximity
R2.3 Increase investment in two-way communication messaging with clients
R2.4 Interoperability Roadmap for Pandemic Preparedness
R2.5 Introduce system supporting microplanning of national & rural vaccine delivery

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 atypical explosion in the digitalization of the health sector in the partner countries, leading to an uncoordinated multiplication of digital solutions, sometimes on a very small scale. This hampers the consistency of the data collected and reveals major gaps in the capacity of these numerous developed systems to manage and guide informed decision-making on pandemic prevention. Good governance and a shared strategy are therefore needed to enable the alignment of multilateral partners and integrated digital solutions. 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 epidemics.

It is within this framework that the GIZ's Global Health and Digitalization Program and other international stakeholders have sought to identify and map the gaps in the digital health ecosystem of partner countries. In mid-2020, the Program succeeded in defining a DPP context and a prototype tool for conducting local assessments. Meanwhile, USAID, in collaboration with Digital Square, has also succeeded in setting up the Map & Match database which provides a good illustration of the digital tools implemented by many stakeholders in the field of public health.

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

1.1 DPPA

GFA Consulting has been commissioned by GIZ to develop a prototype of the DPPA tool. The concept was developed based on a 2019 framework that provides a systematic tool and methodology to identify gaps and opportunities in existing digital solutions in a given country to enable the national health system to be prepared to respond to a pandemic.

The tool integrates and builds on the important work of other partners, including USAID's Map and Match (M&M) database, feedback from various stakeholders such as CDC, the World Bank, Vital Wave and the Unicef/WHO-led Digital Center of Excellence (DICE). In addition, the DPPA tool has integrated the EDIT (Early Stage Digital Health Investment Tool) a digital global asset developed by the Kati Collective Organization.

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

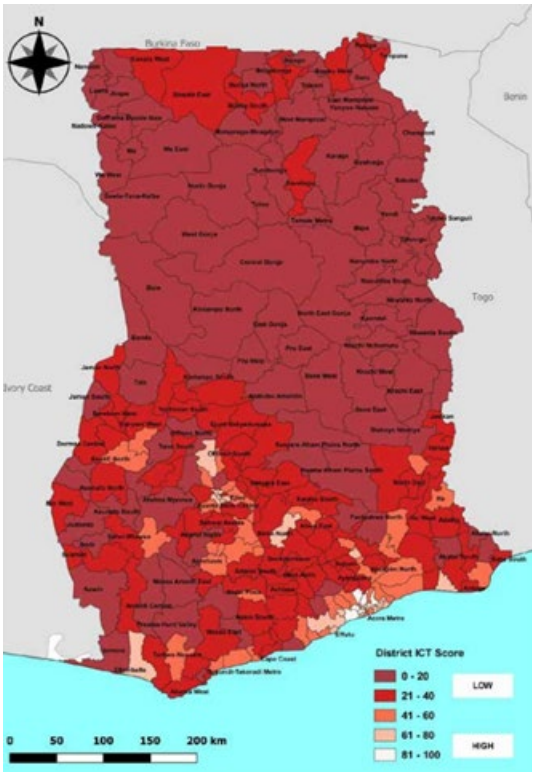
The first version of the DPPA was finalized in October 2021 and piloted in five ECOWAS member countries, namely Cote d'Ivoire, Ghana, Nigeria, Togo and Sierra Leone.

1.2 Ghana as a pilot country

The population of Ghana is 30.8 million, made up of 15.6 million females (50.7%) and 15,1 million males (49.3%). The national population density in the 2021 Primary Health Care is 129 persons per square kilometre. Ghana's population is young, with a median age of 21, and with 57% of the population under the age of 25. Ghana has made impressive strides in improving its healthcare system. By 2014, infant mortality had declined by 50% from levels in 1995, and under 5 deaths by 25%. Overall life expectancy has also increased by +-4%, which can be attributed to increased healthcare expenditure over the years. Though there has been rapid growth of urban areas, close to 50% of the country's population reside in rural, and often hard to reach, areas.

The Vice President is in charge of the digital agenda and cross-sector working. The Ministry of Communications and Digitisation is now driving National IT Architecture, Cybersecurity Policy. The Health Sector is working in alignment with these policies. However, the Health System is decentralised, with Districts having control over their own IT budgets, and this presents considerable challenges for implementation and interoperability. Ghana has successfully contained the COVID-19 pandemic as of March 2022. There have been 155,496 confirmed cases of COVID-19 with 1,367 deaths, as at 13th January 2022 to WHO, and a total of 9,004,225 vaccine doses have been administered.

As shown in **Map 1**, Ghana is divided into sixteen (16) regions (Ahafo, Ashanti, Bono, Bono East, Central, Eastern, Greater Accra, Northern, North East, Oti, Savannah, Upper East, Upper West and Volta Region), which in turn are subdivided into 262 metropolitans, municipals and districts (MMDs). In the Digital Health sector the use of ICT has been identified to be mainly be in the nation's capital and main regional centres.



Map 1 *Map of Ghana showing the 16 regions and 262 districts*

[1]Districts of Ghana - Wikipedia
[2]2020 District League Table.pdf (unicef.org)

02 DPPA TOOLKIT AND METHODS

The process of gathering the results of the DPPA can be described in five (5) steps. After a preliminary work (1) and 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 existing tools landscape needs to be mapped (4) and interpreted in regard to Opportunities, Gaps and recommendations (5).

2.1 WP1: Preliminary Work with Stakeholders

Before starting with the DPPA process the support and approval of the Ministry of Health and key stakeholders in the health sector were obtained, and meetings to introduce the Tool, and its purposes but above all the benefit the outcomes could bring to the digital health strategies and donor coordinated activities before and during different phases of an outbreak.

For the mapping of the stakeholder in the DPPA Tool, a simple two way coding has been defined. This is to represent key actors that can contribute to very important decision-making processes for the gathering of information and implementation of recommendations.

Primary: key actor for information gathering or decision making; E.g. Selected national governmental stakeholders might for example be primary actors that could support the assessment procedure.

Secondary: key actor for dissemination of information; E.g. Multilateral stakeholders could be interested to fund some of the recommendations as part of their agenda.

2.2 WP2: Analysis of the Digital Health Ecosystem and EDIT Tool

A **substantive part of the DPPA** is to analyze the status of the **digital health Ecosystem.** This should help identify key elements of the system that can be reused, leveraged, and build on to improve the health system in a country before, during and after pandemic outbreaks. The tool captures basic epidemiologist data, qualitative information about the country digital health readiness and data sources for the possible indicators of aggregated data collected and monitored centrally by the country health authorities.

To complete this aspect of the DPPA, the **EDIT (Early-Stage Digital Health Investment Tool)** has been integrated as an essential part of the country level digital health (infrastructure, strategic) readiness assessment process. It is a digital public good developed by Kati Collective (**https://katicollective.com/**). It defines a set of **79 indicators** that helps describing a country-level digital health landscape and defining areas that need specifics improvement or digital solutions. **The EDIT indicators are set in six (6) essential building blocks:** human capacity, investments and funding, data capture and use, infrastructure, standards and interoperability, and governance and policy. EDIT labelled **each indicator as either informational, enabling, or critical.** In a further process, EDIT allows the scoring of the indicators according to the country context with a number between **1 (non existent) to 5 (functional at a mature level). A minimum score of three (3)** as final score of the overall EDIT Assessment should be a **good indicator for a country concerning its digital health readiness** to conduct activities at national level.

2.3 WP3: Map and Match Data versus Existing Tools

The **Map & Match is a USAID** funded project which provides a landscape of existing, adaptable digital tools used at scale in countries. Those tools have been subsequently matched to potential use cases for COVID-19 and broader pandemic management.

In this context the Map & Match database was used as a **starting point** to get a set of existing digital solutions for the country. Therefore, the first step was to **validate the Map and Match data locally in the country context.**

The second step is for the cases where there is a c**ountry level database or knowledge of other digital solutions in the health sector,** to consider **extending the list** of available solutions before starting the assessment.

With these updates, the DPPA tool automatically generates a t**able with all available DPP functional opportunities** in the country.

The following are the minimum information for each that must be validated locally in the country prior assessment begin.

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. This is important as it will be used throughout the whole process to describe the solution.
Primary purpose of tool	A short description of the tool and the status in the country is important to evaluate the existing opportunities. In case this information is not available, a simple text describing what effort has been done 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 or districts 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 DPPA uses need to be listed. Monitoring Laboratory systems Case management Contact tracing Proximity tracing Coordination & operations Supply chain & health facility logistics Health facility administration Health worker training Risk communication & community engagement One health Interoperability Vaccine delivery Data analytics, visualization & use

Figure 1 *Important information on the digital tools evaluated*

2.4 WP4: DPP Uses Cases and Mapping Process

The DPP uses cases and functionalities have been developed in coordination with the USAID M&M use cases which have been further defined in a framework describing how digital tools can be adapted and used during different phases of an outbreak (Digital Applications and Tools Across an Epidemiological Curve) [4],[5].

The **DPP uses cases** have been further defined in **64 sub-functionalities.**

For the **pilot phase of the DPPA**, the mapping process consists of validating locally with the national key players the DPP uses cases against the existing landscape. The process has been documented in a e-learning format to allow the stakeholders to understand the process. For the evaluation a simple two-way coding was defined:

- **(1) Deployed:** If the tool is deployed the functionality is used in the country.
- **(2) Functionality existent in software package, but NOT deployed:** If it is not used.
- **( ) Unknown / NA:** Empty choices specify that the status is unknown or not available.

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.

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 ENGAGE-MENT
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 labora-tory for testing
2.2	Guidance (to health workers) on the methos to collect a sample
2.3	Notifications when results are avail-able (to patient, to healthcare facility for contact tracing etc.)
2.4	Integration wih case management application and surveillance tools (to confirm suspected cases are positive or not)

Figure 2: *Functionalities of digital DPP systems to be assessed*

[4]https://digital-square.squarespace.com/s/Map-and-Match_Executive-Summary.pdf
[5]https://digitalsquare.org/s/DATEC-FINAL.pdf

2.5 WP5: Recommendations

The DPP assessment develops two (2) types of recommendations:

2.5.1 Towards the digital health ecosystem

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

2.5.2 Concerning pandemic preparedness

Based on the available DPP opportunities, which ideally display all existing digital tools in the country, and the validated table of DPP 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 DPP. 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 DPP 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 GHANA

3.1 WP1: Preliminary Works and Stakeholders

During the initial period, contacts were made with the Heads for Information Technology departments of the Ministry of Health and Ghana Health Service to inform them about the project and get their support to identify the relevant key stakeholders for the assignment.

The training of the short-term expert on the assessment tool took place in October 2021 followed by the stakeholder analysis and mapping. One-to-one sessions with the Head of IT at GHS and MOH were used to share the DPPA tool, and the process required for data collection. Additional training was provided to help guide report generation.

Data collection was performed between 30th October 2022 and February 2022. Interviews were held with key stakeholders familiar with the health applications and platforms. A focus group meeting (made of 8 technical team members) was conducted with staff and management of the Centre for Health Information Management of the Ghana Health Service to understand the digital Health ecosystem in Ghana.

The aim was to identify, for each software package, the functionality available, the gaps and the opportunities, and to collect any additional qualitative data where relevant in GHS. It also afforded the consultant the opportunity to learn the dynamics and how decisions are taken regarding digital information solutions in the country. Visits and calls completed the first step to collect additional information as needed. In interviews with those knowledgeable about the systems, these software packages were discussed in terms of their detailed functionality.

To summarize the actor landscaping, the following **PRIMARY ACTORS** were exclusively identified as follows:

Ministry of Health (MoH) Ghana:
It is the Ministry responsible for policy direction, standards development and enforcement. It supervises delivery projects across multiple health institutions, and it ensures the mobilisation of resources and provides strategic direction.

Ghana Health Service (GHS):
It is the policy implementation arm of the MoH and responsible for providing comprehensive and accessible health service with special emphasis on primary health care at Ghana regional, district and sub-district levels in accordance with approved national policies.

Research Statistics Information Management Directorate:
This directorate is responsible for conducting research into policy and strategy options, compiles, and analyses data for the Ministry and government as a whole. It maintains a data bank for effective and efficient decision-making.

Centre for Health Information Management (CHIM):
The Centre is under the Policy Planning Monitoring and Evaluation Division (PPMED) of the GHS and serves as the focal unit responsible for the collection, analysis, reporting and presentation of health service information of the Health Sector.

Policy, Planning and Monitoring Evaluation (PPME):
The Division leads the technical process for formulating plans and carrying out trends assessment for Ghana Health Service by drawing on relevant sources of information to analyze the overall performance of the Service and monitor progress in implementing key policies. PPME directorate also ensures the development of comprehensive operational policies, sustainable strategic plans, systems, programmes, and budgets to cover all activities of the GHS and its partners. It supports the development of an integrated Health Information System for decision-making performance monitoring.

SECONDARY ACTORS
were from the multilateral organizations:

Millennium Promise Alliance:
MPA mobilises cutting-edge science and technology and using a multi-sector and multi-scale approach for effective local development, Millennium Promise seeks to accelerate sustainable development and eradicate poverty across rural sub-Saharan Africa and beyond. MPA supported MoH and GHS to develop and implement Port Health declaration Form System and Covid Tracker.

Korea International Cooperation Agency (KOICA):
Supports joint response to global issues (poverty, gender equality, climate, change, human rights, etc.), KOICA has carried out multilateral development cooperation projects primarily in countries lacking in or excluded from aid and areas with ongoing conflicts, utilizing the expertise and networks of the international organisations to supplement existing two-party bilateral aid.

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH:
is a technical partner and currently has a health programme under the DeveloPPP in Ghana. GIZ advises in other fields of international cooperation for sustainable development such as international education work with the aim of shaping a future worth living around the world.

University of Oslo:
The University of Oslo and the Research Council of Norway have the goal of strengthening health systems in the Global South. They are the developers and lead technical advisors for DHIS2 platform. They provide stable funding that has enabled the DHIS2 project to expand and sustain over time, to have the flexibility to explore the latest technologies, to develop a network of experts across countries and regions, and to continue delivering a stable and generic open-source platform — provided for download at no cost, with no licensing fees — that can be adapted to meet new challenges and local demands.

United State Agency for International Development:
USAID supports breakthrough innovations, applies market-based approaches, and advances efforts in digital health, private sector engagement, and human-centred design in order to maximize the impact of its global health work.

United Nations Children's Fund (UNICEF):
leverages digital health to strengthen health systems and enhance the reach and quality of care for maternal and children's health. In Ghana UNICEF is partnering young start-ups in the development of innovative, open-source, market-driven products and solutions that help address complex problems impacting the well-being of children and young people, especially the most vulnerable.impact of its global health work.

World Bank:
The World Bank Group supports the economic and social development policies of the Government of Ghana by supporting the creation of a competitive environment for the private sector to flourish and play a greater role in job creation. It also supports policies and programs that aim to strengthen digital transformation for improved service delivery and productivity, improve governance, and promotes greater inclusion, including strengthening women's economic empowerment.

World Health Organisation:
The WHO promotes evidence-based health policymaking through a comprehensive and rigorous analysis of the dynamics of the health situation and health system in Ghana. It also provides trends of priority health problems and the health systems profile, including a description of institutional frameworks, trends in the national response, key issues and challenges.

3.2 WP2: Digital Health Eco-System in Ghana and EDIT results

With an overall EDIT critical indicator score of 3.05 (52/17), the digital health field in Ghana has a lot of opportunities to grow. Countries are strongly encouraged to achieve a score of level 3 or higher in the EDIT tool for all critical indicators before moving forward with a digital health solution and review potential actions that could improve the score.

As shown in **Figure 3,** Ghana can build on robust digital readiness in human capacity and infrastructure to strengthen governance and interoperability. In the following, contextual factors are discussed that can be considered contextually relevant for digital pandemic preparedness.

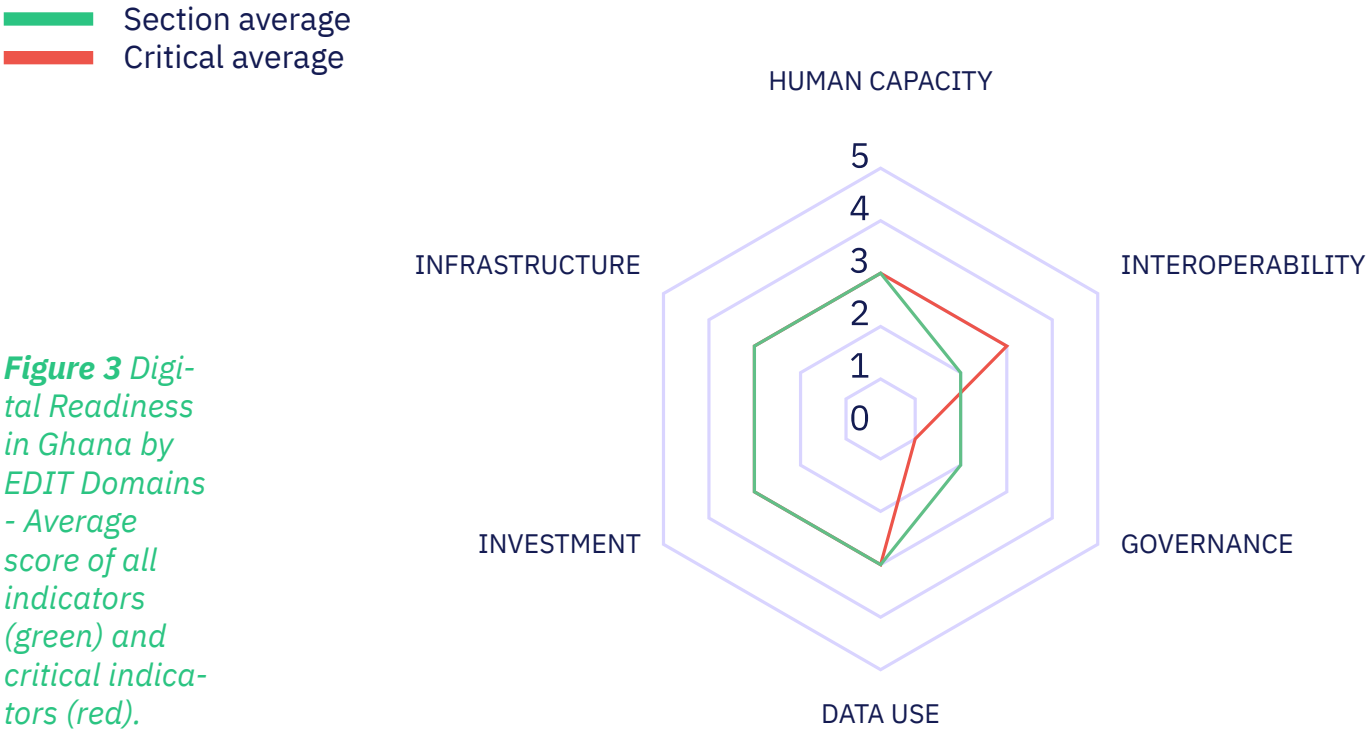


***Figure 3** Digital Readiness in Ghana by EDIT Domains - Average score of all indicators (green) and critical indicators (red).*

3.2.1 Digital Health Strategy

The Government of Ghana has released the following policies relevant to digital health

1. ICT for Accelerated Development (ICT4AD) Policy [6]
2. Health Sector's ICT Policy and Strategy [7]
3. Ghana e-Health Strategy.[8]

In 2017 a process began to update the Strategy. Covid has caused a hiatus in the work. But the intent is to have a new Digital Health Strategy in 2022, and it will align with the National Health Policy for 2020-2025, and the WHO Global Digital Health Strategy.

Although these national strategies provide a basic framework for future development of digital health services, future revisions could address the need to expand ICT infrastructure in remote and rural communities, which make up close to 50% of the country's population and more in depth consider building an ecosystem that supports public health emergencies and pandemics.

When implementing the policy, the MoH focusses on the use of open-source software as much as possible and to link all health programs data reporting to the DHIS2, so that even if the different programs' tools overlap, these data elements will be defined only once in the data warehouse. At the same time, MOH is procuring and deploying a proprietary health information system (Light Wave Information System) across the country. In addition, GHS has taken a bold decision to develop multiple health modules on the DHIS2 application to track and monitor treatment and care for people living with HIV and affected by TB. It offers Maternal Child Health opportunities to improve health services for harder-to-reach rural and marginalised communities.

Additional digital tools have been deployed to address acute needs that have arisen as a direct or indirect consequence of the pandemic (e.g., SORMAS, Covid 19 tracing app, remote triage emergency services). However, many of the solutions that have been developed and implemented during the emergency could be consolidated in the future, contributing to the definition and adoption of new digital models of care. Moving forward, MoH should assess and evaluate digital systems deployed during the pandemic in relation to suitability to integrate into the health systems of Ghana and ability to provide sustained financial and technical resources to support the application.

Strong Leadership that can coordinate activities and define and enforce clear roles and responsibilities is crucial to implement digital health policies. As **Figure 4** demonstrates, opportunities exist to grow the regulatory and governance aspects of digital health.

[6]Microsoft Word - Ghana-ICTAD Policy-Master-final-2.doc (moc.gov.gh)
[7]Health-Sector-ICT-Policy-and-Strategy.pdf (moh.gov.gh)
[8]Layout 1 (isfteh.org)

BOLD:
critical factors

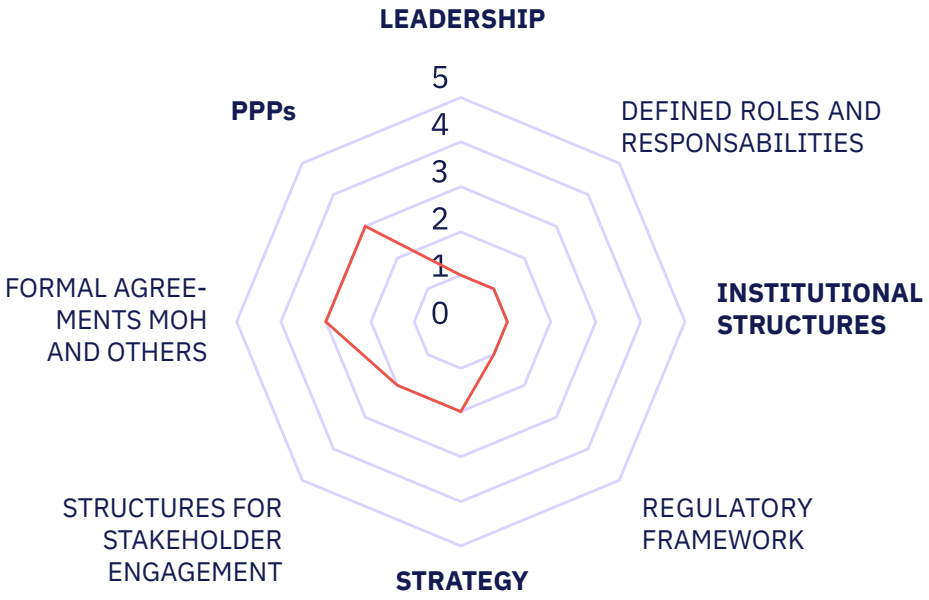


Figure 4
Performance of Critical and Enabling Factors in the Governance Domain of the EDIT Tool

To put these strategies into action, costed plans and aligned committed funding is crucial. The Centre for Health Information Management (CHIM) is mandated to lead implementation of various digital health solutions within the GHS. However, they are not always consulted when new programs are being considered. As a result, most projects are planned without proper IT budgets and sustainability plans.

As illustrated by the investment domain of the EDIT Tool in **Figure 5,** opportunities exist for political leadership to engage funding organizations and implementing partners and drive a comprehensive and focused approach towards a robust digital health infrastructure by developing costed plans and strategic budget lines for digital health as part of an overall approach towards strengthening digital infrastructure.

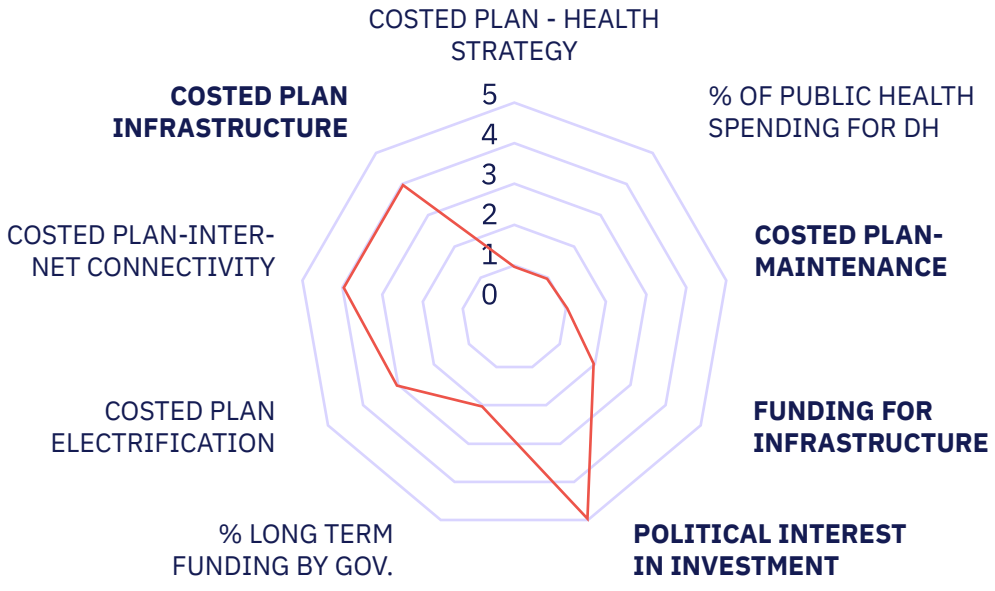


Figure 5
Performance of Critical and Enabling Factors in the Investment Domain of the EDIT Tool

As **Figure 6** shows, Ghana has made good progress in establishing its Master Facility List, but has work to do to have the necessary standards in place to enable interoperability of data.

BOLD:
critical factors

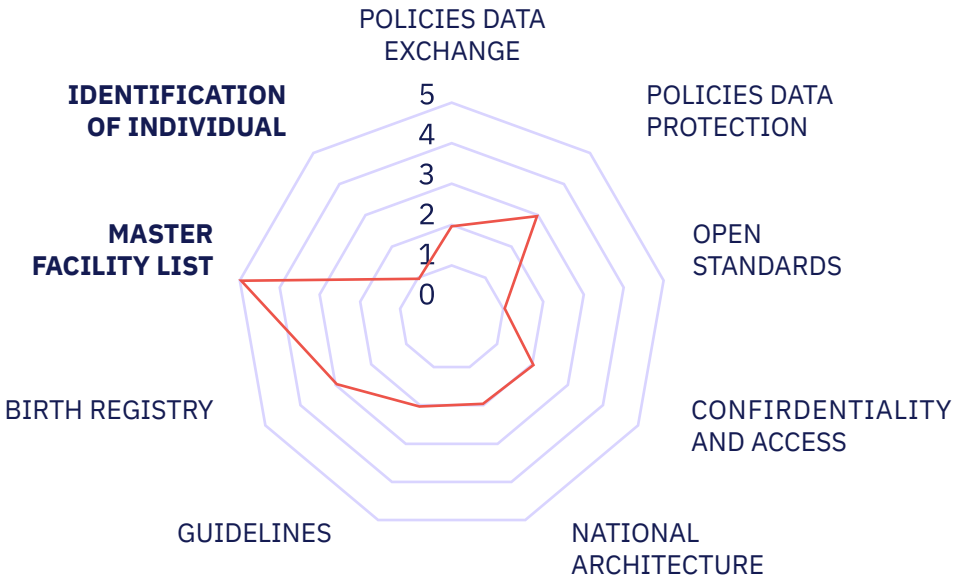


Figure 6
Performance of Critical and Enabling Factors in the Standards and Interoperability Domain of the EDIT Tool

3.2.2 Status of Digitalization

Digital Infrastructure
The Internet Readiness Index as a global benchmarking tool ranks Ghana 16th among lower-middle-income countries globally and 5th in Africa[9]. As of January 2021, 90% of Ghana's landmass was covered by mobile networks and use of mobile phones grew in a 3.1-fold annual increase to 41.7 million mobile connections. 3G coverage accounts for 60 per cent of the total connections, 4G has started gaining traction and is expected to overtake 2G services by 2023. 3G and 4G will account for nearly 95 per cent of total connections by 2025.

In terms of internet speed, Ghana was recently ranked 79th in the world and first in Africa in a global index for the fastest and most affordable internet rates in the subregion. And more people access the internet on their mobile devices than from a personal computer and social media.

The greater availability of mobile devices, including the growing access to and use of smartphones, decreasing costs of hardware, as well as better network connectivity (including broadband) has expanded opportunities for the inclusion of digital technology in programming in areas with sufficient internet access. Here, a rapidly growing number of local innovation hubs provide support and foster collaboration among innovators and digital entrepreneurs, strengthening responsiveness to local needs. Improvements in design tools as well as distribution platforms has made it possible to get ideas developed and available faster.

[9]Ghana – Network Readiness Index

However, access to the internet is centred around major cities and towns with little or no access to those in the hinterlands. This infrastructure deficit in rural areas remains one of the major challenges against internet connectivity in the country. To address this deficit, Ghana Investment Fund for Electronic communication (GIFEC) is investing 1% of all communication revenue to bridge the rural urban divide in internet connectivity, providing support to smaller telecommunication companies such as Bluetown Ghana to extend internet infrastructure to rural areas and schools. The government is also facilitating more public private partnership projects in the telecommunication sector especially for rural communities.

Digital Infrastructure in the Health System

Although most (96%) of health facilities in the country have mobile network coverage, Ghana has been relatively slow to adopt digitalization in the health sector, with most hospitals only partially digitised and an insufficient number of computers in the health system to support real time data collection and reporting.

In tertiary and secondary health facilities, the availability of network infrastructure and hardware is robust. However, in rural communities or basic health facilities, IT equipment is limited and access to electricity is unstable in some districts. Facilities must invest in backup sources of electricity such as standby generators or solar power to supplement the national grid and ensure functionality not only of their digital infrastructure but also other electronic equipment relevant for health care delivery. Community-based Health Planning Services (CHPS) compounds and health posts in general do not have computers, although Ghana Health Service (with the support of KOICA and donations from Samsung Corporation) is distributing tablets and phones to support collection of health data at health post and community level. Nevertheless, Digital health interventions have been implemented through mobile health, including through SMS and toll-free calls.

Currently most health facilities rely on cloud storage services of international service providers such as Amazon, Google and Microsoft, because of interruption in electricity supply and lack of skills to support on premise hosting of the servers. International storage providers are often less expensive than local cloud storage service providers such as RackAfrica, MTN and Templedata. There are plans to build a data centre and extend dedicated network coverage to all health facilities, but these plans have not been costed and budgeted for.

The underlying health information technology infrastructure is weak, and maintenance of the digital infrastructure varies. The governmental system does not have a central registry or inventory of electronic equipment and in the absence of routine maintenance plans, most maintenance is done on an ad-hoc basis, often delayed through extended procurement and approval procedures. Tech support is currently organised in an informal way, based on the network of the individual ICT manager. There is a limited amount of donor or governmental funding committed to maintenance of the infrastructure and this might further contribute to the lack of formalised technical support structures and unenforced service level agreements. Further, there is no enforced policy on electronic waste. Old computers and printers are kept in old warehouses for audit purposes over a long period of time.

Most of the local information technology vendors mainly provide basic ICT services and have restricted resources to develop robust solutions in a timely manner that can be brought to scale. Skills and knowledge transfer is crucial for developing data architecture and design for interoperability within government organisations at the national level. There are skilled resources in the private sector. However, in the public sector poor salaries and working conditions mean it is not able to attract and retain some of the most highly skilled staff. This limits the health sector's ability to adopt new systems and technologies which have been tested and proven successful in developed countries.

BOLD:
critical factors

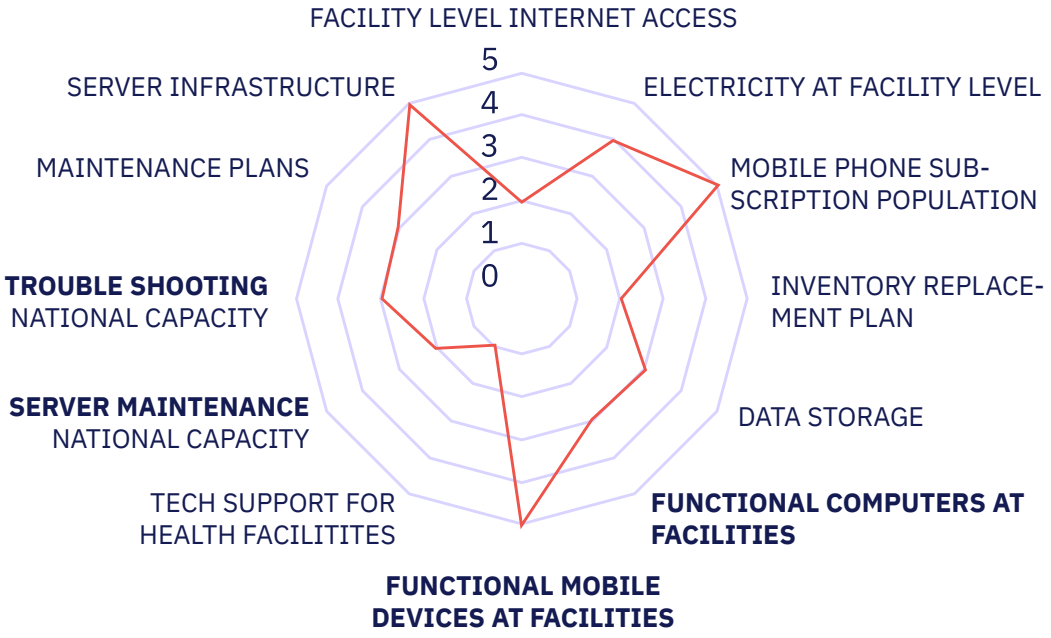


Figure 7
Performance of Critical and Enabling Factors in the Infrastructure Domain of the EDIT Tool

Health Data in Ghana

Good data is essential in planning and ensures proper accountability and reporting. Quality data forms the essence and foundation of the decision-making process, and it is imperative for all decision-makers to make use of the relevant data at all levels.

The Policy, Planning, Monitoring and Evaluation division within the Ghana Health Service (GHS) is charged with monitoring and evaluation as well as data management of all activities under the GHS.

Data entered into DHIS2 include measures on finance, laboratory, pharmacy, disease control, maternal health, surgical operations and occupational health. However, data utilisation in the service is often hindered by weak organisational structures and a myriad of challenges both inherent and external. This includes a lack of data utilisation among decision-makers, low motivation, inadequate trained staff, lack of technical skills and technology, particularly, at the lower levels, and poorly funded M&E activities. Most health facilities produce data for the purpose of reporting to the national office and not for internal use. The use of data for internal decision making is very low and not part of the culture of most institutions.

BOLD:
critical factors

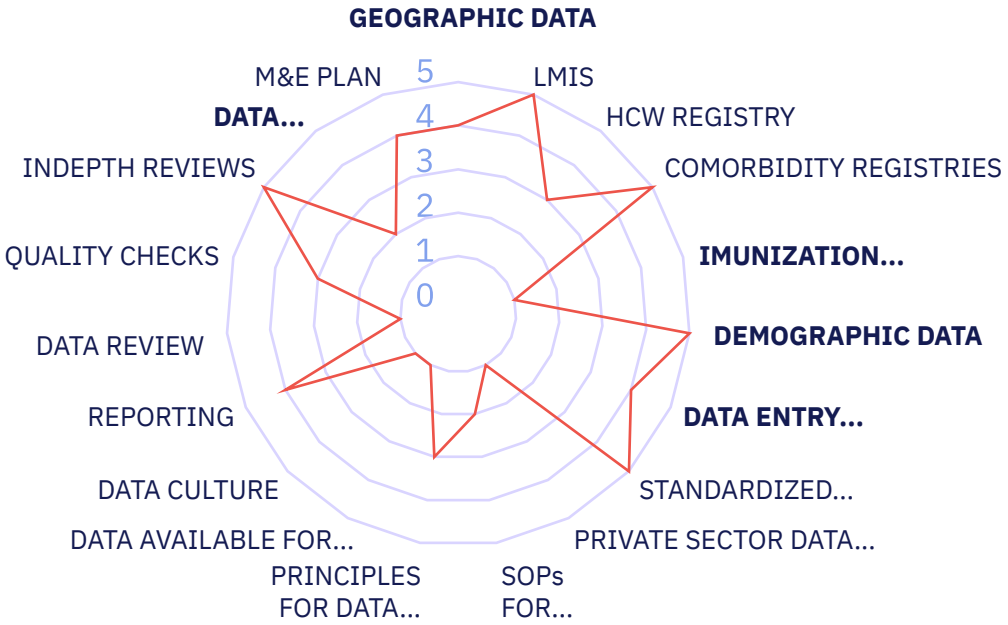


Figure 8 *Performance of Critical and Enabling Factors in the Data and Data Use Domain of the EDIT Tool*

Human resources in Digital Health (Human Capacity, Data Use)
Most often, ICT capacity building initiatives are directed towards end user training in the use of a technology rather than the transfer of technical skills for the long-term sustainability of the projects.

Key technical support staff building and maintaining existing digital health infrastructure do not have current professional accreditation in their specialist field. GHS has difficulty in attracting and retaining skills such as cloud infrastructure engineers, data scientists, and data architects due to lack of competitive salary scale and career progression. Internal ICT support is very weak at all levels due to weak oversight responsibility for ICT services that are outsourced. From various reports on capacity for ICT in the health sector, it has become increasingly clear that not much priority is placed on ICT in the health sector. Studies have identified challenges in upskilling health service personnel to manage new digital technologies, as well as the additional burdens that these technologies can place on frontline health workers in rural areas e.g. in terms of the handling and security of devices and data entry.

BOLD:
critical factors

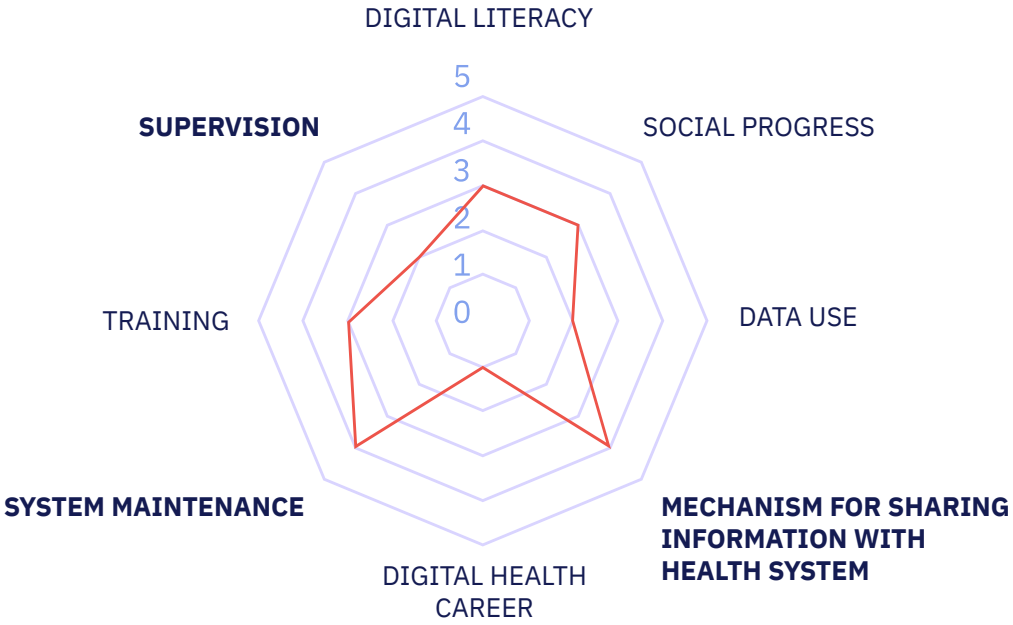


Figure 9
Critical and Enabling Factors in the EDIT Domain Human Resources

Ghana is updating its Digital Health Strategy, and in doing so can build on an encouraging state of digital health readiness. Though attWention needs to be paid to several important issues such as identity management, rural infrastructure development, increasing digital health skills and the ability to troubleshoot IT problems at District level, fundamentally the foundations are all in place and now need to be built on.

3.3 WP3: Opportunities

The table below presents the number of digital tools reviewed during this assessment in Ghana grouped by the outcome of the usage status at national level.

Out of 63 tools identified in the M&M Dataset for Ghana, 16 could be validated as present and relevant for pandemic preparedness, 21 tools were not used in the context of DPP and 23 tools were not operational at the time of assessment. We further identified 15 additional tools that were considered relevant for pandemic preparedness and response.

Table 1 *Overview of tools assessed in Ghana*

Assessment status		Software solutions
Assessment Conducted	1	Lightwave Health Information System
	2	Health Declaration Form
	3	OpenMRS
	4	Community Health Toolkit
	5	DHIS2 (DHIS2 + Aggregate + Tracker)
	6	e-learning modules on COVID-19
	7	Ghana Integrated Logistics Management Information System (GhiLMIS)
	8	Telemedicine
	9	GxAlert
	10	Health Administration and Management Systems (HAMS)
	11	Hello Nurse
	12	Integrated Disease Surveillance and Response (IDSR) (DHIS2)
	13	One Network/Resolve (OpenLMIS)
	14	Real-time COVID-19 Tracker
	15	SORMAS
	16	Zipline
	17	Redbird app
Decommissioned	1	Ada Health App
	2	AfriDoctor
	3	Bahmni
	4	CAD4COVID
	5	COVIDConnect
	6	DiHPART

	7	Early Warning System (Commcare)
	8	e-Blood
	9	E-Learning Modules for Midwives
	10	Elearning Moodle
	11	EMPower II
	12	End-Use Verification (EUV) Activity surveys
	13	iHRIS
	14	Millennium Villages Global Network (MVG-NET)
	15	mNutrition
	16	Mobile Midwife
	17	mSupply
	18	No Yawa
	19	OpenHDS
	20	RapidPro
	21	RECOVR (ODK)
Not useful for Pandemic	1	Airtel Insurance
	2	Cadasta Platform
	3	iCycleBeads™Smartphone Apps
	4	IFPRI Agricultural Survey (ODK)
	5	Peek Solutions (RAAB7 & Peek Acuity)
	6	Safe Delivery App
	7	Vantage
	8	Zero Mothers Die
	9	Zzapp
	10	mNutrition
	11	mPharma
Useful but could not find key individuals with knowledge for interview	1	Amplio Talking Book
	2	Blood Information System
	3	Commcare
	4	Community Health Toolkit
	5	Covid-19Triage Tool
	6	Eneza Education
	7	Fionet
	8	HIPSTER (ODK)
	9	mPedigree
	10	MSME IVR survey tool (Viamo)
	11	Viamo 3-2-1 Service
	12	World Continuing Education Alliance

At first only two (2) categories seem to not be served. For all other categories as shown in the table below, there is at least one opportunity that could be deployed nationally. The opportunities represent digital tools that can be adapted very quickly and more easily to the country context if needed.

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

Figure 10 *Opportunities of Digital tools operational in Ghana by use case*

3.4 WP4: Gaps and Interpretation

The opportunities of the digital tools have been validated against the implementations at national level. Email based surveys and individual interviews with key informants and stakeholders were mapped and analysed against the 14 DPP categories and 64 sub functionalities as described in Chapter 2 DPPA Tool and Methods.

The table below shows in detail the gaps identified. As a result, in addition to the two (2) categories that were underserved in the opportunities landscape, other DPP categories were identified. A total of 15 functionalities across 8 DPP categories emerged.

It is also important to note that some of the gaps were justified by the inadequate context in the landscape for the implementation of some digital tools. This also justified the lack of opportunities for these gaps.

Some features have emerged from the pandemic, such as the One Health approach and micro-planning of large-scale immunisation campaigns. The country just hasn't had time to adapt adequate digital tools to address these aspects.

A more detailed overview of the gaps based on existing tool opportunities are in ANNEX 3.

No.	DPP Functionalities	Software packages: DEPLOYED	Software packages: Existing but NOT DEPLOYED
1.3	Early Warning Surveillance based on data from web searches for common symptoms or social media sentiment analysis (or keywords)		
3.7	Unidirectional communication with client via messaging (e.g. SMS, social media, in-app, WhatsApp)		
3.8	Bidirectional communication with client via messaging (e.g. SMS, social media, in-app, WhatsApp, email)		
4.5	Unidirectional communication with contact via messaging (e.g. SMS, social media, in-app, WhatsApp)		1
4.6	Bidirectional communication with contact via messaging (e.g. SMS, social media, in-app, WhatsApp)		
6.7	Big Data analysis (e.g., mobility monitoring based on mobile phone data, rumour monitoring based on social media analysis)		1
11.1	Tracking of infectious disease outbreaks in domesticated animals (livestock etc)		1
11.2	Tracking of infectious disease outbreaks in wildlife		2
11.3	Ecological surveillance of environment for changes that could increase risk of zoonotic infection		2
13.1	Integration with immunization registry		1
13.3	Vaccination/immunization delivery monitoring, tracking and follow-up at client-level		1
13.4	Reporting on adverse effects		1
13.5	Digital vaccine certificate support		1
13.6	Microplanning		1

Table 2 *Gaps by DPP Functionality*

3.5 WP5: Recommendations

The future of managing public health pandemics is likely to be increasingly digital and recognizing the importance of digital technology in this field and in pandemic preparedness planning has become urgent. Public health measures for outbreak response remain relevant today, including surveillance, rapid case identification, interruption of community transmission and strong public communication. Monitoring how these measures are implemented and their impact on incidence and mortality is essential.

The recommendations made here are intended for managing future pandemic outbreaks in Ghana. Some lessons have been learnt and it is important for the government to lead a comprehensive review of the overall country response to COVID 19 pandemic to come out with lasting solutions. The recommendations are not exhaustive and exclusive. Instead they are designed to ignite and facilitate discussions around the sort of digital health ecosystem needed to support the public health digital solutions required for future pandemic response.

3.5.1 Improve the Digital Health Ecosystem

The analysis of the digital health ecosystem and the EDIT tool reveals several topics that need to be addressed to enable the digital health ecosystem to support the public health digital solutions that will be required for future pandemic response.

R1.1. Update eHealth Strategy

The recommendation is for development partners to support the MoH with technical and financial support to revise the current eHealth strategy which is more than 12yrs and out of date with current developments in pandemic preparedness and innovations in ICT. This could be achieved through an all-inclusive multi stakeholder approach including collaborating with all actors within the communities of practice and with consideration to the following core components:

(1) leadership and governance **(2)** investment and operations, **(3)** services and applications for scaling up **(4)** integration and sustainability, while **(5)** standards and interoperability are respected; **(6)** a flexible digital infrastructure; **(7)** an adaptable health workforce and **(8)** legislation, ethics policies and compliance; and **(9)** a people-centered approach.

These activities need to align with the national requirements for delivering health services support with digital technologies, and available guidance, e.g., from the WHO, and AU. The strategic aim for this exercise is to develop cross-sectoral partnerships at national level to align resources and investments to ensure the sustainability and growth of digital health.

The technical team should consider defining the national digital health architecture blueprint or road map, adopt open-source health data standards and aim for reusable systems or assets including interoperability of health information systems at national and district levels to establish an innovative integration of different digital technologies using shared services, ensuring data are of good and comparable quality.

In developing the eHealth strategy, the team should identify and promote sustainable financing models in support of digital health development and sharing of learning to inform future products and services. This is especially important in the era of big data, artificial intelligence including machine learning, implementation, integration, and maintenance, including economic incentives; and design, implement and monitor a change management plan, to support conducive organisational behaviour surrounding newly digitised health processes and practices.

Estimated cost for developing or updating eHealth strategy is around $250,000, the cost includes consultant fees, stakeholder engagement and dissemination. This activity will take 6-12months to complete.

R1.2. Build New Data Warehouse Infrastructure

There are numerous digital health solutions in both public and private healthcare organisations in the country. Currently, 40% of healthcare providers are private and most of them do not provide data consistently to MoH for official statistics which means the government may be under counting certain diseases by almost 40%. Furthermore, during the pandemic, most applications and platforms could not support bidirectional communication; there is no data warehouse infrastructure that could support structured and unstructured data for analysis for evidenced-based decision making.

Most of the existing data warehouse being used in the health ecosystem supports mainly structured data. However, a huge amount of data generated across health facilities is unstructured. It is recommended that MoH supports the modernization of the current data warehouse to host both structured and unstructured data (Data Lake). Technologies such as Artificial Intelligence, Machine Learning and Natural Language Programs will be harnessed to support data analysis and insight into data. The decision whether to build on-premises or cloud data warehouse should be influenced by a strong business case and extensive consultation.

Being proposed for consideration, therefore, is that development partners support MoH explore this approach. The intent would be to acquire digital health solutions consisting of a combination of best-of-breed infrastructure and data warehousing technologies, applications and organisational best practices that collect, integrate, analyse and present large amounts of data from heterogeneous sources and extract useful knowledge from it. The underlying technologies encompass a series of tools, architectures, information services and communication infrastructures that are useful for the data integration and analysis from heterogeneous data sources. The primary objectives for proposing testing and then building a new data warehouse infrastructure for the healthcare ecosystem in Ghana are:

A.
To ensure comprehensive and seamless data capture, cleaning, and storage.

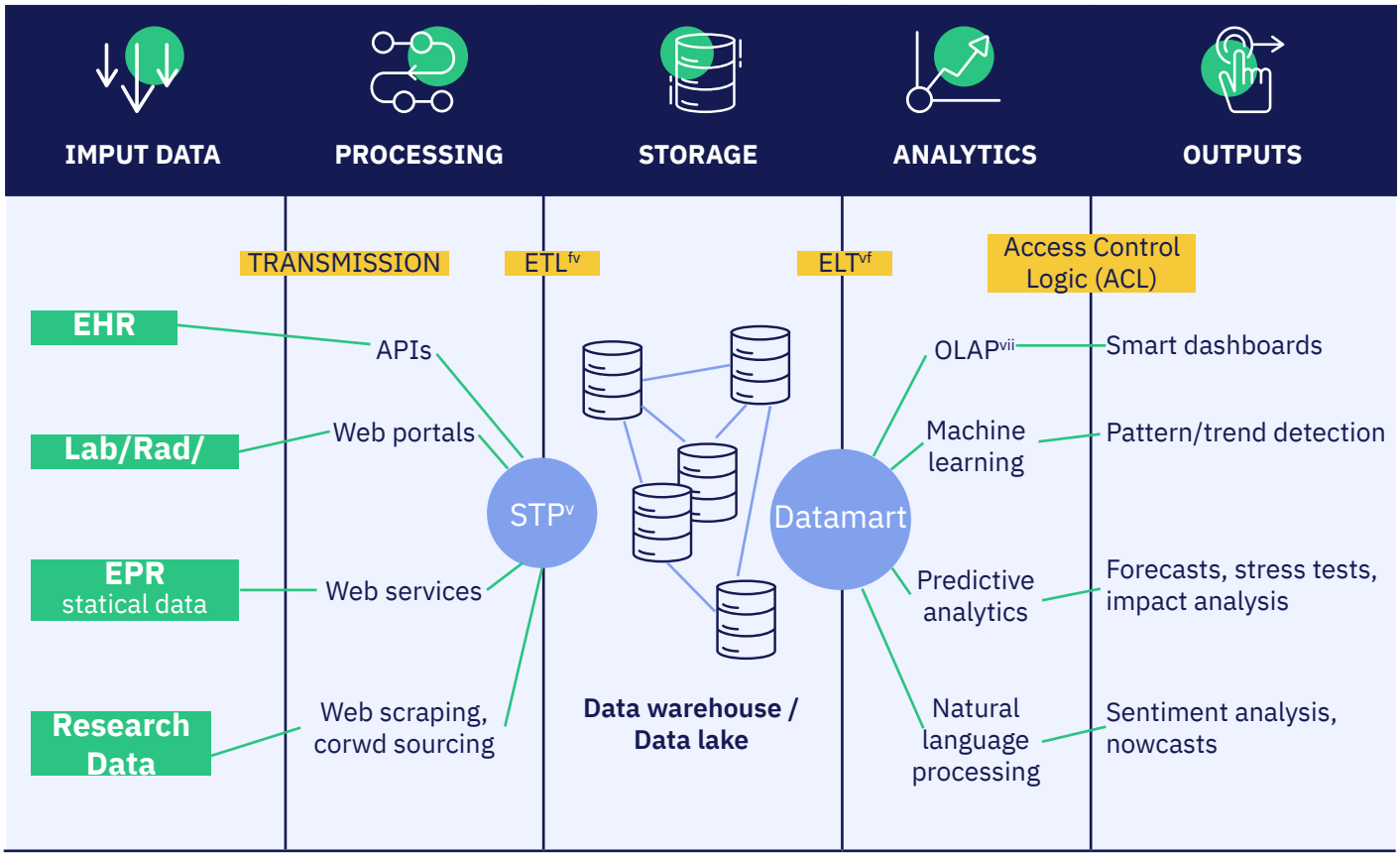
B.
The ability to readily manipulate and analyse data within a single environment large and multiple types (structured and unstructured) of data.

C.
To provide an innovative data source in the production of official statistics.

D.
To ensure accurate decision-making based on interpretation of data.

Data lakes, as data warehousing architecture, allow for greater scalability, versatility, and computational power than existing data portal databases. The key difference lies in the shift from a traditional Extract, Transform, and Load (ETL) workflow in data warehousing and analytics, to a new Extract, Load, and Transform (ELT) process. In other words, "streams" of structured and (crucially) unstructured data from various sources fill the lake without needing to be configured to meet the specific requirements of the platform. Authorised users can come to examine, "dive in," or take samples of the lake as they please. The data can be transformed on demand for visualisation, analysis, or export. With the advanced technology and data storage options of data lakes and Big Data tools, datasets can be "stacked" and analytically overlaid to extract new meanings.

Figure 11 *Proposed Data Warehouse Architecture*



MoH will then make available API web portals, and web scraping tools to all private and public health institutions for free and incentivise them to connect digital health solutions - including Electronic Health Records Systems (EHRS) to the APIs for seamless reporting to the national system. The estimated cost of building or modernising data warehouse infrastructure is $6.5 million. Building a hybrid data centre with cloud infrastructure, hadoop software, analytical tools, development of APIs, network equipment and capacity building. This activity will take 12-24 months of implementation.

R1.3. Update Telemedicine Infrastructure and Develop New Business Model

Telemedicine and remote consultation have already proven to be effective at a time when access to health services for patients who do not have COVID-19 or for patients with nonacute COVID-19 is prevented, impeded, or postponed. Currently, GHS and MoH have telemedicine infrastructure which is being underutilised in various regions across the country. Digital tools such as telemedicine should be integrated into MoH guidelines for public health preparedness, alongside the definition of national regulations and funding frameworks in the context of public health emergencies. But there are some more specific recommendations too.

Firstly, support from development partners will be welcome to upgrade existing telemedicine infrastructure, business models and use cases in preparation for future pandemics and attainment of universal health coverage in the country.

Secondly, it is recommended to support the GHS to continue to improve the telemedicine services e.g., for appointments, patient management, lab request forms and basic electronic prescription functionalities to support the management of Teleconsultation practice across the country. GHS must also develop multiple use cases and business models that support financial sustainability of the Telemedicine centres outside central government budgetary support. Consideration should be given to financing models such as co-payment and private insurance.

The estimated cost should be around $2.5 million. This includes upgrading teleconsultation infrastructure, developing case management software with integrated ePharmacy, eLabs. Stakeholder consultation and new business model implementation. This activity will take 12-18months for implementation and capacity building.

R1.4. Integrate National Data Warehouse with Lab Information System

To prepare for future pandemics, the MoH should prioritise integrating, extending functionalities, and modernising certain key platforms and applications for the short to medium term (1-3 years) to ensure that the country is ready for the next pandemic.

In particular, the MoH should be supported with technical and financial resources to integrate the Laboratory Information System with the new data warehouse through the deployment of Application Programming Interface (API) to connect all major analysers to report data directly into the data warehouse. MoH should explore the possibility of developing or procuring APIs that support multiple analysers and make them available for free to all labs in the country to connect to the national data repository. And there should also be a policy document that spells out standards for future lab information systems across the country for easy and fast integration. Estimated cost is $800,000 for developing, configuring and nationwide wide deployment with estimated 18-24 months implementation timeline.

R1.5. Mirror SORMAS Functionalities in National Information System

The current SORMAS is partly integrated into health delivery structures of the MoH and there is the need of an in-house technical support team to continue improving or adapting the platform. Sustainability of the platform currently depends on external continuous support from development partners. Nevertheless, SORMAS has a range of functionalities that can be harmonised and mirrored in the case management information system that is used across the country for future pandemic

management. It is also important not to have too many parallel systems with the same capabilities deployed across the healthcare ecosystem. Future pandemic case management applications should be concentrated in few platforms to track longitudinal management of cases. Estimated cost is $50,000 and should take 6 months to complete.

R1.6. Develop/ Integrate Immunisation Management System in HMIS Ghana

During a pandemic improving vaccine coverage for individuals and measurement of immunisation program performance and management, research, and population health are very critical. However, currently, the MoH does not have an immunisation recording system (IRS) which is integrated with the public health system to track performance longitudinally (but just another silo application to record the vaccine given). The objective should be for an Immunisation Recording System to store patient vaccine history at the individual level, which helps identify defaulters and reduce dropout rates at the program level and provides data to support resource allocation and strategic planning at the population level. Across levels, (IRS) that capture individual-level data provide an opportunity to redefine traditional vaccine indicators and conduct more timely, granular analyses to support decision-making. IRS will enable immunisation programs to explore outcomes of interest beyond vaccine coverage, including longitudinal outcomes at the population and individual levels. As the IRS is costly to introduce and maintain, it is important for decision-makers to consider all possible benefits to justify the investment.

Development partners should support MoH to either develop a new Vaccine Management System in the national information system or integrate the existing Vaccine management system.

Estimated cost $300,000 and will take 12-18months to complete.

R1.7. Develop Data Science Skills Capabilities

Data science and big data analytics can provide practical insights and aid in the making of strategic decisions concerning the health system. It helps build a comprehensive view of patients, consumers, and clinicians. Data-driven decision-making opens up new possibilities to boost healthcare quality. Currently, MoH does not have various categories of data science professionals to process, manage, analyse, and assimilate the large quantities of fragmented, structured, and unstructured data created by healthcare systems. Big data and its utility in healthcare and medical sciences have become more critical with the dawn of the social media era platforms such as Facebook and Twitter. We recommend that Development Partners work together with MoH to identify gaps and develop a roadmap for data science skills development and retention in the healthcare ecosystem. Partners could support MoH with scholarships and opportunities for continuous professional development especially in areas such as Artificial Intelligence (AI), Machine Learning (ML) and Natural Language Processing technologies. Also, MoH can leverage existing popular eLearning platforms such as Udemy, DataCamp and Coursera by procuring licences or buying courses for staff to develop data science skills.

The estimated cost is $2.5million and 10yrs to develop data science skills across the healthcare ecosystem.

R1.8. Integrate Port Health Declaration Form with Case Management system

Presently, when suspected cases of Covid 19 are identified at the country's ports of entry there is no case management system and follow up system for the suspected clients to be tracked. The existing Port Health Declaration form is not integrated with any system outside of the Kotoka International Airport. The system needs to be integrated with public health case management and lab systems. It is important MoH is supported to integrate port health systems into systems such as DHIS2, Light Wave and SORMAS. Alternatively, any of these systems could also be adapted to mirror functionalities in the Port Health Declaration System. The estimated cost of integration is around $80,000 and 12 months to complete.

R1.9. Develop Master Patient Index

Unique health identification underpins integrated health care. The MoH should be supported with technical and financial resources to develop an enterprise master patient index (EMPI) product that can easily be automated and integrated into a solution for creating a "single source of truth" for patient identity and demographic information. The Patient Index will be pre-configured to work with Health Information systems across the country. One attractive option is to achieve this through the highly successful biometric registration system where citizens over the ages of 16yrs have been given a national ID card. MoH can leverage this national register to create a master patient index enterprise solution to provide primary patient ID for most of the population but will need to ensure there is appropriate confidentiality and security.

The estimated cost of providing this enterprise solution is around $900,000 and 12 months to develop, configure and deployed

R1.10. Establish eHealth Secretariat

Most of the digital health solutions do not adhere to terminologies and clinical coding standards such as ICD10, SNOMED CT that are the foundations and data standards for systems interoperability and integration between digital health designs. This has resulted in interoperability problems across the healthcare ecosystem.

During the Covid 19 pandemic, there was no central technical eHealth body coordinating and evaluating ICT solutions for deployment. A lot of solutions were deployed without engaging MoH and GHS IT staff for their inputs. The recommendation is for MoH to strengthen a Health Information Systems (HIS) governing body and its TWGs and mandate it to drive the eHealth agenda in the country through development of HIS policy, guidelines, strategies, and standards with a clear delineation of boundaries between eHealth and general IT projects within the Ministry of Health which would be responsible for maintaining the infrastructure and other non-clinical technologies within the Ministry. The proposed eHealth Secretariat would work in liaison with other similar working groups regionally, nationally and/or around the world to facilitate joint learning through communities of practice and curriculum-based training initiatives to enhance country capacity on digital health and maximise the impact of both new and existing collaborations and partnerships in the wider digital health ecosystem at national and international level.

Estimated cost for establishing eHealth secretariat is $500,000, and it will take between 12-24 months.

R1.11. Use existing social media networks.
Facebook, WhatsApp, and Telegram social media tools are very popular and have a high market penetration and user volume in Ghana. Most of these platforms have extremely user-friendly functionalities, which could enable health authorities to engage and closely monitor citizen health status and behaviours to reach near 50-60% response rate. The Health Ministry is not actively engaging and educating citizens through these social media platforms which are popular and accessible. There is a genuine fear of misinformation on most social media platforms. However, it is the most cost-effective means of engaging citizens and disseminating information and these platforms could also be harnessed to become official channels for debunking myths and outright untruths.

3.5.2 Digital Pandemic Preparedness

R2.1. Consolidate and Use Surveillance and Case Management Dataset The recommendation is for MoH should consolidate surveillance and case management tools and applications into one or two of the most widely used systems to bring together diverse datasets for infectious-disease emergency preparedness and response. Case management data sources need to be integrated into the formal surveillance landscape and have a role to support future epidemic surveillance.

Chatbot applications and AI tools could be harnessed intelligently to communicate with clients. MoH to liaise with data providers to ensure various data sources and types can be combined and analysed

R2.2. Development of digital tools for self-declaration and anonymous self-detection of proximity
MoH should consider how to adopt or leverage emerging international frameworks with varying levels of privacy preservation such as, Decentralised Privacy-Preserving Proximity Tracing, the Pan-European Privacy-Preserving Proximity Tracing initiative and the joint Google–Apple framework. They could be evaluated and incorporated into a large framework.

During the initial phase of the pandemic attempts were made to deploy contact tracing and proximity tools but serious challenges emerged leading to abandonment of these initiatives. There were concerns that mobile phone location data could violate privacy and civil liberties if it became available. An effective contact tracing will have to rely on the goodwill of the population to keep their Bluetooth signal on in public areas and it will be difficult to enforce and ensure compliance across the country.

R2.3. Increase investment in two-way communication messaging with clients
During the initial period of the Covid 19 pandemic attempts were made to develop and deploy two-way communication messaging with clients or patients. However, this was not possible due to several reasons; there were no platforms or infrastructure within the healthcare ecosystem to support collection, transformation, and analysis of both structured and unstructured data for decision making. Tools such as machine learning, Artificial Intelligence and Natural Language Processing have not been deployed extensively for use in the healthcare ecosystem. Also, Ghana has many local languages, and the messaging system only supports the English language, which means most of the population who are not literate in the language cannot use the system. Analysing two-way communication requires data science professionals, unfortunately these skills set are currently lacking

within the healthcare system in Ghana. The recommendation is to increase funding and invest in two-way communication tools, platforms and skills set to ensure MoH can leverage and harness them for effective communication and surveillance. Development partners can also support local tech start-ups to develop innovative platforms through local competitions and accelerated programs for some of these technologies.

R2.4. Interoperability Roadmap for Pandemic Preparedness

Enabling data exchange within and across healthcare organisations will require a paradigm shift towards the establishment within the environment of the healthcare providers of a vendor-neutral interoperability architecture that is modular, scalable, service-based, and secure. This in turn requires a reframing of purchasers' relationships with vendors, promoting a culture of partnership between them and supported appropriately by health policy. MOH needs to develop a national interoperability roadmap for pandemic preparedness that will be co-developed with all stakeholders in the digital health ecosystem and the broader health community. This will result in an agreed set of national interoperability specifications and standards, accreditation regimes and procurement requirements. A range of initiatives will be needed to engage the broader population in a discussion about how best to access and benefit from health information.

The roadmap must be costed with an activity work plan which will be an essential tool in lobbying for resources. To advance interoperability across the healthcare ecosystem in Ghana, there are several technological changes that need to be undertaken. The MoH should transition the national public and private health infrastructure to a common open API stack for all health use cases—throughout patient, provider, payer, public health, and other services. The logical front-runner is HL7 FHIR. MoH should develop a framework to transition completely to a standard set of open terminologies.

R.2.5. Introduce a system to support micro-planning of national and rural vaccine delivery

The WHO has developed a COVID-19 vaccine micro-planning framework[10] to guide national authorities responsible for immunisation programmes in the allocation and prioritisation of COVID-19 vaccines. This framework consists of eight (8) steps that should be reviewed and updated regularly as key characteristics of COVID-19 vaccines change.

Data related to this micro-planning framework such as target populations, stocks of vaccines and consumables, patients and human resources for health will have to be integrated in the country's digital information system. Therefore, completing the missing functionalities of micro-planning in HMIS can allow a very fast deployment of this framework in Ghana.

The deployment of a digital tool to accompany this framework should consider the following aspects:

- the ability to take a more holistic but also decompartmentalized and simplified view of available health human resources.
- the possibility to automate procedures, but also to speed up delays and to facilitate the dissemination of information.

[10]Guidance on operational microplanning for COVID-19 vaccination: interim guidance, 16 November 2021 (who.int))

- the digital tool must have the ability to schedule vaccinations according to variables such as the 6-week interval between the initial vaccination and the booster, the collection of data on notable side effects of vaccination must also be considered.
- to be able to consider an electronic vaccination register as well as the digital certificate of vaccination.

The software used should be open source, free of charge and have the capacity to interoperate and be supported by technical and financial partners who can support the requesting countries.

04 SUMMARY

The potential for Ghana's digital future lies in development of future plans to put these policies into action. This shift towards digital health could position Ghana to progress towards truly equitable access to digital, mobile, and eHealth services if these approaches are patient centred.

To conclude the assessment of this pilot DPPA in Ghana, a meeting was held to gather comments and suggestions from the ministry and other key stakeholders. Participants from the were represented below:

- The GIZ DeveloPPP program, Sector program Global Health and digital Health
- The Ministry of health
- The GHS
- The World Bank
- The Centre for Health Information Management
- Policy, Planning and Monitoring and Evaluation (PPME) Directorate

Are there any additional stakeholders?

There are further stakeholders and divisions of the Ministry that could have been further assessed. Further interesting stakeholders could have been:

- National Information Technology Agency (NITA)
- National Identification Authority (NIA)
- National Health Insurance Authority (NHIA)
- United States Agency for International Development (USAID)
- Japan International Cooperation Agency (JICA)
- Department for International Development (UKFCDO)

The views and support of the above stakeholders will be most welcome as the findings of the DPPA are converted into action.

Are there any further ongoing initiatives towards the assessment of the ecosystem?

The MoH is in consultation with the World Bank for technical and financial support towards implementation of digital health solutions such as Telemedicine. As part of this initiative, there will be some level of assessment to understand the ecosystem. The World Health Organisation (WHO) is considering having the validated list of opportunities and implementation of this DPPA assessment integrated in their Digital Health Atlas[11].

Are the recommendations covering the needs of the digital health ecosystem?
The 14 categories and 64 DPP functionalities have been used to generate the gaps and recommendations. It was requested to further expand these categories and functionalities to covers:

- More use cases around Telemedicine
- More use cases towards gender and women related health
- One health

Are there any further Digital Health Solutions Inventory which needs to be capture?

The big majority of the software that are used at national level have been covered and assessed by the report. But it is important for a digital solutions inventory similar to DPP conducted every year to understand existing and functioning technologies operating in the country and also to take into consideration the maturity level of most the applications. Close attention should be paid to private sector and charitable health organisations since they constitute 40% of health delivery in Ghana. Future inventory requirements should also focus on hardware infrastructure and skills level and development of key ICT staff at the district, regional and national level to support the digital health ecosystem.

How can the recommendations be prioritised?

First, the Ministry should review the recommendations in an internal round. Afterwards a prioritization workshop shall be organized with the implementation partners to see how to address the most urgent, important, or easy to implement recommendations. During this workshop, time frame for the implementation or necessary further evaluation and estimated amount could be reviewed for each of the recommendations made. This will facilitate decision making and commitments at the partner level.

In the context of the DIPC project, what would be a challenge that could be addresses?

The Digital Innovation for Pandemic Control Project (DIPC) of GIZ aims to compensate for one of the gaps identified at the national level. It is within this framework that a challenge needs to be formulated by the Ministry to the GIZ (DIPC) team based on the recommendations of this DPPA. The challenge will be addressed within a WFP-led Accelerator Program (WFP-World Food Program) and funded with a threshold to a maximum of €250k to the winning vendor. To promote local or regional vendors, the challenge will be published in local and regional networks. The Ministry shall also be actively supporting the WFP in the selection of the winning solution and vendor.

How can partners be engaged to facilitate the implementation of certain measures?

After prioritizing the recommendations, this DPPA report should be consolidated to include the prioritized results of recommendation in the Annex and shared with the secondary actors. This will help define the way forward with each partner in a bi- or multi-lateral manner.

This evaluation should be repeated after the implementation of some recommendations to allow for an assessment of the improvements and changes made.

ANNEX 1: List of persons consulted

No.	Name and surname(s)	Structure of origin	Title
1	Eyram Tawiah	Lerti Arts	Lead developers for Hello Nurse App
2	Mr. Antwi	System for Development	Implementor GHILIMS
3	Sam Ampomah	Ministry of Health	Head of Information Technology at the Ministry of Health
4	Sam Quarshie	Ghana Health Service	Head of Information Technology at the Ghana Health Service
5	Alex Yeboah	Ministry of Health	Elearning Coordinator- MoH
6	Joseph Baah-Sakyi	Millenium Promise	Lead developer for HAMS and Port Health Declaration system
7	Mr. Bempeh	Ghana Health Service	Head of Information Technology at Center for Health Information Management (DHIS2)
8	Mr. Konrad	Mampong Scientific Research Hospital	Lead technical advisor for OpenMRS use and deployment.
9	Dr. Boakye Boateng	Ghana Health Service	Lead strategic advisor Telemedicine project for GHS
10	Dr.Andrew Ayim	Ghana Health Service	Policy, Planning and Monitoring Evaluation (PPME)
11	Dr.Adriana Ignac	SORMAS	Consultant for SORMAS Project
12	Dominic Atweam	WHO- Ghana	Technical Specialist, WHO- Ghana

Table 3 *List of persons consulted*

ANNEX 2: Qualitative EDIT interviews

EDIT CATEGORY	Notes on the Critical Indicators
Human Capacity	The MOH does not have adequate staff with skill sets in e-health systems. The few staff who have undergone professional IT training are not involved in mainstream ICT related activities because the existing Human Resource establishment post does not have a structure for ICT professionals. There is no routine or formal training within MoH for professionals with clinical and non-clinical background in ICT related courses like networking, systems administration, database administration, security, fundamentals of computing and web based systems etc. The MoH relies mostly on temporal digital workforce staff who are on short term contract (National Service Personnel) to fill in the gap in areas in most health facilities. NSP with computer science /information systems degree are posted to health facilities across the country, however, the posting are not evenly distributed across health facilities, there is rural urban divide in NSP allocation and skill mix is not a major consideration in posting NSP to health facilities. Most persons driving and managing the existing e-Health Infrastructure and initiatives have not had proper professional training. With the few who have had some professional training, the Human resource scheme of service does not recognize such professionals and are most often placed in areas where they do not get involved in mainstream ICT related activities. Biostatisticians and regional information officers double as ICT experts. Most ICT capacity building initiative is directed at user training in the use applications rather than transfer technical skills for the long-term sustainability of the projects. Internal ICT support is very weak at all levels leading to a very weak oversight responsibility for ICT services that are outsourced. From various reports on capacity for ICT in the health sector, it has become increasingly clear that not much priority is placed on ICT in the health sector. There are three levels of digital skills that have been identified and necessary for the healthcare economy in Ghana: basic, intermediate, and advanced digital skills. These skill sets are in high demand today, with many job profiles requiring the possession of basic and intermediate digital skills, while the high-tech industry needs advanced or specialist skills to sustain the innovation momentum. The issue of ICT skills for health professionals and eHealth workforce has been garnering increased interest from all relevant stakeholders in health and as a result Ministry of Health introduced ICT training into the curriculum of health training schools and built ICT training centers in all nursing and allied health training schools across Ghana. Development partners such as the USAID also provided technical support and deployed eLearning platforms and contents for

	55 Midwifery training schools. Investigation for this report could not find a practical implementation of an ICT competence framework upon which to model a roadmap or methodology for this assignment. However, the general standardised ICT training in health training schools is critical and serves as a baseline for all health professionals and set the scene for further specialisation. These ICT training can be expressed as competences and standardised in healthcare, applicable to any system, anywhere. These training, both practical and theoretical must be accompanied by assessment and recognition of achievement, but most importantly must be based on individual needs. One single solution will not suit everyone. Competence frameworks can act as a 'non-invasive' check of a health professional's ICT competence and then be a structure upon which to design suitable training interventions or CPD programmes.
Standards and Interoperability	MoH should resource and strengthen regulatory agencies (especially Health Facilities Regulatory Agency (HEFRA)) to roll out a nationwide accreditation process with clear links to facility-based quality management teams for ongoing improvement action. HEFRA should standardise the collection of facilities data and improve use and analysis of data at all levels for evidence-based decision making. Implementation of National ID cards will go a long way to improve the ability of health institutions to be able to unambiguously identify individuals. Now, digital health systems are in silos and some health institutions still rely heavily on paper-based processes, hence it is difficult to identify people without significant challenges.
Governance and Policy	Ministries of Health involvement in leading the process to coordinate digital health solutions has increased, with support and capacity-building from several actors including agencies such as the USAID, KOICA. MoH are in the process of creating or updating national eHealth policies and strategies. A lack of clear standards and strategy at the national level is inhibiting growth of integrated digital health approaches. Greater collaboration between international organisations, governments, and local implementing organizations is needed to avoid vertical implementation of non-compatible or duplicative programs. Digital health will only be successful if its objectives are aligned with top level commitment, stewardship, accountability and transparency in the leadership and governance of the health sector. Having improved harmonisation and alignment is a key element of good governance and establishment of one national plan, one governing framework. There are weak institutional digital health governance structures that provide practical guidance to programmes and implementers Currently, guidance is provided on ad hoc basis from National Information and Technology Agency (NITA)

	in the deployment of network infrastructure and cybersecurity. MoH should strive to update/ develop and institutionalise eHealth governance structure internally as part of the new eHealth strategy. Policies and regulations supporting the establishment and implementation of the governance structures for digital health should be communicated to stakeholders extensively. eHealth strategy was developed in 2010 and technology has evolved over the last 12yrs without major changes.IT leadership at the MOH must make a strong business case for the eHealth strategy to be updated and costed as a matter of urgency because current strategy has outlived its usefulness in the current technological age. MoH should also engage development partners to support this initiative with technical (consultants) and financial resources to update existing eHealth strategy. Resource mobilisation will be central to the success of this project.
Data Capture and Use	Geographic data of public health facilities exist in the DHIS2 system and HeFRA has some public and private health facilities geographic data. Moving forward, MoH must facilitate data sharing between DHIS2 and HeFRA to reduce multiple collection of data. This can be easily achieved through deployment of API between HeFRA system and DHIS2 to support real-time transfer of data. The GhiLMIS implementation and integration not fully rolled-out across all health facilities, there are gaps in the critical pieces of data out of the national aggregate data in the data warehouse. GHILIMS functionalities should be extended to enable the platform to provide and receive supply plans and order/ shipment data on commodities, especially donations from development partners such as WHO, UNICEF and UNFPA. This will ensure transparency between the MOH and SMOs for supply plans, inventory/consumption data, and all order and shipment data for products where the MOH and SMOs coordinate. There are opportunities to include private sector data, with proper permissions and integration could lead to better understanding of private sector supply and demand. The GHS is currently developing Community Health Nurses activities in DHIS2 tracker, this will include immunisation registers. This will be rolled out across the country by the end of 2022. The GHS and development partners should allocate additional resources to ensure smooth implementation and take off after registers have been created in the DHIS2. Ghana conducted the national population Census in June 2021. All the demographic data is available for relevant government agencies. MoH should liaise with Ghana Statistical Service for the most up-to-date data. Also, the two organisations can establish a data sharing agreement/framework for future collaboration.

	GHS has enough administrative staff to perform data entry activities. The challenge is that certain data entry will have to be completed by the clinician in real time, but most clinicians have huge workload and are not able to input data directly. Secondly, most health facilities don't have computers in the consulting room to input data in real time. The potential solution is to provide digital devices to clinicians in the consulting room to support real time data input. MoH and GHS should collaborate to develop and implement a uniform national policy on data reporting and data use by health workers and health sector agencies. They should also monitor data improvement policy implementation in sector agencies, districts, and facilities (data collection, entry /reporting, local use). GHS/ MoH must strengthen leadership and ownership among stakeholders in the health system on data improvement through quality assurance and quality improvement at all levels, in all sub-sectors and in all sector agencies with healthcare ecosystem. GHS should decide and apply indicators for monitoring the implementation of data improvement plans, policies, and outcomes in the priority areas. MoH must use data improvement standards to assess departments of the facility and determine underperforming departments, for mentoring and make recommendations for improvements, with reward systems. GHS must determine sanctions to apply to agencies, districts, and facilities for consistently underperforming and not complying with data reporting responsibilities or reporting standards over a period of time. Use national standards to assess institutions and determine underperforming institutions, for mentoring and make recommendations for improvements, with reward systems.
Investments and Funding	Decentralisation in the health sector and costings and planning responsibilities across levels of government and development partners should support MoH and GHS with external resources/ consultants to facilitate long term planning and costing of digital health solution for the next 5yrs. ICT managers must take the plan and engage stakeholders and leadership of GHS and MoH to make a strong case for investment in digital health solutions. Priority areas should be identified, and resource allocation should be dependent on needs of GHS not on donor partner requirements. The team must develop a long-term roadmap for updating and costing the plan. The contribution of Ghana's ICT sector to the overall GDP (about 3.6%) of the country has grown steadily over the years, becoming one of the best performing sectors in the country's economy. In 2020, the contribution of ICT services was $2.2 billion, or 3.6 percent of the overall GDP of Ghana. The combination of a competitive market structure, an improved international connectivity, an increase in private sector investment, and a reduction in telecommunications prices, at the wholesale level, has been instrumental in fuelling innovation and investments in the broader ICT sector, been instrumental in fuelling innovation and investments in the broader ICT sector, including in IT and IT-enabled Services (ITeS) and applications platforms for everything from finance and payments to agriculture and medical services. Ghana has a robust and competitive

	ICT sector with international connectivity provided by multiple optic fibre submarine cables, a nationwide optic fibre cable linking the main towns and near-national cellular cover age provided by multiple operators. This competitive ICT supply has ensured that the services are not only of high quality, but also have among the lowest costs in Africa, with high capacities for both local and international services. The foundation for this thriving market lies in the reformed ICT policy and regulatory environment of the sector. Indeed, in a paradigm shift, the government reformed the ICT sector from narrowband to broadband. The e-Transform Ghana project will harness information technologies (such as Wide Area Networks (WAN), the Internet, and mobile computing) to transform service operations. The project is a collaboration between the Government of Ghana (GOG) under the auspices of the Ministry of Communications (MOC) and the World Bank (WB) The electronic transformation intervention is aimed at changing the way government functionaries provide services. It will harness information technologies (such as Wide Area Networks (WAN), the Internet, and mobile computing) to transform service operations for a few government agencies including the health, educational, judiciary, sectors etc. Its major components include- • Component 1: Enabling Environment for Electronic Government; • Component 2: Common Services and Infrastructure for Electronic Government; • Component 3: Scale up of e-Services and Applications; • Component 4: Project Management Support. The project will involve the development of internet and computer networks and its expansion. It will be implemented nationwide across the three geophysical zones of Ghana namely the Coastal, Middle and Northern belts. Some potential positive project impacts include; (i) the improvement of intra-organizational and inter-organisational management due to the introduction of electronic network technologies and standards; (ii) introduction of environmentally friendly methods of operation for example, reducing material consumption through the shifting away from books to bytes, compact disks to MP3s.
Infrastructure	Most of the secondary and tertiary health facilities have functioning computers. CHPS compound and health post do not have computers. GHS with the support of KOICA is distributing tablets to support collection of health data, health post and community level. Most (96%) of health facilities in the country have mobile network coverage via either of the 3c mobile network providers in the country. With the support of Samsung Corporation most health facilities have at least 1 table and the government is also planning to donate 13,000 tablets to health facilities for data collection. These tablets were used in the recent population census by the Ghana

	Statistical Service. MoH should build the capacity of the ICT staff at the Regional and District level to be able to undertake planned maintenance of servers. It is also important for technical leads to identify and select Youtube Videos tutorials to help staff at lower-level use to build their capacity to maintain ICT infrastructure. Also, Service Level Agreement (SLA) with vendors should include support skills transfer and capacity building at the local level. Supporting staff to undertake server maintenance certifications. In-service training for district level ICT managers are crucial in maintaining business continuity of the infrastructure. Secondly, GHS must establish a call centre to provide second and third level technical support to district and regional managers to seek support in resolving technical issues. The call centre will enhance knowledge and skill transfer and also minimise costly travels to district offices to provide technical support on some trivial issues.

ANNEX 3: Detailed view of digital tool opportunities

Digital Tools	Description in the context of Ghana	DPP Categories
COVID-19 App TRACKER	This application enables health authorities to contact an individual who has exposure to a suspected or probable COVID-19 case. The Covid 19 Tracker App can be extended to support proximity tracing and automated mass contact tracing and education on probable epidemic related cases. The App has the functionalities that could be harnessed for health worker training on epidemic related through Video, Image, and sound educational materials. Also, the app could be harnessed to support Vaccine Passport if the government decides to implement it in Ghana. The Covid19 tracker could be leveraged for near real-time contact tracing among the general population. The tracker could also be integrated with referral and lab testing systems. The probable use of the App could be Vaccine Passport or immunisation passport for citizens. The registration functionality should use the National Identification Number as the unique patient identifier during registration to ensure the ID could be used across multiple systems and providers. The Covid 19 tracker should incorporate health worker educational materials via audio and video in regarding preventative measures like quarantine, handwashing, etc. The system should support viewing details on services delivered and patient status by healthcare worker/health facility. It should allow health facilities to input service delivered to patients related to Covid 19. The Covid19 tracker could be leveraged for near real-time contact tracing among the general population. The tracker could also be integrated with referral and lab testing systems. The probable use of the App could be Vaccine Passport or immunisation passport for citizens.	**Surveillance**

DHIS2	DHIS2 has been deployed nationwide since 2012 and has relied on local capacity with minimal support from DHIS2 Community of Practice. Over the years, a local team has managed to develop a tracker for TB, HIV, Maternal and Child Health and CHPS operationalization on DHIS2 platform. The DHIS2 platform could be extended to support several use cases and health programs. Currently, there is an ongoing programme to digitise community health outreach activities into the DHIS, that will integrate vaccination scheduling, management and tracking in the DHIS2. DHIS2 offers a number of mobile solutions, including SMS, plain HTML, and Java options for feature phones as well as a Web-based solution with offline support for smartphones. Clients can use their mobile phones for registering cases, events, and personal information tracking individuals, conducting surveys and collecting aggregate data. Other technical features of the software include the ability to use the application offline and open sourcing software. The DHIS2 can assist with the appropriate management of data in the health system through integration and aggregation of information, as well as facilitate data entry at the operational level of services provision. The DHIS2 system can be adapted for different health programmes and use cases to support service delivery within GHS from primary to tertiary. The DHIS2 has health coding standards and interoperability standards to integrate with multiple applications within the healthcare ecosystem. There is an ongoing programme to develop Rest API to connect DHIS2 with major brands of laboratory analyzers in major hospital and private labs in Ghana for seamless transfer of data from lab systems to the DHIS2. DHIS2's data visualisation abilities are limited. For example, there are restrictions with DHIS2 in sharing editable versions of a visualisation, however,by connecting DHIS2 to PowerBI, a powerful business intelligence tool has been beneficial for the DHIS2 community as it helps complement the limitations of DHIS2. This connection has enabled a wider range of visualisation and analytics and also serves as a bridge between DHIS2 and other applications that require visualisations, and finally, it provides analytical and data manipulation avenues with data from DHIS2.	**Coordination and Operations, case management, Monitoring, Laboratory systems, contact tracing, Interoperability, Training of health personnel, Analysis, visualization and use of data.**

	The ability to add new modules to the software based on the needs, localisation capabilities and the use of tools such as Access and Excel has made the DHIS2 software flexible. The software also has a high stability despite difficulties relating to access to electricity and the Internet in some locations. Most DHIS2 modules were not designed to function as a clinical tool, giving immediate feedback to the health worker based on pre-defined indicators. To function as a clinical tool, it is important that the system's workflow is designed to fit with the workflow of the health workers. **Opportunities** Currently the eTracker system (part of DHIS2) has been deployed as an Electronic Immunization Registry (EIR) to improve adherence to the national vaccination schedule and reduce drop-out rates. To ensure sustainability and use of health information systems, integration through extendibility and interoperability are necessary requirements for Ghana's health information ecosystem to overcome data redundancy, disparate systems, and parallel reporting. DHIS2 is the only viable platform that can help GHS to create a uniform HIS environment for data capturing and reporting, because of standardised reporting formats, forms and data elements. Currently, DHIS2 development follows a top-down development approach that concentrates mainly on the needs of the national level without active involvement of users at the lower level. GHS must follow a decentralisation approach based on participatory approach where users at the lower level have input in defining needs and requirements of the lower level.	
Ghana Integrated logistics management information system	Ghana Integrated Logistics Management Information System (GHILMIS) is a secure platform that has tools to support integration with host of other applications and platforms in the healthcare ecosystem (such as HAMS, DHIS2, Vaccine tracking App etc) that will enable automatic data collection, validation, classification, storage, analysis, and visualisation (reporting and dashboards). GHILIMS supports the collection of a wide variety of supply chain data and processing emanating from multiple sources. GHILMIS implementation and integration is not fully rolled-out across all health facilities; there are gaps in the critical pieces of data out of the national aggregate data in the data warehouse.	**Logistics Management**

GHILIMS functionalities could be extended to enable the platform to provide and receive supply plans and order/shipment data on commodities, especially donations from development partners such as WHO, UNICEF and UNFPA. This will ensure transparency between the MOH and SMOs for supply plans, inventory/consumption data, and all order and shipment data for products where the MOH and SMOs coordinate.

There are opportunities to include private sector data, with proper permissions and integration could lead to better understanding of private sector supply and demand.

GHILMIS should be integrated into broader supply chain management systems and District health information systems (DHIS) to enable deeper analysis, better workflows, and greater visibility across the health system. Successful integration with supply chain information system will ensure automatic supply chain data collection, validation, classification, storage, analysis, and visualization (reporting and dashboards).

By linking GHILMIS with DHIS2 and other Health Information Systems will lead to efficient sharing of the same codes such as facility and product code in DHIS2 applications to enable deeper analysis, such as comparing program service data with product consumption or stock availability. The use of API to link Health information systems across the country will automatically gather dispensing or utilisation data.

A comprehensive change management strategy should be employed in a concerted manner at health facilities level staffs on data quality issue, distribution of SOPs, stock cards, and any other necessary GHILMIS-related tools. Staff cannot complete their work without these tools, a foundational requirement for a strong LMIS system. There should be active and committed experts at every level who are engaged in decision-making about the new GHILIMS and who can be change agents among their peers. There should be user support resources for post-deployment support and mentoring, troubleshooting, bug fixing and others. The change management component is a long-term investment and should be factored into any new system by securing sustainable funding. And the GHILMIS should not remain static; structures should be put in place to enable continuous improvement and evolution of the LMIS based on changing circumstances like new products introduced, new distribution nodes or new facilities.

	Thirdly, GHS should quickly formalise LMIS responsibilities in job descriptions for all supply chain staff, especially at the last mile. The ability to coach staff into stronger performance starts by helping them understand their accountability. Integrating GHILIMS with other systems such as DHIS2 will require a high effort for data alignment, programming, testing, and implementation. In the case of the DHIS2, the CHIM and GHILIMS team can work together on a technical approach, pulling the data through the pre-defined DHIS2 WEB API. The technical solution will be mainly implemented by the Center for Health Information Management (CHIM) and GHILIMS team. This will lead to a well-structured DHIS2 management and GHILIMS system maintenance cycle that will prove to be a sustainable investment. It will also allow GHS to quickly respond to the needs of stakeholders such as the supply and procurement department and accommodate their data and reporting needs with a limited and predictable investment. It will put CHIM in a position to contribute to the rationalisation and simplification of the national Health System Architecture, gradually integrating the data management for more vertical programs, on the side of data entry and analytics. Building on the GHILIMS commodities experience will enable the CHIM team to have better understanding and experience with integration of additional logistics data from other stakeholders into the national DHIS2.	
hello nurse	The Hello Nurse App Interactive Learning platform can be adapted for teaching health and safety practices, encouraging attitudinal changes among the youth. The interactive game was designed purposely to engage and educate young adults who enjoy playing computer games. The interactive game app can be used as another channel of reaching out to young adults during epidemics for training. The app can be deployed rapidly, just by letting people download the app from google play store, it requires no training on usage and minimal technical support is required. Developing interactive games for learning requires huge capital outlay and diverse technical expertise. Hello Nurse App, was developed using donor funding, private sector technical expertise and project management from other development partners. The involvement of MoH in the development of the App was very minimal and enthusiasm for the App declined significantly when technical and financial support ended. As with most donor funded projects in Ghana Health Service, product ownership and budgetary support suffered and there was no further development and maintenance.	**Training**

	I will recommend GHS to use less expensive and sophisticated tools to develop interactive learning apps.	
Hospital Administration management system(HAMS)	There are many HAMS being used in both public and private health facilities across Ghana. Most of the HAMS are in silos and do not conform to clinical coding standards and health-care interface standards such as HL7 or FHIR. HAMS have billing and claim processing functionalities and have adopted standards that allow them to process claims from the National Health Insurance. In terms of reporting requirements, HAMS populates its internal data structure with all the relevant information regarding the hospital obtaining the static data from the central database either hosted locally or in the cloud. Health facilities in Ghana using HAMS experience high cost of software development, deployment and improvement and difficulty in migrating from manual processes, because both staff and patients are used to the manual processes and so are unable to speedily cope with the new system. Most health facilities lack IT "friendly" medical personnel, computer workstations and huge influx of patients visiting government hospitals makes the process of migrating to automated processes highly difficult. Attempts should be ma HAMS should be integrated into DHIS2, platform, Logistics and supply chain management system using API to provide vertical integration of health commodities management such as PPEs monitoring and reporting at the facilities level. MoH must make available API from the DHIS2 available to developers of HAM to facilitate seamless communication or reporting of data. To sustain innovation within the healthcare ecosystem in Ghana, it is important MoH to encourage implementation of varied HAM systems. However, MoH must define, develop, and enforce healthcare IT standards that facilitate seamless exchange of data between disparate systems. MoH is aggressively rolling out Light Wave information systems in most government health facilities which have HAMS, which will lead to gradual phasing out of HAMS in public health facilities.	**Coordination and Operations, Case management, Monitoring, Laboratory systems, contact tracing, Interoperability, Training of health personnel, Analysis, visualization and use of data.**
SORMAS	SORMAS is an open-source android and web application software developed for disease surveillance, notification, outbreak response and task process management, contact tracing and equipped with a laboratory module for management of laboratory samples and tests. It enables real-time data reporting via the technique of validated real-time surveillance data that prompts users to address challenges as they arise. The data visualisation (dashboard) platform on SORMAS is interactive and easy-to-use.	**Coordination and Operations, case management, Monitoring, Laboratory systems, contact trac-**

It was designed in a highly interactive and participatory way by those involved in public health surveillance and disease control – the Design thinking approach. The relevant actors of the public health service have also enjoyed concurrent data access and data security and confidentiality.

In addition, the Interoperability layer (Application Programming Interface) of SORMAS enables the harmonization of data with a range of data types from commonly existing surveillance systems, an important element of pandemic prevention. The system has moved from outbreak response to routine disease surveillance and now on the journey towards interoperability with DHIS2.

The capture and analysis of electronic medical records through the integrated case management module provide clinicians with a clear data trail to draw actionable insights using both clinical acumen and objective data to improve patients' episode of care.
The flexible, modular design of SORMAS affords the inclusion of new diseases, technical and functional features, which enables the platform to keep abreast of continual changes with the clinical, disease surveillance and outbreak management scope and landscape. The platform already covers epidemic and priority diseases including COVID-19 and an "emerging disease X' for the immediate inclusion of diseases as they emerge.
Major functional features of SORMAS inter alia: Digital notification at the point of care, case-based surveillance, bi-directional information flow, contact-follow-up management, task process management, response process management, digital medical record, outcome monitoring, outbreak detection algorithms, interoperability with common systems, open source, mobile offline capacities, inclusion of relevant actors, point of entry, multilingual platform, laboratory use, event-based surveillance, user-centred design etc

Opportunities
Review of SORMAS indicates that it is a mature system that can be scaled up to support high infectious disease burden, and, owing to the system's open-source design, can be further

ing, Interoperability, Training of health personnel, Analysis visualization and use of data.

	adapted to meet specific public health needs of Ghana. SORMAS could be adapted and extended to support Health Declaration Form, Zoonotic disease surveillance and passive data collection management features that are important for strengthening outbreak response preparedness are not currently not available in SORMAS. SORMAS spread: Germany, Switzerland, France, Afghanistan, Nepal, Burkina Faso, Ghana, Nigeria, Ivory-Coast, Tanzania, Fiji etc. SORMAS coverage: Over 300,000,000 population under surveillance using SORMAS worldwide.	
OpenMRS	OpenMRS is an open-source application with a large community of developers and implementers in several countries. The MoH initially considered the adoption of OpenMRS as the preferred platform for use across GHS hospitals prior to procurement of the proprietary system (Light Wave) currently being rolled out. OpenMRS has capability, functionalities and data standards that can be adapted for use across primary and secondary healthcare facilities including tools and functionalities that can be adapted to manage multiple epidemic outbreaks. The community of developers are also working on integrating OpenMRS with DHIS to support seamless integration and reporting. The use of OpenMRS in Ghana to support health delivery is on the decline due to MoH decision to roll out Lightwave Health Information System to all the public health facilities across the country. The community of developers in Ghana are no more enthusiastic championing the use and implementation of OpenMRS. At this stage, it is impossible to suggest adoption of OpenMRS as a preferred health information system in the public sector and also adapt it for use in managing epidemics.	**Coordination and Operations, case management, Monitoring, Laboratory systems, contact tracing, Interoperability,** **Analysis, visualization and use of data.**
port health declaration system	The system was built purposely to support testing and recording Covid 19 cases entering or leaving the country. The system was not designed to integrate or share data with other health systems in the country either private or public. There are no plans to integrate the health declaration form with other systems that offer more flexible and richer functionalities such as SORMAS and DHIS2 Covid Tracker. There are no potential use cases for the system in the country apart from limited use at the Kotoka International Airport. It is designed purposely to collect Covid test data and payment processing at the Airport and nothing else. The Health Declaration Information system should be replaced	**Laboratory Surveillance**

	with DHIS or SORMAS because the two systems have better and more flexible functionalities to support longitudinal tracking of clients entering or leaving the country who have tested positive. For example, a client who tested positive at the airport can be assigned a unique health ID that can be used throughout client interaction with public health facilities. It will also allow Ghana to share or verify COVID status of international travellers, because DHIS2 is used in over 70 countries and most of them are using it to track covide cases. There potential of using DHIS2 to support sharing of covid status across the West African Sub-region is enormous.	
Telemedicine	Telemedicine infrastructure is dependent on wide coverage and reliability of the network, availability of Closed User Group (CUG) services, support for Voice over IP communication (VoIP) and minimum 3G internet connectivity. The software currently being used at the various Teleconsultation centres to record and track service provision is excel spreadsheet. It is a proprietary application and lacks the capability for extension into other areas beyond the original scope it was designed for. It is hosted on a desktop server and cannot be easily integrated with other applications in the GHS. Again, the closed source nature of software will make it difficult for it to be extended to areas beyond the original hierarchical reporting structure. Excel can be used for analysis and visualisation of data on a limited scale and has other limitations with regards to security and data protection. Telemedicine offers a huge opportunity for achieving universal health coverage in Ghana, however, MOH needs to change the care model for telemedicine and provide sustainability plans including cost recovery of services.	**Case management** **Surveillance**

ANNEX 4: Overview of gaps and opportunities of existing digital tools

S/N	DPP Functionalities	Software packages: DEPLOYED	Software packages: Existing but NOT DEPLOYED
1.1	Real-time reporting of aggregate data on individuals with symptoms, laboratory confirmation, etc, (ref, Coordination & Operations)	3 DHIS2, Port Health, OpenMRS	1 Light Wave
1.2	Specification of a subset of minimun critical data points for reporting to facilitate rapid analysis and planning	4 DHIS2, Port Health, SORMAS, HAMS	
1.3	Early warning surveillance based on data from web searches for common symptoms or social media sentiment analysis (or keywords)		1 SORMAS
2.1	Link client and healthcare workers to the client sample sent to the laboratory for testing	4 DHIS2, OpenMRS, Light Wave, Port Health	1 SORMAS
2.2	Guidance (to health workers) on the method to collect a sample	Hello Nurse	2 SORMAS, DHIS2
2.3	Notifications when results are available (to client, to healthcare facility for contact tracing, etc)	3 Ligth Wave, OpenMRS, HAMS	1 SORMAS
2.4	Integration with case management application and surveillance tools (to confirm suspected cases are positive or not)	3 DHIS2, OpenMRS, Light Wave	3 Port Health, GxAlert, SORMAS
3.1	Registration of clients in the systems with a unique ID	4 HAMS, DHIS2, Light Wave, SORMAS, OpenMRS	
3.2	Client's past health records available from the system	4 HAMS, DHIS2, Light Wave, SORMAS, OpenMRS	
3.3	Input of client contract information	5 HAMS, DHIS2, Light Wave, SORMAS, Open MRS	
3.4	Input of client demographics, vital signs, risk factors, and symptoms	6 HAMS, DHIS2, Light Wavem SORMAS, OpenMRS	

3.5	Creation of lab requests	3 OpenMRS, HAMS, Light Wave	2 DHIS2, SORMAS
3.6	Communication with client via phone call (through app)		2 DHIS2, SORMAS
3.7	Undirectional communication with client via messaging (e.g. SMS, social media, in-app, WhatsApp)		2 DHIS2, SORMAS
3.8	Bidirectional communication with client via messaging (e.g. SMS, social media, in-app, WhatsApp, email)		2 DHIS2, SORMAS
3.9	Monitoring and updating of further client interactions and outcomes	3 DHIS2, OpenMRS, Light Wave	
3.10	View a summary record and services provided for a client per encounter	4 DHIS2, OpenMRS, Light Wave, HAMS	
3.11	Editing of record in case of errors	6 DHIS2, OpenMRS, Light	
	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 Port Health System	1 SORMAS, DHIS2
4.1	Documentation of detailed contact history about the time, place, and person for each high-risk encounter	2 Covid 19 Tracker, SORMAS	1 SORMAS
4.2	Creation of a listing of high-risk contacts linked to suspected and existing cases	1 Covid 19 Tracker, SORMAS	1 SORMAS
4.3	Creation of record to input demographics and risk factors og high-risk contact	2 Covid 19 Tracker, SORMAS	1 SORMAS
4.4	Communication with contact via phone call (through app)		2 DHIS2, SORMAS
4.5	Undirectional communication with contact via messaging (e.g. SMS, social media, in-app. WhatsApp)		2 DHIS2, SORMAS
4.6	Undirectional communication with contact via messaging (e.g. SMS, social media, in-app. WhatsApp)		2 DHIS2, SORMAS
4.7	Update contact records with new changes / symptoms	6 HAMS, DHIS2, Light Wave, SORMAS, OpenMRS	
4.8	Editing of contact record in case of errors	5 HAMS, DHIS2, Light Wave, SORMAS	

4.9	Functionality adapted to generalised epidemic response (not strictly COVID-19(	6 DHIS2, OpenMRS, Light Wave, Port Health, GxAlert, SO-MAS	
4.10	Allows simultaneous management of multiple epidemic types	6 DHIS2, OpenMRS, Light Wave, HAMS, SORMAS	
4.11	Compatibility with country public health management information system (HMIS)	5 DHIS2, OpenMRS, Light Wave, HAMS, SORMAS	
5.1	Automated mass contact tracing of anonymous contacts via smartphone (or bracelet) Bluetooth signals	1 Covid 19 Tracker	2 DHIS2, SORMAS
5.2	Optional notification of positive infection diagnosis with high-risk contacts via user's smartphone app	2 Covid 19 Tracker, Port Health	2 SORMAS, DHIS2
5.3	Functionality adapted to generalised epidemic response (not stricktly COVID-19)	3 DHIS2, OpenMRS, SORMAS	2 HAMS, Light Wave
6.1	Easy access to real time aggregated to inform response	5 DHIS2, OpenMRS, Light Wave, Port Health, GxAlert	1 SORMAS
6.2	Clear visualisations of key indicators	5 DHIS2, OpenMRS, Light Wave, HAMS	1 SORMAS
6.3	Efficient and effective communications with health facilities and field staff	1 eLearning Covid	2 SORMAS, DHIS2
6.4	Modelling of epidemic impact scenarios to prepare response (simulations)	5 DHIS2, OpenMRS, Light Wave	1 SORMAS
6.5	Clear visualisation of risk factors (risk index) at subnational level	6 DHIS2, OpenMRS, Light Wave, Port Health, GxAlert, SO-MAS	1 SORMAS
6.6	Monitoring of response capacities (relevant health personnel, hospital beds, equipment, national or internal Emergency Medical Teams)	4 DHIS2, OpenMRS, Light Wave, HAMS	1 SORMAS
6.7	Big Data analysis (e.g. mobility monitoring based on mobile phone data, rumour monitoring based on social media analysis)		2 DHIS2, SORMAS
7.1	Registrarion of healthcare facilities	1 DHIS2	1 GHILIMS

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)	2 GHILIMS, DHIS2	2 HAMS, Light Wave
7.3	Collection and reporting of data on epidemic-specific equipment(x-ray machines, critical care beds, ventilators, etc)	2 GHILIMS, DHIS2	2 HAMS, Light Wave
7.4	Collection and reporting of data on epidemic-specific operational metrics (e.g. available ICU capacity, current staffing levels etc)	2 DHIS2, OpenMRS	2 HAMS, Light Wave
8.1	Fiscal managment		2 GHILIMS, DHIS2
8.2	Donor compliance reporting (Fraud prevention, transparent monitoring, etc)		2 GHILIMS, DHIS2
8.3	Human resource management		1 HRIS
9.1	Epidemic-specific symptoms monitoring	2 Covid 19 Tracker, SORMAS	
9.2	Use of personal protective equipment (PPE), delivering vaccination, etc.	1 DHIS2	1 SORMAS
9.3	Safety protocols for facilities	1 DHIS2	2 DHIS2, SORMAS
10.1	Point of care communications tools (videos through app, atc)	1 eLearning Covid	2 DHIS2, SORMAS
10.2	Integrated mass communications tools (web, social media, SMS, robocalls, etc)		3 GxAlert, DHIS2, SORMAS
11.1	Tracking of infectious disease outbreaks in domesticated animals (livestock etc)		3 GxAlert, DHIS2, SORMAS
11.2	Tracking of infectious disease outbreaks in wildlife		3 GxAlert, DHIS2, SORMAS
11.3	Ecological surveillance of environment for changes that could increase risk of zoonotic infection		3 GxAlert, DHIS2, SORMAS
12.1	Standardised interface (IHE, OpenHIE, REST, API, HL7, HL7-FHIR, supporting the OpenHIE architecture and workflows)	2 DHIS2, OpenMRS	2 HAMS, Light Wave
12.2	Support for healthcare Coding Standars (e.g. ICD-9, ICD-10, LOINC, SNOMED)	2 DHIS2, OpenMRS	2 HAMS, Light Wave
13.1	Integration with immunization registry		2 DHIS2, SORMAS

13.2	Immunization scheduling	1 DHIS2	1 SORMAS
13.2	Vaccination/Immunization delivery monitoring, tracking and follow-up at client	1 DHIS2	1 SORMAS
13.4	Reporting on adverse effects		2 SORMAS, DHIS2
13.5	Digital vaccine certificicate support		2 DHIS2, SORMAS
13.6	Microplanning	2 DHIS2, OpenMRS	1 SORMAS
14.1	Inbuilt data visualisation features	6 GHILIMS, HAMS, DHIS2, Light Wave, SORMAS, OpenMRS	
14.2	Multi-level data aggregation and user acess to inform decision-making	6 GHILIMS, HAMS, DHIS2, Light Wave, SORMAS, OpenMRS	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