Health Data Ecosystem Mapping
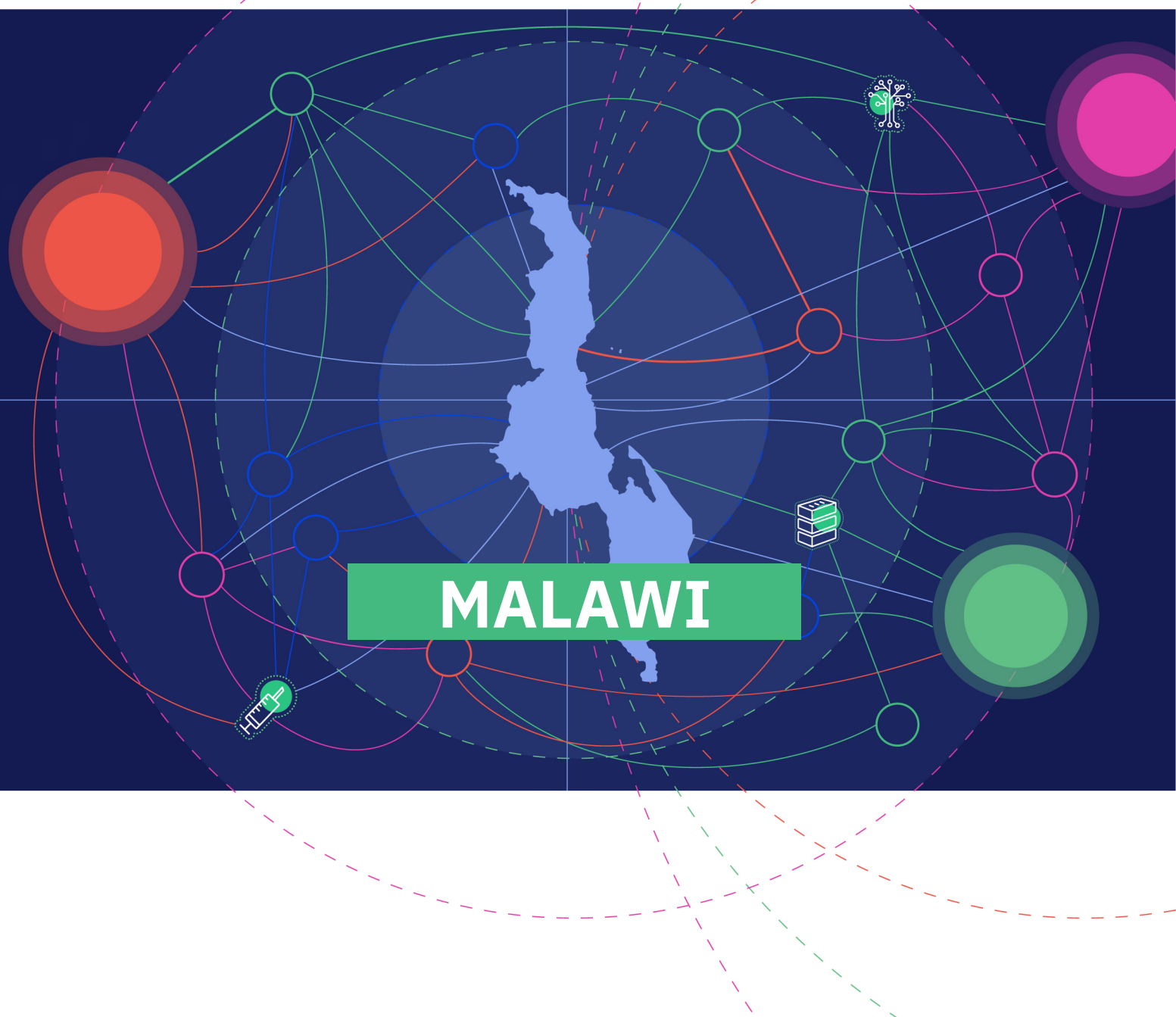
Scaling the Use of Digital tools for
Vaccination Planning, Deployment
and Monitoring

DIPC

MALAWI

digital square

PATH

german cooperation
DEUTSCHE ZUSAMMENARBEIT

Implemented by

giz
Deutsche Gesellschaft
für Internationale
Zusammenarbeit (GIZ) GmbH

CONTENTS

01
ACRONYMS

API	Application programming interfaces Plus BMZ
CDC	Centers for Disease Control and Prevention
CMED	Central Monitoring and Evaluation Division
CPD	Continual professional development
CRVS	Civil Registration and Vital Statistics
DAK	Digital adaptation kit
DCSA	Disease Control Surveillance Assistant
DDE	Demographics Data Exchange
DHD	Digital Health Division
DHTWG	Digital Health Technical Working Group
DIPC	Digital Innovation in Pandemic Control
DHIS2	District Health Information System 2
EGPAF	Elizabeth Glaser Pediatric AIDS Foundation
eHIN	Electronic Health Information Network
EIR	Electronic immunization registry
EMR	Electronic medical record
EPI	Expanded Programme on Immunization
FHIR	Fast Healthcare Interoperability Resources
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
HISP	Health Information Systems Program
UNDP	United Nations Development Programme

UNICEF	United Nations Children's Fund
HMIS	Health management information system
HSA	Health Surveillance Assistant
iCHIS	Integrated Community Health Information System
ICT	Information communication technology
MaHIS	Malawi Healthcare Information System
MHFR	Master Health Facility Registry
MOH	Ministry of Health
NRB	National Registration Bureau
NRIS	National Registration and Identification System
OpenHIE	Open Health Information Exchange
OHSP	One Health Surveillance Platform
OpenLMIS	Open Logistics Management Information System
OpenMRS	Open Medical Record System
OpenSRP	Open Smart Register Platform
PCMT	Product Catalog Master Tool
QMD SMT	Quality Management Directorate Senior Management Team
SMART	Standards-based, machine-readable, adaptive, requirements-based,testable
SURD	System and User Requirements Document
USAID	United States Agency for International Development
WHO	World Health Organization

02
EXECUTIVE SUMMARY

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) launched the initial **Digital Innovation in Pandemic Control (DIPC)** project in 2021 to bring digital health technical expertise to countries to create more pandemic-prepared health systems. In November 2022, the DIPC project provided an award to Digital Square to partner with ministries of health and other key stakeholders to scale the use of digital tools for COVID-19 and routine vaccination planning, deployment, and monitoring. **Digital Square is now implementing the DIPC project to create models for improved and more sustainable pandemic-prepared health systems with a focus on immunization** workflows using three exemplar countries: Ghana, Malawi, and Tanzania.

Digital Square partnered with Malawi's Ministry of Health's (MOH) Digital Health Division (DHD) and Expanded Programme on Immunization (EPI) to better understand the digital systems currently used to support immunization by conducting a desk review, holding consultative sessions, and convening a workshop to identify and validate digital systems. This country profile summarizes findings from those activities, outlining ten key digital systems currently supporting aspects of immunization and their major functional features, existing challenges, and recommendations to strengthen each one based on the World Health Organization's (WHO) *Classification of Digital Health Interventions.* The systems profiled in this report include the Integrated Community Health Information System (iCHIS), One Health Surveillance Platform (OHSP), District Health Information Software 2 (DHIS2), OpenLMIS, Electronic Health Information Network (eHIN), Master Health Facility Registry (MHFR), Demographics Data Exchange (DDE), Product Catalog Master Tool (PCMT), and national identity systems. Findings also highlight that although the MOH is experiencing rapid growth in the development and adoption of these mobile and web-based digital tools, a number of the existing systems are non-integrated and/or interoperable, leading to inefficiencies and a lack of accurate data.

During a consultative meeting that included the deputy directors of MOH-DHD and EPI, the DIPC team became aware of plans to develop a national electronic immunization registry (EIR) that would include immunizations for both children and adults within the Malawi Healthcare Information System (MaHIS) intended to cover all public hospitals, though resource constraints had hindered progress on its development. Fortunately, the MOH-DHD and EPI recognized DIPC as the right initiative to support the development of a national EIR, which became the focus of DIPC in Malawi.

Digital Square worked with the MOH to finalize the work plan for the DIPC project with the following priorities:

1. Localize the new immunization System and User Requirements Document (SURD) so health care is administered according to clinical guidelines that increase quality of care:
As the WHO's Digital Adaptation Kit for Immunization (DAK) has not yet been published, the user requirements workshop held in July 2023 utilized a generic SURD for Immunization, developed using the same principles and format of WHO's standards-based, machine-readable, adaptive, requirements-based, and testable (SMART) guidelines. This approach ensures national clinical guidelines for immunization are embedded into any immunization digital system built or enhanced using this documentation. Adapting a generic SURD to meet the requirements of the local Malawian context allows for a rapid definition and validation process, producing a localized document in the DAK format.

2.Develop an EIR within MaHIS:
This process will include the digitization of the current paper-based immunization registers to allow real-time visibility of all immunization processes at all 21 static sites in Mchinji District and three static sites in Ntcheu District. The EIR will be included as a module within the MaHIS, with the goal of eventually making the EIR available to all static sites in the country.

3. Strengthen the capacity of MOH partners to manage and adapt the EIR so it can be locally sustained:
Digital Square will assess the capacity needs of the MOH and design and conduct country-level training for the DHD team to ensure they are able to maintain the EIR and support users following the conclusion of the DIPC project.

03
BACKGROUND
DIPC project overview

Since the beginning of the COVID-19 pandemic, **Digital Square** has leveraged its unique role and strengths to support countries, donors, and partners to use existing digital tools in pandemic response efforts. Harnessing our technical expertise and established relationships across the global digital health ecosystem, including our engagement with and support of digital public goods for health, Digital Square is supporting countries to innovatively select and adapt digital tools to navigate the complexities of the pandemic and strengthen routine immunization systems.

GIZ, together with GIZ actors from the field of digitalization and health, including the **Digital Health Centre of Excellence (DICE)** initiative co-led by **United Nations Children's Fund (UNICEF)** and **WHO**, launched the **Digital Pandemic Control (DIPC)** project in 2021 to bring digital health technical expertise to countries to create more pandemic-prepared health systems. The DIPC project provided an award to Digital Square to partner with ministries of health and other key stakeholders from November 2022–2024 to scale the use of digital tools for COVID-19 vaccination planning, deployment, and monitoring. The DIPC project is aligning its project activities with countries' national digital health strategies to strengthen health systems so they are better equipped to respond to COVID-19 and future pandemics.

The DIPC project is creating models for improved and more sustainable pandemic-prepared health systems with a focus on immunization workflows using three exemplar countries: **Ghana, Malawi, and Tanzania.** The project is carrying out the work by focusing on three primary workstreams (see Figure 1):

Figure 1: DIPC Workstreams and project goals.
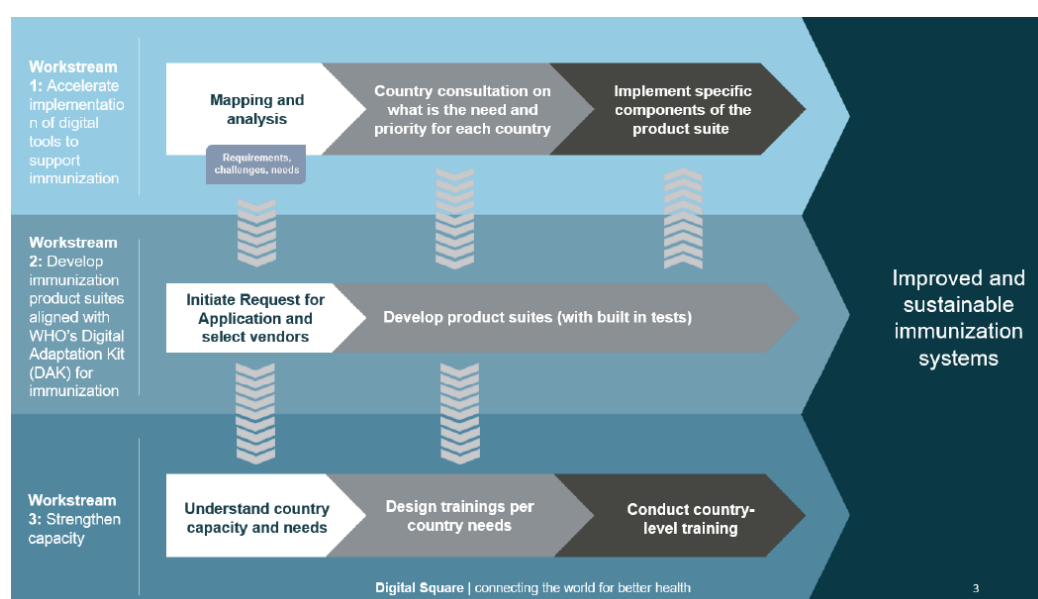
04
ECOSYSTEM MAPPING SCOPE AND METHODOLOGY

Digital Square mapped the digital immunization ecosystem in Malawi as an initial activity under Workstream 1 aimed at accelerating the implementation of digital systems to support COVID-19 and routine immunization. Digital Square, together with the MOH-DHD, employed the following methods to collect the data included in this report:

Conducted a **desk review** of Malawi's health and digital governance documents. Resources reviewed to inform the report included:

1. Map and Match Malawi Country brief
2. The President's Malaria Initiative (PMI) Digital Community Health Initiative (DCHI) Malawi country profile
3. Digital Pandemic preparedness report
4. Access to Information Act (2018)
5. eTransactions and Cyber Security Act (2018)
6. National Digital Economy Strategy (2020)

Organized an **ecosystem mapping workshop** with country leaders and external stakeholders where participants identified and validated digital tools that currently support immunization in Malawi per desk review results. Following the workshop, Digital Square partnered with the MOH to review the workshop findings and, as a result, recognized that the digital systems that were mapped during the workshop were supplementary to immunization. Digital Square and the MOH concluded that the DIPC team should focus on creating a tool that would support immunization in the country by creating an EIR built within the MaHIS to achieve this goal.

Held **consultative sessions** with country leaders, including several telephone interviews with the MOH-DHD, to understand more about the systems.

Enabling environment

Leadership, governance, and coordination of stakeholders

Malawi's digital health landscape

The National Digital Health Strategy highlights that Malawi does not have a "digital health solution which can cover all services provided at a health facility." This has led to a mixed approach using both digital and paper systems implemented by a variety of partners. While there are efforts to implement digital health systems, the MOH recognized there was a lack of standards and guidelines enforced during implementation. The Malawi MOH is structured to provide stewardship of all digital health initiatives, as seen in Figure 2.

In 2020, the MOH formed the DHD to coordinate and manage the development and implementation of sustainable, secure, and interoperable digital health solutions. The DHD Technical Working Group tasked the DHD to introduce MaHIS, an all-encompassing digital system, to coordinate digital health products efficiently and enhance existing investments. This move aimed to align with the Health Sector Strategic Plan III and strengthen information communication technology (ICT) infrastructure. In 2022, the MOH, through the Central Monitoring and Evaluation Division (CMED), demonstrated its commitment to DHD by appointing a deputy director to head the department. Through the DHD, Malawi has begun efforts to ensure current and future digital health systems are interoperable and sustainable.

To support the implementation of new digital health systems, the MOH has drafted several standard operating procedures (SOPs) that cover security guidelines, interoperability of systems, introduction of new digital systems, disaster recovery and data breach, among others. In terms of interoperability, the MOH has taken a standards-based approach. The MOH began work on an Open Health Information Exchange (OpenHIE) framework and developed an interoperability layer in 2018. The first integration between OpenLMIS and DHIS2 occurred the following year.

Figure 2. *Governance structure of the Malawi Ministry of Health as it relates to digital health.*

Acronyms: MOH: Ministry of Health; PIU: Program Implementation Unit; SH: Secretary for Health; SMT: Senior Management Team.
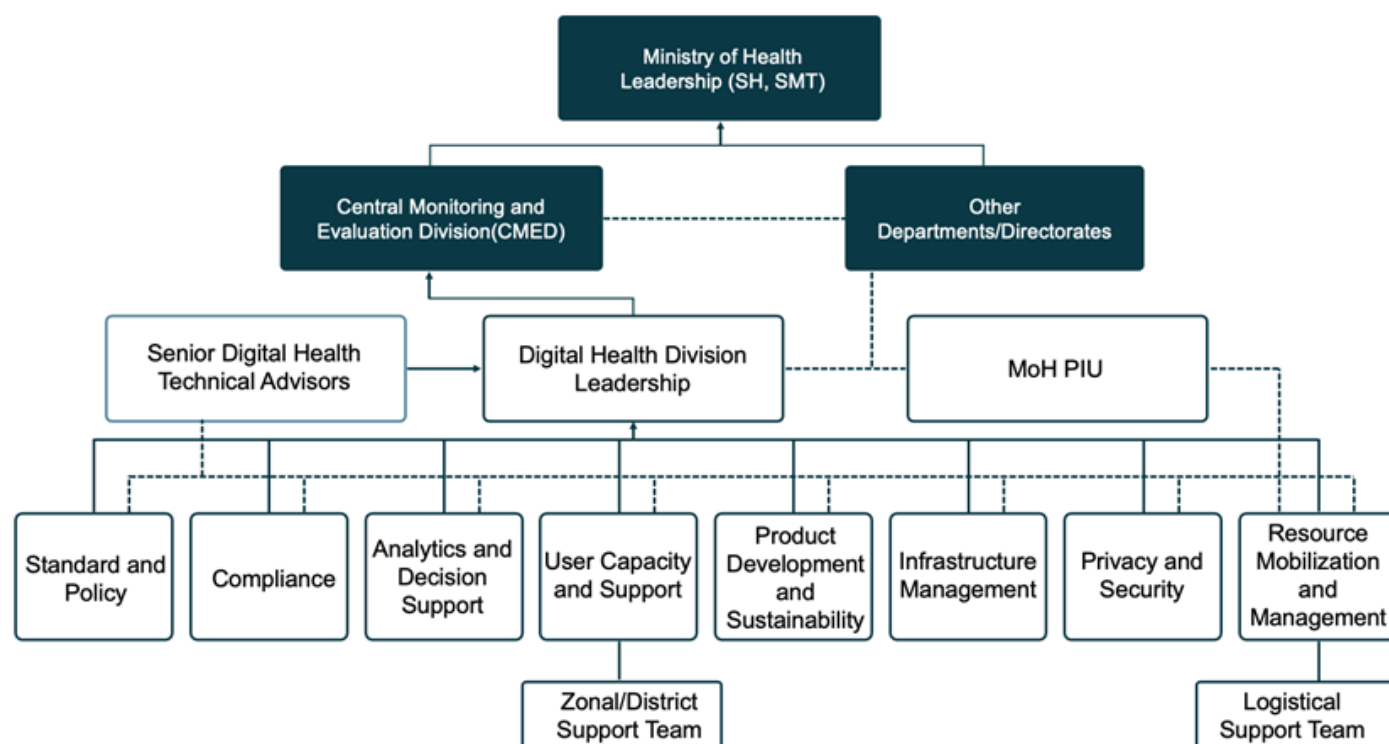
The MOH works with many funders, implementing partners, and multilateral organizations, in addition to governance mechanisms, in the digital health immunization space, as seen below in Table 1. Though the list below is not comprehensive, it is intended to provide a robust picture of the stakeholder landscape.

Malawi's Immunization profile

Table 1: Key stakeholders and governance mechanisms pertinent to the digital health immunization space.

MOH departments
- Quality Management Directorate (QMD) (contains the Digital Health Division [DHD])
  - DHD spearheads integration of Digital Health Solutions under the Ministry Leadership of Secretary for Health (SH) and Senior Management Team (SMT). The SMT meets every two weeks where the DHD may present any pertinent issues regarding digital health.
- Ministry of Information Communication Technology (ICT) through eGovernment
- Central Monitoring and Evaluation Division (CMED)

Governance mechanisms
- Digital Health Steering Committee
- Digital Health Technical Working Group (DHTWG)
  - The DHTWG meets every quarter and acts as an advisor board to the SMT, addressing various aspects of the initiatives happening, updating stakeholders on developments, and using the extensive technical expertise available to improve the digital health landscape. The DHTWG stakeholders include government representatives, development partners, and implementers.
- National Digital Health Task Force

Funders
- Bill & Melinda Gates Foundation (Kuunika Project)
- GIZ
- Global Fund
- United States Agency for International Development (USAID)
- US Centers for Disease Control and Prevention (CDC)
- Vital Wave

Implementing partners
- Compelling Works
- CooperSmith
- Luke International Norway
- management4health

Multilateral organizations
- UNICEF
- WHO
- UNICEF

Strategy

Digital Square analyzed Malawi's National Digital Health Strategy: 2020–2025 to determine where there was alignment across the DIPC project workstreams to prioritize how the project can support the MOH to deliver on the activities named in its national digital health strategy, as seen in Table 2. Digital Square is partnering with the MOH to develop and implement an EIR within the MaHIS while also providing technical documentation, training (e.g., on the expanded functionality of digital immunization systems), and mentoring to health workers to develop, implement, and maintain the EIR.

Table 2: A snapshot of the analysis showing alignment opportunities between the national strategy activities and DIPC project workstreams.	
National Digital Health Strategy activity	**DIPC project workstream**
1.3.1: Develop and enforce sustainability measures for digital health solutions	1: Accelerate implementation of a national electronic immunization registry to support immunization systems
3.1.1: Train health care workers and IT personnel in digital health solutions	3: Implement innovative and sustainable capacity-strengthening approaches
3.1.3: Introduce an eLearning platform for continual professional development (CPD)	
3.1.4: Introduce capacity-building and skills transfer to government as part of implementation of new and existing digital health solutions	
7.1.1: Facilitate training in international systems' interoperability frameworks and standards	

Key findings from the ecosystem mapping reveal that the MOH has strong existing digital health governance mechanisms and documents in place, such as a DHTWG and the National Digital Health Strategy: 2020–2025. In this strategy, Malawi outlined its vision, "to attain a sustainable and harmonized country-led digital

health system that covers all areas of service provision and enables efficient delivery of health services to beneficiaries at all levels of the health system." The mission is to "improve the delivery of health services by providing digital health tools that are harmonized, sustainable, reliable, interoperable, secure, and compliant with standards to increase efficiency and enable the provision of quality services at the point of service." The DHD is mandated to harmonize and ensure new systems being introduced are in line with the strategy's objective of strengthening the sharing and accessibility of data across systems to enable use (objective 7). The expected outcome of the strategy is to have digital systems that are able to share data with each other based on the **OpenHIE Architecture Framework.**

Technical capacity

The MOH has the capacity to sustain and maintain digital systems like the EIR within the MaHIS. The MOH's QMD demonstrated its dedication to support the DHD by assigning a deputy director to run the department. Additionally, QMD recently approved the DHD to recruit 25 members of staff to support the various interventions being made within the digital health space. The DHD is also supported by multiple implementing partners with seconded technical advisors across multiple interventions.

The MOH also has a local data center that hosts different systems in the country and is supported by government and different partners to ensure it has high availability. This data center is where the EIR will be hosted. More than 700 health facilities operating the electronic medical record (EMR) system for outpatient departments have local servers at the facility. These facility-based local servers act as a backup for the central-level server and enhance the offline functionality at the facility level. The EIR will utilize these decentralized servers to improve its system availability.

Personnel at the facility level have basic skills in computer usage due to the many digital systems that have been deployed at the facilities. This will make the system uptake easier because the majority of users are already knowledgeable about computer and tablet usage and the training focus will be on the particular EIR system. The districts selected in this first phase of the EIR have users (i.e., disease control surveillance assistants [DCSAs] previously known as health surveillance assistants [HSAs]) already using the tablets for iCHIS and eRegister systems. The EIR will be added as an additional application to their already existing tablets. This is in line with the MOH's approach to integrating resources for different interventions at the facility level regardless of the partner in support.

Current state

During the ecosystem mapping workshop conducted by Digital Square, EPI presented the current challenges they are facing, as described below:

1. **Poor data management at the peripheral level:** Data is not properly or fully documented or traced when a user does not hand over the data to colleagues.
2. **Different targets in the same area for different programs:** The target area for immunization is different from other disease programs.
3. **Stockouts at different levels:** Supply chain management challenges result in items being out of stock at different levels of the supply chain.
4. **Top-to-bottom approach system:** Some decisions are made without involving health care workers in facilities, resulting in gaps in the system.
5. **Poor data archiving and loss of information:** This challenge occurs at all levels of the system, including during data validation and archiving.
6. **Poor monitoring and use of data mainly where it is generated:** Facilities are not using data that they generate to make decisions.
7. **Poor management of resources:** Some vaccines expire before being utilized.

05

OVERVIEW OF MALAWI'S DIGITAL SYSTEMS TO SUPPORT IMMUNIZATION

Figure 3 defines components, features, and requirements of a digital system. The figure illustrates how requirements make up a software system feature and how those features roll into a functional component.

Figure 4 (next page) illustrates how a Health Information Exchange composed of various digital health systems may be implemented together to fulfill the five core immunization workflows, shown at the bottom of the diagram. It also shows how the software components supporting immunization and vaccine supply chain management are aligned with the **OpenHIE Architecture** domains. The point of service applications (e.g., immunization information system, microplanning tools, notification service) should be designed to exchange data with the OpenHIE registry service applications, and each other, via an interoperability layer. The interoperability layer is a middleware software that enables secure, standards-based communication between software applications. The five additional digital systems shown on the right-hand side may interact with the immunization system in the future, although they are out of scope for this DIPC project phase because they are not directly involved in the core immunization workflows. This also emphasizes the importance of why a system architecture that is interoperable is a critical part of any immunization solution. Table 3 provides an overview of the digital tools used across immunization workflows, including national scale and subnational scale.
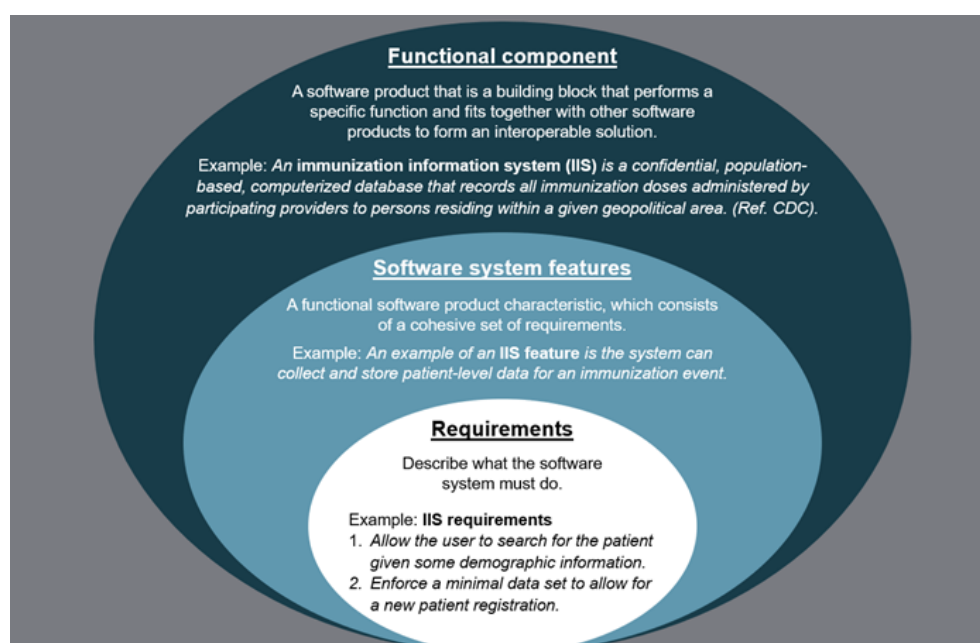
Figure 3.
Components, features, and requirements of a digital system.

Figure 4.
Functional components of immunization.
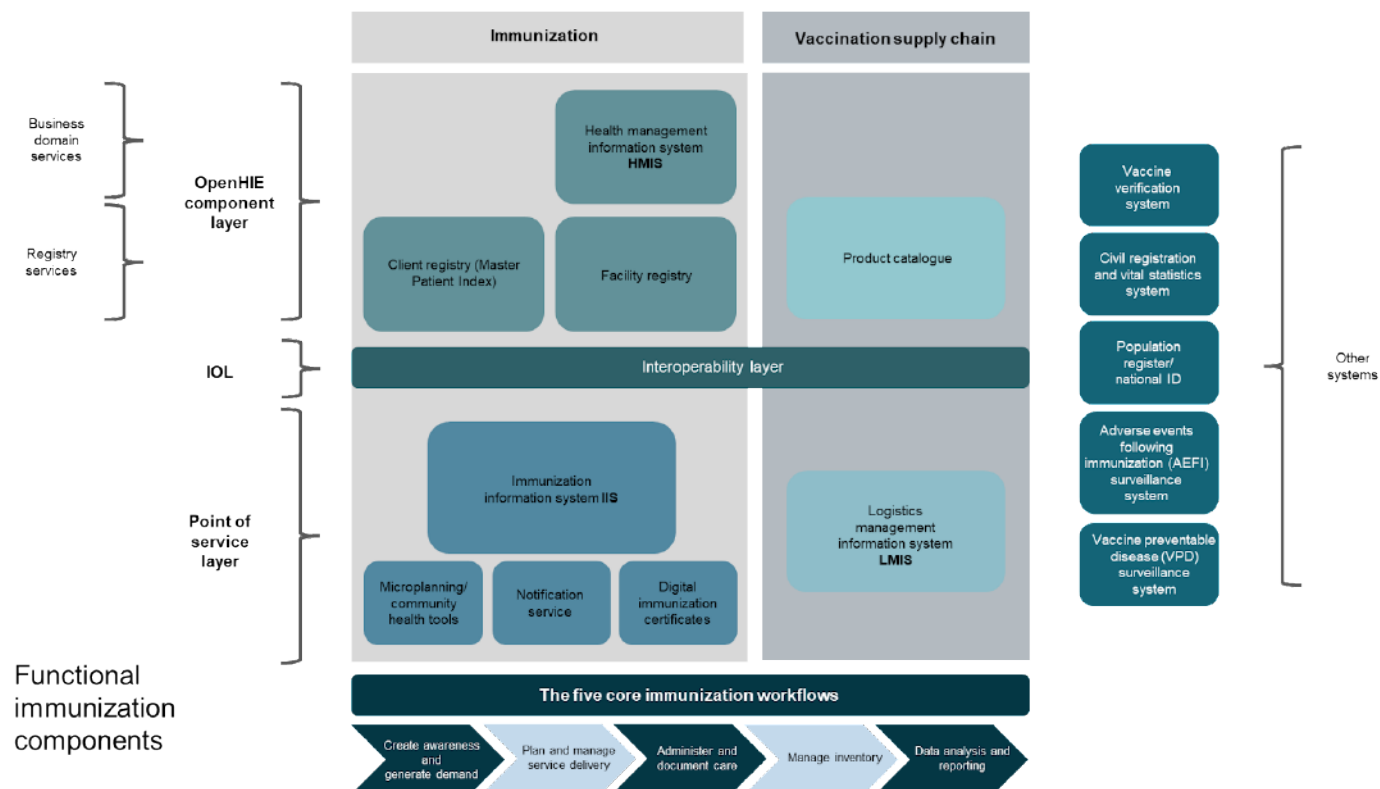
Table 3: Overview of digital tools used across immunization workflows.

Work-flow	Civil registration and national ID	Client registry	Com-munity health	Create aware-ness & generate demand	Digital immu-niza-tion certifi-cates	Facility registry	Health man-age-ment infor-mation system	Health worker regis-try	Immu-nization infor-mation system	Interop-erability layer	Moni-toring, evalu-ation, account-ability, and learning (MEAL)	Learn-ing and training system	Logistic man-agement infor-mation system	Micro-planning	Product catalog	Surveil-lance
National scale	CRVS NRIS	DDE	OHSP	CCPF, WhatsApp chatbots, RapidPro (U-report), 929 USSD COVID-19 Dash-board	OHSP	MHFR	DHIS2 (HMIS)	iHRIS	OHSP	Open-HIM	ISSPM	CPD Moodle	Open-LMIS eHIN		PCMT	DHIS2 Ep Info, RapidPro
Subna-tional scale			Com-mCare iCHIS OpenSRP						iCHIS OpenSRP				Open-Boxes Com-mCare cStock			OpenSRP
Not yet de-ployed but planned									MaHIS							

Acronyms: CCPF: Chipatala cha pa Foni, CPD: Continual Professional Development, CRVS: Civil Registration and Vital Statistics, DDE: Demographics Data Exchange, DHIS2: District Health In-formation Software 2, eHIN: Electronic Health Information Network, HMIS: Health Information Systems Program, iCHIS: Integrated Community Health Information System, ISSPM: Integrated Supportive Supervision Peer Mentorship, MaHIS: Malawi Healthcare Information System, MHFR: Master Health Facility Registry, NRIS: National Registration and Identification System, OHSP: One Health Surveillance Platform, OpenHIM; Open Health Information Mediator, OpenLMIS: Open Logistics Management Information System, OpenSRP: Open Smart Register Platform, PCMT: Product Catalog Management Tool.

06

RESULTS OF MALAWI'S KEY DIGITAL SYSTEMS SUPPORTING THE IMMUNIZATION HEALTH DOMAIN

Descriptions and parameters overview

The section below describes the digital systems Malawi uses to support the immunization health domain. For each digital system, where available, the results provide a s**ystem overview and details about its major features,[a] users, challenges, and recommendations.** The DIPC project used WHO's **Classification of Digital Health Interventions v1.0[b]** (Figure 5) to frame the results of this mapping. By looking at the users, challenges, and recommendations for each digital system, we describe how each supports the immunization health domain and where gaps and opportunities exist to improve each one.

The **major features of digital systems** include **functional features** that describe the programmatic requirements the digital system must have to meet the users' needs and achieve tasks within a business process. An example of a functional feature is the ability to register a new client in the immunization registry. This also includes **nonfunctional requirements** that provide the general attributes and features of the digital system to ensure usability and overcome technical and physical constraints. In addition to security and privacy features that have their own section in the analysis due to their importance, other examples of nonfunctional requirements include the ability to work offline or having multiple language settings.

Interoperability and standards describe which other digital systems can effectively exchange information with the priority system and whether the system's architecture is based on
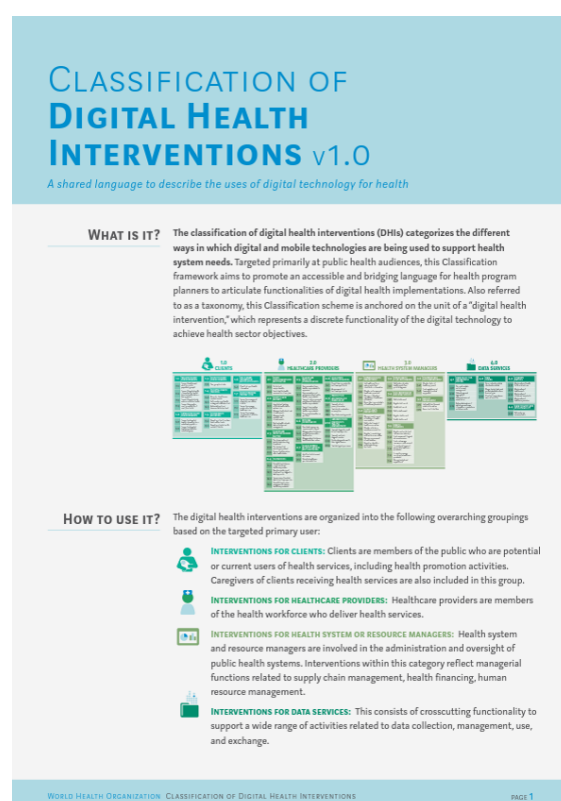
data standards. Building interoperable digital systems that allows for the exchange of information between systems is an essential component to improving patient care, and using a standards-based approach when building these systems ensures data is 'uniformly and efficiently exchanged across systems."[c]

Users describe the targeted primary user of each intervention. WHO's Classification of Digital Health Interventions breaks users into the following four overarching groupings (for the results in this profile, the section below will only focus on the first three user groupings):

01 **Interventions for clients:** Clients are members of the public who are potential or current users of health services, including health promotion activities. Caregivers of clients receiving health services are also included in this group.

02 **Interventions for health care providers:** Health care providers are members of the health workforce who deliver health services. *Examples of job roles in Malawi pertaining to this user grouping include community health workers, nurses, doctors, facility-level immunization providers, and pharmacists/pharmacist technicians.*

03 **Interventions for health system or resource managers:** Health system and resource managers are involved in the administration and oversight of public health systems. Interventions within this category reflect managerial functions related to supply chain management, health financing, and human resource management. *Examples of job titles in Malawi pertaining to this user grouping include supply chain managers, human resource managers, and finance officers.*

04 **Interventions for data services:** This consists of cross-cutting functionality to support a wide range of activities related to data collection, management, use, and exchange.

Health system challenges describe issues that each system faces categorized according to WHO's eight groupings in its Classification of Digital Health Interventions:

1. Information

2. Availability

3. Quality

4. Acceptability

5. Utilization

6. Efficiency

7. Cost

8. Accountability

Recommendations are organized using tables and use the same four categories from the user descriptions above to specify which user grouping the recommendation is intended to target (i.e., the clients, health care providers, health system or resource managers, and data services).

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[a]Many digital tools have a separate callout box for security and privacy features to emphasize the importance of these non-functional requirements.
[b]WHO's Classification of Digital Health Interventions is a resource document that provides a shared language to describe the uses of digital technology.
[c]Digital Square Global Goods Guidebook, Fourth Edition. Seattle: PATH; 2023.

Digital system 1: Malawi Healthcare Information System (Ma-HIS)

MaHIS is designed to be modular in nature, covering many components and digital processes for health facilities, including outpatient, inpatient, and lab systems. It is based on a microservices architecture—a collection of loosely coupled services, communicating through application programming interfaces (APIs). It is also based on the Open Medical Record System (OpenMRS) database model, a flexible model that addresses the who, what, when, where, and how of medical encounters. The MaHIS immunization modules developed under DIPC will be one of the first systems to exchange data with another system via an interoperability layer, thus supporting one of the stated objectives of the national digital health strategy. The planned use case is to integrate with iCHIS via the Open Health Information Mediator (OpenHIM) interoperability layer.

DIPC will support the immunization registry module, which will be built on the technology below:

- **Schema:** The data model will correspond to OpenMRS version 1.7.0 for patient care delivery. However, the plan is to upgrade the data model to version 1.9.0. It will use SQL and NoSQL databases for structured and unstructured data, Redis for caching, and AWS S3 for file storage.
- **Frontend:** This implementation will use technology that abides by the acceptable standards with high maintainability, such as long-term support and in-country capacity (i.e., React and Java).
- **Business logic:** Ruby on Rails.
- **Microservices:** To be developed on preferred open source languages.
- MaHIS will implement a three-tier approach to backup and recovery strategy at the facility, district, and national level.

The scope of MaHIS is comprehensive, covering a wide range of health care services, from community-level outreach to specialized technical support services and health care management functions. This will include public health facilities, faith-based health care service providers, and private health care institutions. MaHIS will span all points of care within the health care system, ensuring that data is captured, managed, and utilized effectively to improve health care delivery and quality, monitor program performance, and support decision-making at all levels of the health care system in Malawi.

At the time of this writing, MaHIS has no functional module; however, there are several modules that are currently being built by different implementers and donors. The modules include:

1. Adult Emergency Trauma Centre (AETC)
2. Ambulatory services (OPD services, including dental, skin; antenatal care; postnatal care; and maternal and child health)
3. Non-communicable diseases (NCD)
4. Immunization registry (DIPC project)

Figure 6 is a conceptual model of MaHIS to show how it will operate at all levels of the health system, including at the district and national levels, patient and facility levels, and community level. As shown, MaHIS will send aggregate data to the Management Information System (MIS) for reporting and visualization so that health system managers can use the data to make informed decisions. The DIPC project is working on the immunization registry, which includes the growth monitoring module; this data will be stored in the outpatient department (OPD) section of the MaHIS. The MaHIS will also include inpatient department (IPD) data and emergency department (ED) data. All three (i.e., OPD, IPD, and ED) feed into the MIS. Around the outer edges of the model, other systems feed data into the IPD, ED, and OPD that are also funneled into the MaHIS so that system users are seeing data from all levels of the health system in a secure manner to have a comprehensive view of the health trends on the ground.

Showing how it is designed to interoperate with iCHIS for community health services and LIMS for lab services.

Conceptual model of usage of MaHIS in Malawi, 2023 v1.3

System overview								
Global Goods Guidebook v.4 (pages)	**Scale**	**Primary WHO classification**	**System owners**	**Health and interoperability standards**	**Offline capability**	**Licensing**	**Funders**	**Implementers**
Open-MRS (34)	Sub-national	H: Electronic Medical Record	MOH	Uses concept mapping to be able to support a wide range of health coding standards (e.g., LOINC, Rx-NORM, ICD10). Supports interoperability standard of HL7 FHIR.	Yes	Free and open source	GIZ and multiple funders for different modules	Compelling Works, Digital Square, EGPAF, Luke International Norway (LIN), and others depending on modules

Major features of the digital solution

MaHIS is an integrated comprehensive system aiming at having an all-encompassing harmonized digital health system that will include the following modules:
- 1. Electronic immunization registry
- 2. Outpatient department
- 3. Inpatient department
- 4. Emergency department
- 5. Laboratory information management system
- 6. Radiology information system
- 7. Pharmacy information system
- 8. Picture archiving and communication system
- 9. iCHIS
- 10. Management information system for reporting

Security and privacy

Basic requirements	Description
Password requirements	Credentials with strong passwords will be required to access the system.
Data encryptions (data in motion and at rest)	Data encryption and protection are instrumental in securing information at rest and in transit, while data privacy and consent management play pivotal roles in regulatory compliance and respecting patient preferences.
Access level/user permissions	Users will have different roles and permissions to access the system. Detailed security standards and implementations are accessible here.

Users

Users can run this digital system on browsers and mobile applications.

Grouping	Users	Description
1 Clients	No	
2 Health care providers	Yes	Frontline health care workers, health care technical support staff, health care services for facility logistics, administrative and management officers
3 Health system or resource managers	Yes	

As the system is not yet operational, there are no challenges or recommendations to report.

Digital system 2: Civil Registration and Vital Statistics (CRVS) and National Registration and Identification System (NRIS)

The CRVS system used in Malawi is a locally developed software by Elizabeth Glaser Pediatric AIDS Foundation (EGPAF). It is an in-house developed software with business logic running on Ruby on Rails. NRIS is a system developed by the National Registration Bureau (NRB) that is a combination of proprietary and open source microservices. NRIS is used to identify citizens who are above the age of 16, using biometrics. The system also prints chip-enabled plastic cards that are used as national ID cards. CRVS and NRIS are linked, and they share data. Data captured by CRVS is transferred and stored in NRIS. The NRB owns both systems.

Solution overview							
Scale	**Primary WHO classification**	**System owners**	**Health and interoperability standards**	**Offline capability**	**Licensing**	**Funders**	**Implementers**
National	B: Civil Registration and Vital Statistics	NRB	Using custom API for interoperability	Yes	Open source	CDC	EGPAF, NRB
National	A: Census, population information and data warehouse	NRB	Using custom API for interoperability	Yes	Proprietary	Malawi Government, UNDP, and other funders	NRB

Major features of digital system
• Birth and death registration (CRVS)
• National ID data and card production (NRIS)

Security and privacy	
Basic requirements	**Description**
Secure APIs	Both systems have secure APIs they use to integrate with other systems.

Users		
Users can run this digital system on mobile laptops and desktop computers.		
Grouping	**Users**	**Description**
1 Clients	No	
2 Health care providers	Yes	Nurses and NRB staff for NRIS are the main users. According to Annex 4 of the Malawi Digital Health Solutions assessment, user engagement and training exist for CRVS. Although users feel comfortable using the system and find it easy to use, they note user support could be timelier.
3 Health system or resource managers	No	

Health system challenges: End users shared the challenges they encountered using the system that are categorized according to WHO's Classification of Digital Health Interventions in the table below.		
1	**Information**	
1.5	Lack of access to information or data	• Not linked with current EMRs • Only covers people 16 years of age and above

Recommendations: End users made several recommendations to improve the system that are categorized according to WHO's Classification of Digital Health Interventions in the table below.		
1	**Data services**	
1.5	Data exchange across systems	Enabling interoperability between the EIR module and CRVS and NRIS will provide the ability to verify the national identity numbers used in the EIR and potentially also support birth notifications from the EIR to the CRVS system.

Digital system 3: Demographics Data Exchange (DDE)

DDE is an in-house developed system from which different health systems get patient and client data. The system, developed by EGPAF and funded by the CDC, can read national ID cards and birth certificate QR codes and extract their personal information to link with the health records found within the DDE system. DDE is desktop-based and enables clients to be identified using their health IDs currently generated by DDE. The long-term plan is to switch to the national IDs generated by NRIS, but MOH and NRIS are yet to agree on the way forward.

System overview							
Scale	**Primary WHO classification**	**System owners**	**Health and interoperability standards**	**Offline capability**	**Licensing**	**Funders**	**Implementers**
National	P: Identification registries and directories	MOH	The system uses custom APIs for interoperability. There are plans to implement OpenHIE architecture.	No	Open source	CDC	EGPAF

Major features of digital system

- Client identification and information

Security and privacy	
Basic requirements	**Description**
Data encryptions (data in motion and at rest)	Yes, data is encrypted.

Users		
Grouping	**Users**	**Description**
1 Clients	No	
2 Health care providers	No	
3 Health system or resource managers	No	
4 Data services	Yes	This is not designed for end users. It is a backend service that interfaces with other systems for client identification.

Health system challenges: End users shared the challenges they encountered using the system that are categorized according to WHO's Classification of Digital Health Interventions in the table below.

1	Information	
1.5	Lack of access to information or data	Does not have all population data.

Recommendations: End users made several recommendations to improve the system that are categorized according to WHO's Classification of Digital Health Interventions in the table below.

2	Healthcare providers	
2.1.1	Verify client unique identity	Enable EIR to verify patient identity.
4	Data services	
4.1.1	Data exchange across systems	Continue to strengthen and expand the use of DDE by connecting it to the new EIR.

Digital system 4: District Health Information System 2(DHIS2)

DHIS2 is an open source, web-based health management information system (HMIS) platform. It supports the collection, analysis, visualization, and sharing of both aggregate and individual-level data, including mobile and offline data collection using the DHIS2 Android app. The core DHIS2 software development is managed by the Health Information Systems Program (HISP) at the University of Oslo. HISP is a global network of 15 in-country and regional organizations, providing daily direct support to ministries of health and local implementers of DHIS2.

System overview								
Global Goods Guidebook V4 (pages)	**Scale**	**Primary WHO classification**	**System owners**	**Health and interoperability standards**	**Offline capability**	**Licensing**	**Funders**	**Implementers**
DHIS2 (41–42)	National	N: Health Management Information System	MOH	Health standards: ICD-9, ICD-10, ICD-11; LOINC; GS1; SNOMED Interoperability standards: HL7 FHIR; ADX; mCSD; SVCM	Yes	Free and open source; BSD-3-clause	DHIS2, Gates Foundation, Gavi, Global Fund, MOH, NORAD, UNICEF, USAID	DHIS2, HISP Malawi, MOH

Major features of digital system

- Health management information system
  - Serves as a data warehouse that provides aggregated data visualizations, including maps, charts, and dashboards.
- Logistics management information system
- Surveillance
  - Collects, manages, and analyzes transactional, case-based data records

Users		
Users can run this digital system on mobile phones, tablets, laptops, and desktop computers.		
Grouping	**Users**	**Description**
1 Clients	No	
2 Health care providers	Yes	Health workers at facility and community levels.
3 Health system or resource managers	Yes	Supervisors, program managers and district health officers, national-level stakeholders, administrators, and MOH.

Security and privacy	
Basic requirements	**Description**
Password requirements	Minimum of 8 characters with a mixture of special characters and numbers.
Data encryptions (data in motion and at rest)	DHIS2 allows for the encryption of data. Web-proxy server configured with TLS/SSL. Database data are in a separate location, which allows for encryption at rest.
Access level/user permissions	Users are authenticated, with mechanisms to detect illegal/unauthorized or repeated access, and permissions are granted based on roles and configured privileges.

Health system challenges: End users shared the challenges they encountered using the system that are categorized according to WHO's Classification of Digital Health Interventions in the table below.

1	Information	
1.5	Lack of access to information or data	High downtime, limited access to users.
2	Availability	
2.4	Insufficient supply of qualified health workers	There is a human resource gap (i.e., there are very few people who manage DHIS2 in Malawi).

Recommendations: End users made several recommendations to improve the system that are categorized according to WHO's Classification of Digital Health Interventions in the table below.

#	Category	
4.1	Data collection, management, and use	Public aggregate data from DHIS2 must be easily accessible.

Digital system 5: Integrated Community Health Information System (iCHIS)

iCHIS is a DHIS2-based nationwide system designed to track individual-level data for community health care services. It is a mobile application that uses DHIS2 Tracker as its platform of implementation. The Department of Computer Science at the University of Malawi (UNIMA) is the local partner who does the development work.

System overview								
Global Goods Guidebook V4 (pages)	**Scale**	**Primary WHO classification**	**System owners**	**Health and interoperability standards**	**Offline capability**	**Licensing**	**Funders**	**Implementers**
DHIS2 (41–42)	Subnational	F: Community Based-Information System	MOH	Health standards: ICD-9, ICD-10, ICD-11; LOINC; GS1; SNOMED Interoperability standards: HL7 FHIR; ADX; mCSD; SVCM	Yes	BSD-3-clause	GIZ, Save the Children, UNICEF, USAID MOMENTUM (Amref, Palladium, and D-tree)	MOH, Last Mile Health, mothers2mothers (m2m), and Wandikweza

Major features of digital system
• Immunization registry at community level
• EMR at the community level

Security and privacy	
Basic requirements	**Description**
Password requirements	Minimum of 8 characters with a mixture of special characters and numbers.
Data encryptions (data in motion and at rest)	iCHIS allows for the encryption of data. Web-proxy server configured with TLS/SSL. Database data are in a separate location, which allows for encryption at rest.
Access level/user permissions	Users are authenticated, with mechanisms to detect illegal/unauthorized or repeated access, and permissions are granted based on roles and configured privileges.

Users		
Users can run this digital system on mobile phones, tablets, laptops, and desktop computers.		
Grouping	**Users**	**Description**
1 Clients	No	
2 Health care providers	Yes	DCSAs
3 Health system or resource managers	Yes	MOH central-level staff, iCHIS IT support, stakeholders

Health system challenges: End users shared the challenges they encountered using the system that are categorized according to WHO's Classification of Digital Health Interventions in the table below.

1	Information	
1.5	Lack of access to information or data	Only covers child immunization.
5	Utilization	
5.2	Geographic inaccessibility	Limited implementation. Covers only 11 districts at the community level.

Recommendations: End users made several recommendations to improve the system that are categorized according to WHO's Classification of Digital Health Interventions in the table below.

2.2	Client health records	
2.2.4	Routine health indicator data collection and management	Suggest including modules such as EPI and supply chain.

Digital system 6: One Health Surveillance Platform (OHSP)

OHSP is a DHIS2-based system used to monitor COVID-19 vaccination with an e-Vaccination module that is interoperable with the HMIS. It is a mobile application that uses the DHIS2 tracker as its platform of implementation. The local partner who does the development work is Luke International.

System overview								
Global Goods Guidebook V4 (pages)	**Scale**	**Primary WHO classification**	**System owners**	**Health and interoperability standards**	**Offline capability**	**Licensing**	**Funders**	**Implementers**
DHIS2 (41–42)	National	N: Health management information system (HMIS) V: Public health and disease surveillance system*	MOH	Health standards: ICD-9, ICD-10, ICD-11; LOINC; GS1; SNOMED Interoperability standards: HL7 FHIR; ADX; mCSD; SVCM	Yes	BSD-3-clause	CDC, UNICEF, World Bank	Luke International

Major features of digital system

- Acts as an immunization registry for COVID-19 at the community and facility level.
- Captures individual-level data for the full vaccination process, from registration to vaccine administration and monitoring of adverse events following immunization (AEFI).
- Sends and receives laboratory diagnostic data on COVID-19-reported cases from the National Laboratory Information System (LIMS) to assist with the management of COVID-19 testing and results tracking.
- Captures vaccine stock level data and will send an SMS reminder to individuals for their second dose of vaccination.
- Verifies a person's vaccination status and printing of vaccination certificates (eVAX module).

Security and privacy	
Basic requirements	**Description**
Password requirements	Minimum of 8 characters with a mixture of special characters and numbers.
Data encryptions (data in motion and at rest)	OHSP allows for the encryption of data. Web-proxy server configured with TLS/SSL. Database data are in a separate location, which allows for encryption at rest.
Access level/user permissions	Users are authenticated, with mechanisms to detect illegal/unauthorized or repeated access, and permissions are granted based on roles and configured privileges.

Users		
Users can run this digital system on mobile phones, tablets, laptops, and desktop computers.		
Grouping	**Users**	**Description**
1 Clients	No	
2 Health care providers	Yes	DCSAs
3 Health system or resource managers	Yes	MOH central-level staff, OHSP IT support, stakeholders

Health system challenges: End users shared the challenges they encountered using the system that are categorized according to WHO's Classification of Digital Health Interventions in the table below.

#	Challenge	
1.5	Lack of access to information or data	Not many health workers and managers have access to OSHP data to help them make decisions; it is not publicly available.

Recommendations: End users made several recommendations to improve the system that are categorized according to WHO's Classification of Digital Health Interventions in the table below.

2.2	Client health records	
2.2.4	Routine health indicator data collection and management	Provide access to health workers and stakeholders to use OSHP data for decision-making.

Digital system 7: Master Health Facility Registry (MHFR)

The Master Health Facility Registry (MHFR) is the national registry of all facilities maintained by the MOH and was completed in 2018. MHFR is a web service with a user interface that allows health workers to get access to the full list of facilities and view summaries through the dashboard, along with performing custom queries that depend on specific information.

System Overview							
Scale	**Primary WHO classification**	**System owners**	**Health and interoperability standards**	**Offline capability**	**Licensing**	**Funders**	**Implementers**
National	K: Facility Management Information Systems	MOH	Does not currently support internationally recognized standards	No	Open source	Luke International, Kuunika Project: Data for Action	Baobab Health Trust, MOH

Major features of digital system

- Facility registry
  - A centrally maintained registry that stores minimum required data about public health facilities, such as facility ID, name, and location.

Users

Users can run this digital solution on laptops and desktop computers.

Grouping	Users	Description
1 Clients	No	
2 Health care providers	No	
3 Health system or resource managers	Yes	IT managers, stakeholders

Security and privacy	
Basic requirements	**Description**
Password requirements	None. The information is publicly available at https://zipatala.health.gov.mw/.
Data encryptions (data in motion and at rest)	Uses secure APIs.
Access level/user permissions	Administrative rights are needed to update any information.

Health system challenges: End users shared the challenges they encountered using the system that are categorized according to WHO's Classification of Digital Health Interventions in the table below.	
1	**Information**
1.3	Lack of quality/reliable data	Data are not recently updated.

Recommendations: End users made several recommendations to improve the system that are categorized according to WHO's Classification of Digital Health Interventions in the table below.	
2.2	**Client health records**
2.2.4	Routine health indicator data collection and management	Frequently update the health facility details to reflect the updates at facility level. Integrate with more health systems to harmonize the naming and referencing of facilities across the ecosystem.

Digital system 8: OpenLMIS

OpenLMIS is a powerful open source, cloud-based electronic logistics management information system (LMIS). It was built to manage health commodity supply chains. OpenLMIS automates LMIS business processes throughout the entire supply chain, reducing the burden on health workers while improving data accuracy, data timeliness, and data visibility. The MOH has identified the open source licensing and sustainable model for user support as two key benefits of the OpenLMIS to be used for reporting and inventory management.

System overview								
Global Goods Guidebook V4 (pages)	**Scale**	**Primary WHO classification**	**System owners**	**Health and interoperability standards**	**Offline capability**	**Licensing**	**Funders**	**Implementers**
Open-LMIS (50)	National	T: Logistics management information system (LMIS)	MOH	Interoperability standards: HL7 FHIR	Yes	Open source	Gates Foundation, USAID	MOH, US-AID GH-SC-PSM project, Village-eReach

Major features of digital system
• Periodic stock movement reporting
• Inventory management

Security and privacy	
Basic requirements	**Description**
Password requirements	Minimum of eight characters with a mixture of special characters and numbers.
Data encryptions (data in motion and at rest)	Operate in secure encrypted mode using HTTPS.
Access level/user permissions	Users are authenticated, with mechanisms to detect illegal/unauthorized or repeated access, and permissions are granted based on roles and configured privileges.

Users		
Users can run this digital solution on laptops and desktop computers.		
Grouping	**Users**	**Description**
1 Clients	No	
2 Health care providers	Yes	DCSAs, nurses, pharmacy personnel, clinicians
3 Health system or resource managers	Yes	MOH central-level staff, OpenLMIS IT support, stakeholders

Health system challenges: End users shared the challenges they encountered using the system that are categorized according to WHO's Classification of Digital Health Interventions in the table below.

1	Information	
1.2	Delayed reporting of events	Data is one month late.
1.3	Lack of quality/reliable data	Inventory management module has issues with actual stock levels.
7	Cost	
7.2	Lack of effective resource allocation	High maintenance bills to support partner.

Recommendations: End users made several recommendations to improve the system that are categorized according to WHO's Classification of Digital Health Interventions in the table below.

#	Category	
3.2.1	Manage inventory and distribution of health commodities	Resolve issues reported by facilities on inventory management and scale the system to all health facilities.
		Create technical support team in country to reduce support costs and increase sustainability.

Digital system 9: Electronic Health Information Network (eHIN)

Electronic Health Information Network (eHIN) is a proprietary mobile and web-based system by Logistimo. The system is used for inventory management in all static sites in the country, allowing users to report re-al-time vaccine balances and usage from their facility. The mobile application, which has extensive offline capabilities, is funded and implemented by the United Nations Development Programme (UNDP).

System Overview							
Scale	**Primary WHO classification**	**System owners**	**Health and interoperability standards**	**Offline capability**	**Licensing**	**Funders**	**Implementers**
National	T: Logistics management information system (LMIS)	Logistimo	Logistics standard: GS1	Yes	Proprietary	UNDP	UNDP

Major features of digital system
• Inventory management system
• Dispensation system
• Mobile app with offline capabilities
• GS1 barcode scanning

Users		
Users can run this digital solution on laptops and desktop computers.		
Grouping	**Users**	**Description**
1 Clients	No	
2 Health care providers	Yes	DCSAs, nurses, pharmacy personnel, clinicians
3 Health system or resource managers	Yes	MOH central level staff, eHIN IT support, stakeholders

Security and privacy	
Basic requirements	**Description**
Password requirements	Minimum of eight characters with a mixture of special characters and numbers.
Data encryptions (data in motion and at rest)	The platform offers enterprise-grade security at application and data center levels. All data transmitted over the wire are protected using a Secure Socket Layer (SSL) with strong encryption. Sensitive information in the database(s) is encrypted. Strong architecture and protocols ensure infrastructure and network security at the data center—including firewalls, security groups, and other aspects that protect clients and their users.
Access level/user permissions	Users are authenticated, with mechanisms to detect illegal/unauthorized or repeated access, and permissions are granted based on roles and configured privileges.

Health system challenges: End users shared the challenges they encountered using the system that are categorized according to WHO's Classification of Digital Health Interventions in the table below.

1	Information	
1.5	Lack of access to information or data	Lack of available APIs for interoperability. The system has APIs that need extra subscriptions. Currently, Malawi has not subscribed to these; hence, the APIs are not available to us. Conversations on possible integrations have started between UNDP, MOH, and Logistimo.
2	**Availability**	
2.4	Insufficient supply of qualified health workers	Lack of adequate user support. The in-country support system is not adequate for the 3,000-plus users currently using the system. Discussions are underway between UNDP and MOH on how this support can be improved.
7	**Cost**	
7.2	Lack of effective resource allocation	Expensive to maintain—lack of financial support to support system. The system has UNDP as a single funder.

Recommendations: End users made several recommendations to improve the system that are categorized according to WHO's Classification of Digital Health Interventions in the table below.

#	Category	
3.2.1	Manage inventory and distribution of health commodities	

Digital system 10: Project Catalog Management Tool (PCMT)

PCMT connects product catalogs to show a clear journey from manufacturer to patient. It establishes master data that include GS1 identifiers, global categories, and mappings to local identifiers. This enables end-to-end visibility, allows shipments to flow between systems, and helps supply chains perform.

System overview								
Global Goods Guidebook V4 (pages)	**Scale**	**Primary WHO classification**	**System owners**	**Health and interoperability standards**	**Offline capability**	**Licensing**	**Funders**	**Implementers**
PCMT (47)	National	P: Identification registries and directories	MOH	Logistic standards: GS1 Interoperability standards: HL7 FHIR	No	NPOSL-3.0	USAID	USAID GHSC-PSM Project, VillageReach

Major features of digital system
• Product catalog

Security and privacy	
Basic requirements	**Description**
Password requirements	Requires a mixture of special characters and numbers.
Data encryptions (data in motion and at rest)	Secure APIs and database security applied.
Access level/user permissions	General users and administrators.

Users		
Users can run this digital system on mobile phones, tablets, laptops, and desktop computers.		
Grouping	**Users**	**Description**
1 Clients	No	
2 Health care providers	Yes	Pharmacy personnel
3 Health system or resource managers	Yes	Product managers, national regulatory bodies, pharmacy data managers, and logistics managers

Health system challenges: End users shared the challenges they encountered using the system that are categorized according to WHO's Classification of Digital Health Interventions in the table below.		
1	**Information**	
1.7	Lack of unique identifier	The PMCT has not yet incorporated information for all immunization products.

Recommendations: End users made several recommendations to improve the system that are categorized according to WHO's Classification of Digital Health Interventions in the table below.		
#	**Category**	
3.2.1	Manage inventory and distribution of health commodities	The PMCT needs to be updated with relevant information for all immunization-related products.

07
CONCLUSION AND NEXT STEPS

During this ecosystem mapping exercise, the MOH and Digital Square identified opportunities where the DIPC project can provide support to strengthen the digital health immunization systems for Malawi. As the report detailed out above, the primary challenges identified during this ecosystem mapping phase are:

01 **The need for an electronic immunization registry to be incorporated within the planned MaHIS.** The existing paper-based immunization registers need to be digitalized to provide improved visibility of immunization service delivery, and this should be incorporated into the existing MOH-approved MaHIS that is being rolled out nationally.

02 **Lack of interoperability between existing systems.** There are many digital health systems in use across the immunization domain, but the lack of interoperability leads to siloed information that cannot be shared across systems. Inefficiencies due to duplicate data entry across systems also means that the benefits of those investments have not been fully realized.

The Malawi National Health Strategy sets out a clear vision for the digital health ecosystem, including the use of the Open Health Information Exchange interoperability framework. Thus, the focus of DIPC project implementation in Malawi will be aimed at strengthening existing in-country digital immunization tools by working together through 2024 to:

01 **Enhance the MaHIS through the addition of an electronic immunization register,** according to a defined and validated set of requirements as prioritized by the MOH, within the time and budget constraints. The aim is to implement this new functionality at all static immunization sites in Mchinji District and three immunization static sites in Ntcheu District.

02 **Support interoperability of current digital immunization tools** by defining and validating the data exchange requirements for the electronic immunization registry and identifying the priority interoperability workflows.

03 **Strengthen the capacity of users to make effective use of the new immunization module** through the provision of training materials and a capacity development plan.

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