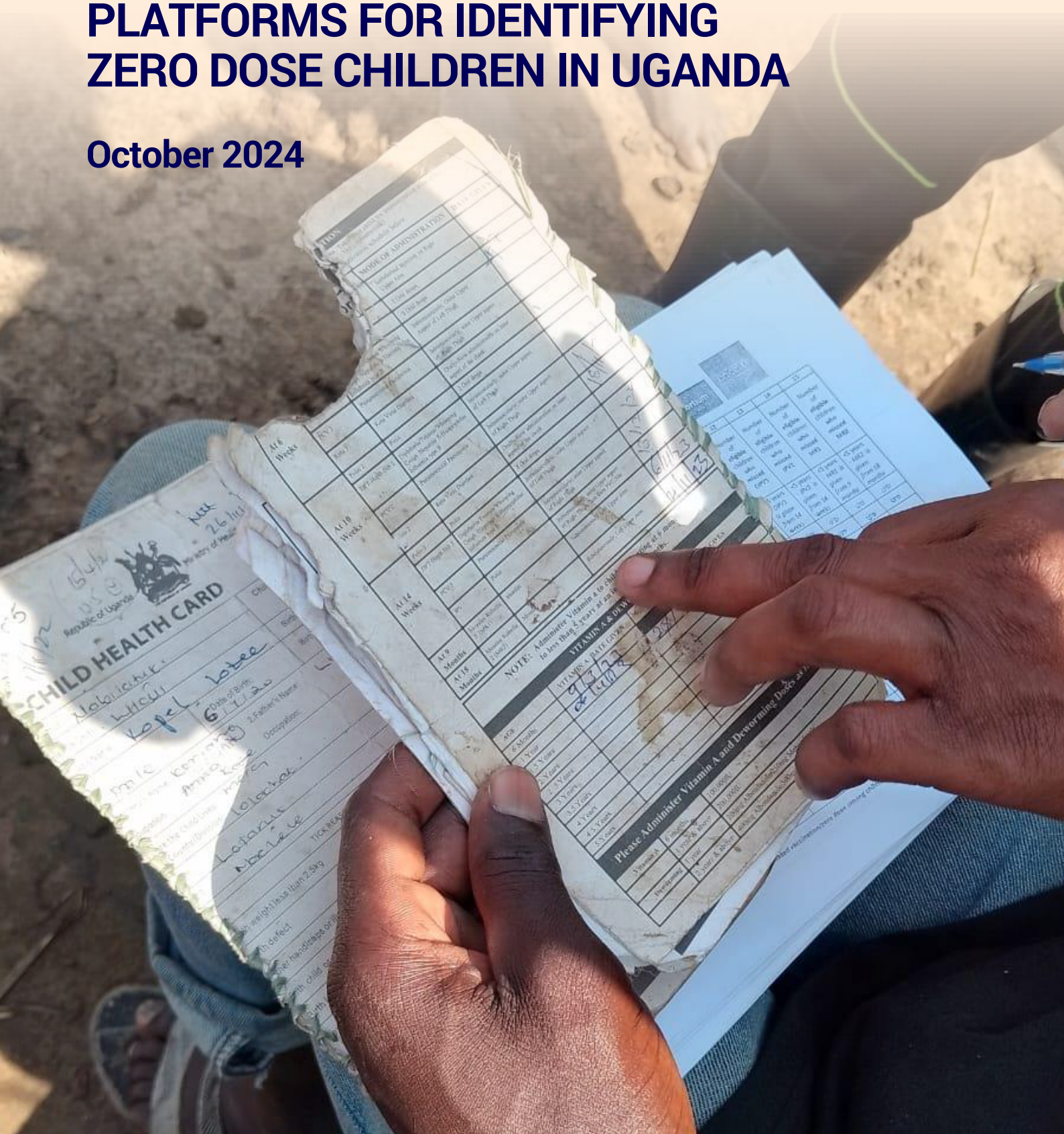
Uganda Learning Hub For Immunisation Equity

UTILITY OF DATA CAPTURE PLATFORMS FOR IDENTIFYING ZERO DOSE CHILDREN IN UGANDA

October 2024



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Uganda Learning Hub for Immunisation Equity Team

Report on a **Utility of data capture platforms for identifying zero dose children in Uganda**

Uganda Learning Hub for Immunisation Equity; 2024

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EXECUTIVE SUMMARY

Introduction:

The main data capture system for identifying and monitoring immunisation uptake in Uganda is the District Health Information System (DHIS2). However, there are concerns about the quality of data captured, and its inability to capture individual-level data which is key in characterizing the zero dose children for purposes of targeted programming to ensure no one is left behind. This analysis of the immunisation data ecosystem in Uganda aims to address this gap by providing evidence on what data capture systems exist, the extent to which they capture data on the zero-dose child and how the data ecosystem could be improved to comprehensively identify and characterize the zero-dose child.

Methods:

Data was collected from March to December 2023 through document review, two stakeholder scoping meetings, structured observations of data capture platforms, 19 key informant interviews with stakeholders at national and district stakeholders in Mukono, Lira and Mubende districts, and secondary data analysis of DHIS2 and the electronic Community Health Information System (eCHIS) data.

Results:

There are several immunisation data capture platforms in Uganda, and each platform is at a different level of deployment. The main data capture platforms include: the DHIS2 used at health facilities across the country; the Smart-Paper Technology (SPT) currently being piloted in 11 districts; and the Electronic Community Health Information System (eCHIS) used for registration at community level, currently being piloted in 19 districts. Other systems include the house-to-house registration which is being piloted by UNICEF in four districts; the Smart Health App at prototype stage and yet to be piloted, UgaVax, and the Epidemic Vaccination (EpiVac) which is mainly focused on Coronavirus (COVID-19) vaccination data. System Pilots are largely supported by implementing partners, while DHIS2 is largely supported by government.

All data systems are generally interoperable with DHIS2. All data systems largely capture and use the same indicators – diphtheria-pertussis-tetanus vaccine first dose (DPT1) and diphtheria-pertussis-tetanus vaccine third dose (DPT3) to estimate Zero-dose children (ZDC) and under-immunized (UI) children, although the emerging estimates sometimes differ. The difference is generally related to the source of the data, quality of data, and denominator used. DHIS2 and SPT estimate ZDC and UI burden using health facility records while eCHIS uses house-to-house data. This analysis, indeed, found that the ZDC and UI burden estimate through eCHIS was higher than the estimates under DHIS2. However, each of the data systems had challenges and opportunities that could be leveraged. For example, DHIS2 is affected by data quality issues – incomplete data, untimeliness in reporting, and inaccuracies - mainly emanating from facility-level.

The DHIS2 also does not provide individual-level data to help characterise and track the ZDC or UI child. The advantage of DHIS2, however, is the extensive geographical coverage and its interoperability with other systems. The SPT system had notable variations between data recorded at the health facility and the data that reflects in the DHIS2. This variation was mainly due to the sensitivity of the SPT towards the quality of recording data on the forms. A key feature of SPT, however, is the unique identifier system,

which is essential for tracking immunisation status of registered children. The eCHIS system prides itself in the recording data from household level which assures high level of data accuracy. However, with eCHIS, it was complex to ascertain immunisation status of a child in the absence of a vaccination card. Also, the eCHIS data is yet to be successfully integrated into DHIS2 due to technical challenges currently being addressed

Conclusion:

There are multiple systems and related tools used for identifying, reaching, and monitoring zero-dose and under-immunized children in Uganda, each at different stages of maturity, implementation, and geographical coverage. The DHIS2 is the predominantly used system across the health facilities in the country. It is well developed, tested, and interoperable with other data systems within the health sector. Each immunisation data capture system has challenges (limitations or gaps) in estimating the burden of zero-dose and under-immunized children. However, the systems also have opportunities that could be leveraged to improve immunisation data in Uganda for better and more reliable estimates.

LEARNINGS

1. Different data capture systems generate different zero-dose estimates and this is largely attributed to discrepancies in not only the numerator data but also the source of data for the denominator used in the estimation.
2. The quality of immunisation data – completeness, timeliness, completeness, comprehensiveness, validity, consistency, and integrity – is very critical in accurate and reliable estimation of the burden of ZD and UI children.
3. Facility-based data capture systems may not accurately determine the burden of ZD and UI children, because they leave out children who do not interface with the health system.
4. Determining eligible populations from community (household) level records or data could be a more reliable approach to estimating the burden of ZD and UI children compared to relying on UBOS population projection data which may not consider the ever-changing factors within communities.
5. An immunisation data capture system is a key influence on the prevailing burden of ZD and UI children, but it is not the panacea. High Risk Communities (HRCs) still play a crucial role in influencing the burden of ZD and UI in many districts in Uganda.
6. Identifying the ZD or UI child through a data system is a starting point but not an end in itself in addressing the challenge. Additional effort must focus on tracking and bringing the children into the system to complete their schedules, in addition to addressing the obstacles to immunisation uptake.
7. Except DHIS2, most existing immunisation data capture systems are currently implemented as pilots and largely financed and supported by implementing partners which pauses concerns about their deployment, roll-out and institutionalisation beyond the initial funding modalities.
8. Lack of systematic triangulation of coverage data with other systems such as financial, human resource, health facility capacity, and surveillance, constrains the potential to generate a better and actionable perspective on key bottlenecks to reach ZD communities.

9. It is still challenging to link children who need immunisation services from communities to health facilities. Under the eCHIS system, VHTs are required to refer children to health facilities if they find that the child has missed their vaccination schedule during home visits. However, there is also no system to monitor whether the child indeed was taken to the facility or if indeed they received the required vaccine.
10. Lack of a national-level health indicators tracking system that is linked to the National Identification and Registration Authority (NIRA) civil registration system implies that it is not easy to track vaccination schedules for children wherever they are located, making it hard to estimate with certainty the ZD burden and UI in Uganda.

RECOMMENDATIONS

1. Ministry of Health should invest in and deploy a functional digitalised system, at the community level to collect house-hold level data, which can improve accuracy and quality of immunisation data.
2. Ministry of Health should conduct frequent but systematic data triangulation exercises – for example, through immunisation coverage surveys, censuses, Lot Quality Assessments (LQAs), etc – to improve reliability of the data and better understand immunisation coverage. Additionally, systematic triangulation should be conducted with systems whose data may not necessarily be included in the DHIS2, for example, financial systems, human resource systems, among others.
3. Ministry of Health should conduct regular targeted assessments in specific and priority ZD communities (e.g. using Behavioural and Social Drivers of Vaccination (BeSD) and other demand related tools) to systematically collect any emerging and context-specific evidence on immunisation coverage and more critically on key barriers to immunisation.
4. Ministry of Health should develop a national-wide tracking system where every child registered at birth can be tracked to ascertain their immunisation status irrespective of where they seek health care services. This system could be linked with the civil registration system and interoperable with other existing systems within the health sector so that vaccination status can be identified at every point of care for any child.
5. Ministry of Health and partners should consider building the capacity of frontline health workers for data collection, reporting, real-time data analysis and use for real time action.

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ABBREVIATIONS

ADHO	Assistant District Health Officer
BeSD	Behavioural and Social Drivers of Vaccination
COVID-19	Corona Virus
DEC	District Executive Committee
DHI	Division of Health Information
DHIS2	District Health Information System
DHO	District Health Offices
DPT	Diphtheria Pertussis Tetanus
DQA	Data Quality Assessment
e-CHIS	Electronic Community Health Information System
EMR	Electronic Medical Records
EPI	Expanded Program on Immunisation
EpiVac	Expanded Programme for Immunisation Vaccination
HMIS	Health Management Information System
HRC	High Risk Community
HSD	Health Sub-district
ICCM	Integrated Community Case Management
ID	Identification Number
IDI	In-depth interview
IPD	In-patient Department
KII	Key informant interview
LIN	Learners Identification Number
LQA	Lot Quality Assessments
M&L	Monitoring and Learning
MakSPH	Makerere University School of Public Health
MDA	Ministries, Departments, and Agencies

MoH	Ministry of Health
MR	Measles-Rubella
Mtrac	Mobile Tracking
NIRA	National Identification and Registration Authority
OPD	Out-Patient Department
RE-AIM	Reach, Effectiveness, Adoption, Implementation and Maintenance
REC	Reaching Every Child / Community
RED	Reaching Every District
RMNCH	Reproductive, Maternal, Newborn and Child health
SPF	Smart Paper Forms
SPT	Smart Paper Technology
TBA	Traditional Birth Attendant
TPC	Technical Planning Committees
UBOS	Uganda Bureau of Statistics
UHMC	Health Unit Management Committees
UI	Under Immunized
UNEPI	Uganda National Expanded Programme on Immunisation
UNICEF	United Nations International Children's Emergency Fund
USAID	United States Agency for International Development
VHT	Village Health Teams
VPD	Vaccine-Preventable Disease
WHO	World Health Organisation
ZDC	Zero Dose Children
ZDLH	Zero Dose Learning Hub

1.0 INTRODUCTION

1.1 Background

Globally, immunisation is a key and cost-effective public health intervention aimed at reducing morbidity, mortality, and disability due to vaccine-preventable diseases. The Government of Uganda, through the Uganda National Expanded Program on Immunisation (UNEPI) has prioritized immunisation to ensure that every child and priority population at risk of vaccine-preventable disease are fully vaccinated. The UNEPI has expanded immunisation service delivery nationally, resulting in significant improvements in DPT3 coverage from 91% in 2011 to 97% in 2021. This has been achieved through routine immunisation within the health facility and enhanced by outreach services for populations living in areas with limited access to fixed services. However, there have been concerns that despite the strong efforts and interventions being rolled out to ensure no child is left behind, there are still pockets of children missing out on these lifesaving vaccinations.

According to the Uganda Annual Health Sector Performance Report 2020/2021, immunisation coverage for DTP3 remained stagnant at 87%, far below the national target of 96%, with only 40 out of 136 districts (29.4%) achieving the national target of 96% . The concern is compounded by the quality of data used for routine monitoring of immunisation service delivery in Uganda. At a sectoral level, the District Health Information System (DHIS2) represents an attempt at data integration, although a myriad of challenges still exists with the nature of data captured, quality of the data, and use which undermine the usefulness of the data for proper planning, programming, and tracking of coverage indicators. Additionally, there may be other data capture platforms and tools that may exist within government institutions (such as the Uganda Bureau of Statistics (UBOS), civil registration systems and others) and among institutions supported by implementing partners. However, it's not clear how these data capture systems are linked and synchronized to optimize data for decision-making.

1.2 Context

The mapping of the data ecosystem landscape in Uganda is part of the sub-studies of the Zero-Dose Learning Hub (ZDLH) for Immunisation in Uganda. The ZDLH is a consortium of three organisations (Infectious Diseases Research Collaboration (IDRC), PATH Uganda and Makerere University School of Public Health) implementing the LH from February 2023 to December 2025. The LH is working closely with the Ministry of Health and other key immunisation stakeholders at national and sub-national levels including academia, and civil society organizations (CSOs). The goal of the LH is to generate evidence on identifying and reaching Zero Dose Children (ZDC) – those who miss the first dose of the Diphtheria Pertussis and tetanus-containing vaccine (DPT1), under Immunised (UI) children- those who miss DPT3 and missed communities in Uganda to inform immunisation equity interventions.

1.3 Rationale

Data is a key ingredient in the monitoring and tracking of service delivery. Uganda's immunisation programme reflects a success story, where the UNEPI has expanded immunisation service delivery nationally, resulting in significant improvements in coverage from 91% in 2011 to 97% in 2021. Despite this coverage, there are still reported variations in immunisation uptake and coverage across geographical areas. The main data capture system for identifying and monitoring immunisation uptake in Uganda is the DHIS2. However, there are concerns about the quality of data captured, and its inability to capture individual-level data which is key in characterizing the ZDC for purposes of targeted programming to ensure no one is left behind. This ZDLH landscape analysis of the immunisation data ecosystem in Uganda aims to address this gap by providing evidence on what data capture systems exist, the extent to which they capture data on the zero-dose child and provide recommendations on how the data ecosystem could be improved to comprehensively identify and characterize the zero-dose child.

1.4 Evaluation objectives

General objective

To evaluate the utility of the different data capture platforms for identifying ZDC, UI, and missed communities in Uganda.

Specific objectives

1. To identify and describe the different immunisation data capture platforms or systems currently in use in Uganda.
2. To examine the relationship between the data capture platforms or systems and the zero-dose burden in Uganda.
3. To explore the challenges and opportunities for the immunisation data ecosystem in identifying the ZDC burden in Uganda.

2.0 METHODOLOGY

2.1 Data collection

Data was collected from March 2023 to December 2023 through the following key approaches:

a) **Document Review** – This involved a review of various documents including reports of the Ministry of Health particularly those by the Division of Health Information (DHI,) project reports and documents of other implementing partners as well as other research reports. The rationale was to identify different data capture systems, indicators, usability, interoperability, challenges, and opportunities of those existing platforms.

b) **Stakeholder Engagements** – Two scoping meetings were held, one with the UNEPI monitoring and evaluation and another with the DHI teams at MoH. The meetings aimed to identify the existing immunisation data capture platforms that warranted in-depth investigation and learning, and the critical stakeholders in the data ecosystem to engage in the study.

c) **Key Informant Interviews (KIIs)**–KIIs were conducted from August to December 2023. A total of 19 KIIs were conducted with purposively selected stakeholders at national and sub-national levels (See Table 1). The KIIs mainly explored among others: (1) the nature and characteristics of existing data capture systems; (2) data and indicators captured; (3) tools used; (4) interoperability of the system; (5) the extent of use of the data generated; and (6) utility of the system in capturing and characterising the zero-dose. At the sub-national level, two districts; Lira and Mukono – were selected for the study because they had a combination of data platforms. The third district, Mubende, was selected because it had a high ZDC burden. It was, therefore, necessary to understand if the reported ZDC burden was linked to the existing data capture system in the district.

Table 1: Key informant interviews conducted

Level	Number of KIIs	Description of respondents
National	8	Immunisation and surveillance data specialist M&E specialist (UNEPI) Assistant commissioner (Health information management) M&E technical advisor (MOH-community health department) National Coordinator for Smart Paper Technology (SPT) Digital specialist (EMR focal person) – MoH Founder/Executive Director (MedRef) M&E manager - Living Goods
Lira district	5	ADHO (1) District Biostatistician (1) EPI health facility focal person (1) VHTs (1) Health information assistant (1)

Level	Number of KIIs	Description of respondents
Mukono district	4	ADHO (1) District Biostatistician (1) Data officers/Health workers (2)
Mubende district	2	District Biostatistician District HMIS focal person

d) **Structured observations** - The team observed how some of the data capture platforms operated, to gain first-hand information on the operations of the systems. The team observed the SPT, eCHIS, DHIS2 systems, and the house-to-house registration piloted by UNICEF. The observation focused on understanding what and how data is captured, the data transmission mechanisms, data quality checks in place, and how data is summarised and aggregated.

e) **Secondary data analysis** - To compare the performance of the different data capture platforms on estimating the ZD burden, we abstracted DHIS2 and eCHIS data for a district (Lira) where both platforms were deployed. It was noted that in areas where SPT was deployed, the DHIS2 was structured to receive only SPT data. Therefore, DHIS2 data in areas where SPT is deployed represents SPT data. Data for eCHIS was accessed from the Department of Community Health at MoH. This is because currently, eCHIS data is not yet synchronized into DHIS2, thus it comes directly from the community to a separate system within MoH. The key immunisation variables abstracted were DPT1 and DPT3 which are the indicators used to estimate the proportion of ZDC and UI children respectively. The comparison was done to establish the utility of the different data capture platforms in estimating the zero-dose burden. The lessons generated from this comparison would guide recommendations for deploying an appropriate data capture system in Uganda.

2.2 Data management and analysis

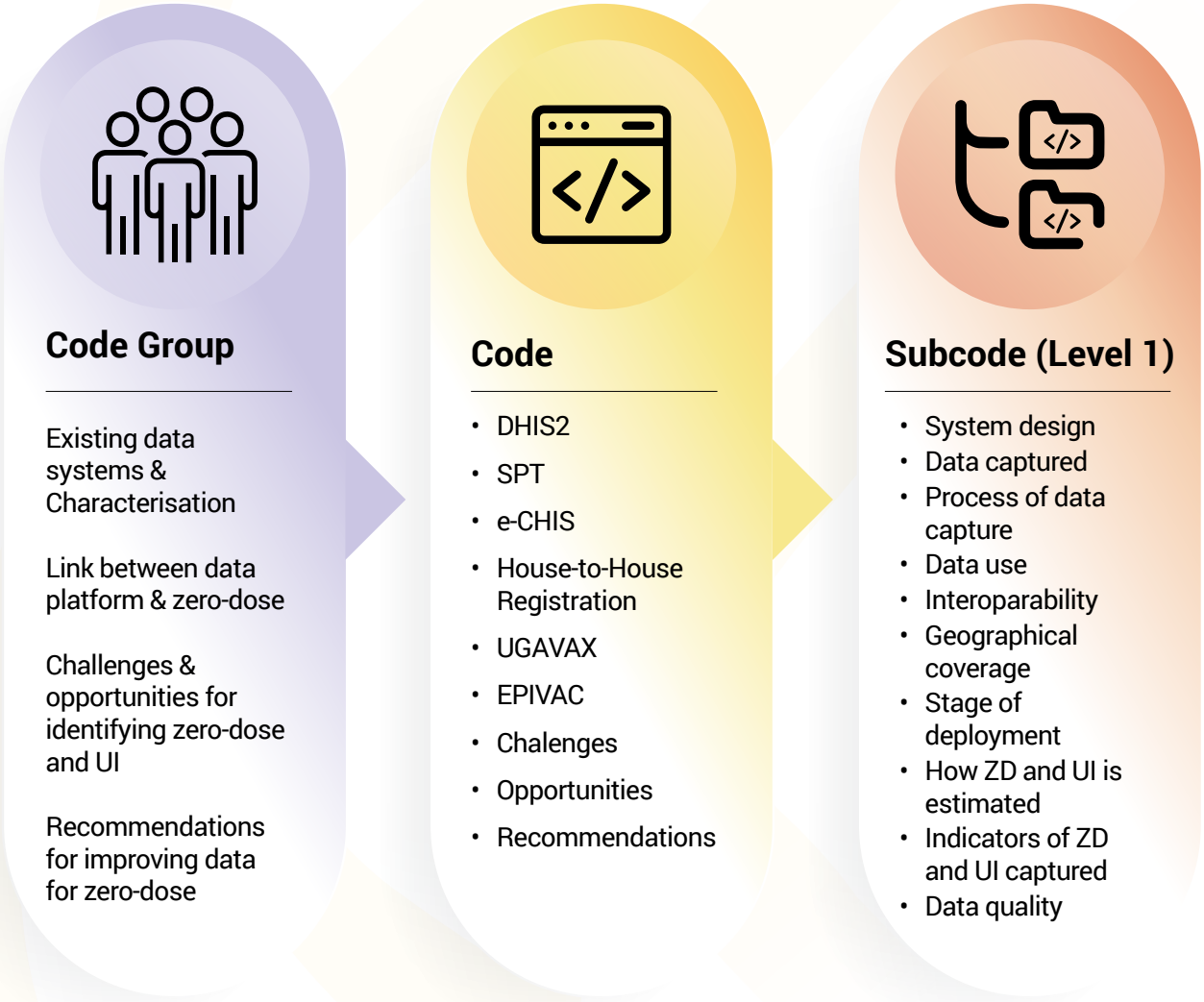
Document Review - Summaries of emerging issues were extracted from documents reviewed and reported based on emerging themes in relation to the study objectives. The emerging issues were summarised using themes generated from the qualitative coding framework.

Data management - The team took notes and summaries during stakeholder engagements which supplemented data from other sources at the analysis level. These summary notes from meetings and observations were typed into an MS. Word file and shared within the research team frequently. Research assistants who were involved in the field data collection conducted the structured observations and typed their detailed field notes into an MS. Word document which was later uploaded to NVivo 14 (QSR International, Cambridge, MA) for coding at the end of each day. The meetings were conducted in English given that all targeted stakeholders understood and spoke English. Audio files were downloaded onto a password-protected computer hard drive and backed up regularly. Audio recordings were listened to carefully and then transcribed into MS Word in English and made ready for exporting to NVivo 14 (QSR International, Cambridge, MA) qualitative data management software for coding and analysis.

Qualitative data analysis - The interview transcripts were reviewed and all statements pertinent to the sub-themes identified were extracted and placed under the identified themes. The process of labelling all the statements from the data collected (also known as coding) was completed using qualitative data analysis software, NVivo 14 (QSR International, Cambridge, MA). The initial coding was conducted independently by the lead social scientist, discussed with different members of the study team and then

a final coding scheme was agreed on and applied to all transcripts. Alongside the coding, a reflective analytical diary was kept drawing out and justifying emerging themes and lines of inquiry through the fieldwork process. Following the coding process, themes were developed and later refined.

Figure 1: Coding Frame



Quantitative data analysis- using STATA 18.5 SE—Standard Edition, DHIS2 and eCHIS data (September to December 2023) for 3 health centres in Lira district (Abala HC III, Agali HC III, and Ogur HC IV) were analysed to generate absolute numbers of ZD and UI children and presented on a comparative bar graph.

2.3 Ethical considerations

The Learning Hub sought approval from Makerere University School of Public Health, the Research and Ethics Committee and the Uganda National Council for Science and Technology. Further permission to conduct the study was obtained from Ministry of Health which facilitated district and health facility entry. Written consent was obtained from all study participants before any interviews were conducted. The study also used de-identified information when reporting the findings.


D CONTROL PROGRAMME
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3.0 FINDINGS

In this section, we present the findings starting with a description of the key existing immunisation data capture platforms in Uganda, followed by a detailed description of each of the platforms along specific system characterisations such as design, data captured and the process, geographical coverage and stage of deployment, data use, and system interoperability. We then demonstrate the relationship between data systems and ZDC and UI indicators by comparing two key data platforms. We also present the challenges and opportunities for immunisation data in Uganda, key lessons learned from the data ecosystem landscaping exercise, and propose key areas of focus to not only improve immunisation data but also the accuracy of ZDC and UI estimates.

3.1. Existing data capture platforms & characterisation

Finding:

Several immunisation data capture platforms exist in Uganda, but these platforms are at different stages of maturity and implementation. The main platforms are: (1) the DHIS2 used at health facilities across the country; (2) the Smart-Paper Technology (SPT) that has been piloted in health facilities in 11 districts; (3) the Electronic Community Health Information System (eCHIS) used for registration at the community level and is currently being piloted in 19 districts. There are other systems such as the house-to-house registration which is currently implemented as a pilot project by UNICEF in 4 districts, the Smart Health Application which has not yet been piloted but is in the nascent stages of development and trial; and EpiVac which is focused on online COVID-19 Vaccination but has also been used for campaigns such as Yellow Fever, MR, etc.

3.1.1 Existing Immunisation Data Capture Platforms

There are several immunisation data capture platforms in Uganda, each at different levels of implementation. However, the main immunisation data capture platforms currently in use are: 1) the District Health Information System (DHIS2); 2) Smart Paper Technology (SPT); and 3) the Electronic Community Health Information System (eCHIS). Other platforms include: 4) House-to-House registration system; 5) UgaVax; 6) Expanded Programme for Immunisation Vaccination (EpiVac), and 7) Smart Health Application. These systems are presented in Figure 2 and briefly described in Table 2.

Table 2: A brief description of existing data capture systems for immunisation

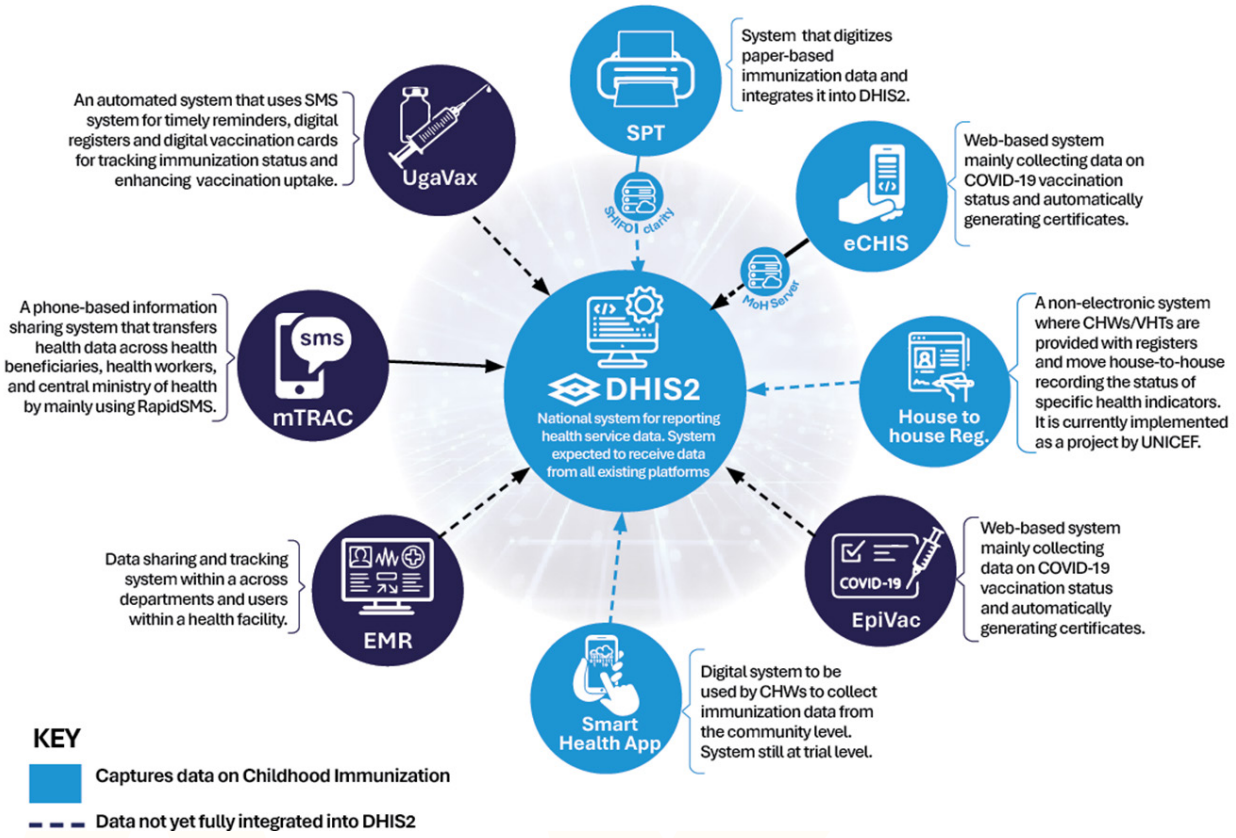
#	Data system	Brief description
1	District Health Management Information software system version 2 (DHIS2)	The DHIS2 is an integrated, web-based, electronic health management information system that is used as a platform for reporting routine health data from health service delivery units or points up to national level so as to facilitate better decision-making for health. Generally, all health service delivery indicators, including immunisation, are captured by the DHIS2. While DHIS2 data is protected, it can still be accessed by anyone upon a formal request for access rights from the Division of Health Informatics, Ministry of Health.
2	Smart Paper Technology (SPT)	This is an innovative solution that digitizes paper-based immunisation data into electronic data using smart-paper forms. Once data has been captured on paper, that data is summarized on smart-paper form which is then scanned at the health facility. The scan 'reads' the data on the form into the system that is expected to integrate that data into the DHIS2 system or platform. As of 2023, SPT was being piloted in 11 districts. However, as of 2024, Ministry of Health suspended its rollout owing to several reported data challenges, including data loss
3	Electronic Community Health Information System (eCHIS)	This is a mobile phone-based system that enables health workers to record and transmit patient information and track health care trends at the community level. The system covers ICCM, RMNCH, Family planning, antenatal care, health promotion, postnatal care, immunisation, stock monitoring, and VHT supervision views. The system is expected to integrate data into the DHIS2. So far, only 19 districts have been covered by the system but plans for a country-wide rollout are underway.

#	Data system	Brief description
4	House-to-House registration system	The community house to house to registration (CHHR) is a non-electronic system currently piloted by UNICEF in four districts. With the system, CHWs/VHTs are provided with registers and move to a new house-to-house recording the status of household members on specific health indicators, including childhood vaccination. Data in the registers is later entered in excel, aggregated, analyzed and used for relevant decisions.
5	UgaVax	This is an automated immunisation tracking system for child vaccination aimed at addressing the challenge of missed vaccinations. The system provides timely reminders to caregivers for vaccination schedules and appointments using a mobile phone SMS system. The system also has a digital register, digital vaccination cards which can be accessed by health workers to ensure efficient monitoring of child vaccination status. This system also expected to have an HPV registry for 12 – 35 years. By the time of conducting this study, the system was not rolled out yet.
6	EpiVac	This is an online data management platform mainly dealing with COVID-19 data. Individuals who have had their COVID1-19 vaccine have their data entered into this system. The individual can easily access a downloadable vaccination certificate by entering their identification number of telephone number in the system. EPIVAC has also been used for monitoring progress of programme campaigns for yellow fever, polio and Measles-Rubella (MR).

#	Data system	Brief description
7	Smart Health Application	The Smart Health App is a digital system developed by Living Goods. The system is used by CHWs to collect data from the community health system, including on pregnancy care, childhood diseases, nutrition, family planning, and immunisation tracking. The data collected is compatible and expected to be integrated into the DHIS2. The system also allows for CHW follow-ups, facilitates facility referrals, etc. The Smart Health App is more or less the foundation for the eCHIS system.
8	mTRAC (Mobile Tracking)	This is a phone-based information sharing system that transfers health data across health beneficiaries, health workers, and central ministry of health. The system uses Rapid SMS to submit data from a community or health facility to the national level. The system monitors different diseases, health emergencies, and medicines. Vaccine Preventable Diseases (VPDs) are also reported through mTRAC on a weekly basis. The data is reported into a dashboard which helps to monitor status and performance of health facilities within districts.
9	Electronic Medical Records (EMR)	This is a system that enables identification and tracking of tracking of patients throughout their hospital or health facility attendance, and patient data can be shared across the departments of the hospital to facilitate better patient management. Similarly, the EMR data is then linked with DHIS2 to enable tracking of performance of health service delivery indicators. Rollout of the EMR system is ongoing.

It is important to note that all systems are expected to integrate their data into the DHIS2 for purposes of aggregation and use at the central level. At the moment, however, the eCHIS integration into DHIS2 is not yet achieved because of technical issues that are currently being addressed. Thus, data from eCHIS is not yet available and accessible through DHIS2. Furthermore, Electronic Medical Records (EMR) and Mobile Tracking (mTRAC), do not currently capture information on childhood immunisation.

Figure 2: Existing data capture platforms



3.1.2 Characterisation of the data capture platforms

a) The District Health Information System (DHIS2)

i) System design:

The DHIS2 is the digital version of the Health Management Information System (HMIS) – an integrated system that collects routine service delivery and utilisation data at every health service delivery point across the country. The DHIS2 has been used in Uganda since 2007. HMIS data collection tools (registers and forms) are deployed to collect different health service delivery indicators (Immunisation, MCH, disease surveillance) under the health system which are then entered into the DHIS2 software system for easy aggregation and use across the country. The DHIS2 has an embedded capacity to allow some basic aggregation and analysis for quick visualization and use. In DHIS2, immunisation is just but one of the service delivery indicators captured by Health Management Information System form 105 (HMIS105). The HMIS105 form only records service utilisation data at a specific health facility and may not specifically indicate if an immunisation service utilisation was a result of a referral from a non-immunisation service.

ii) Data capture and process:

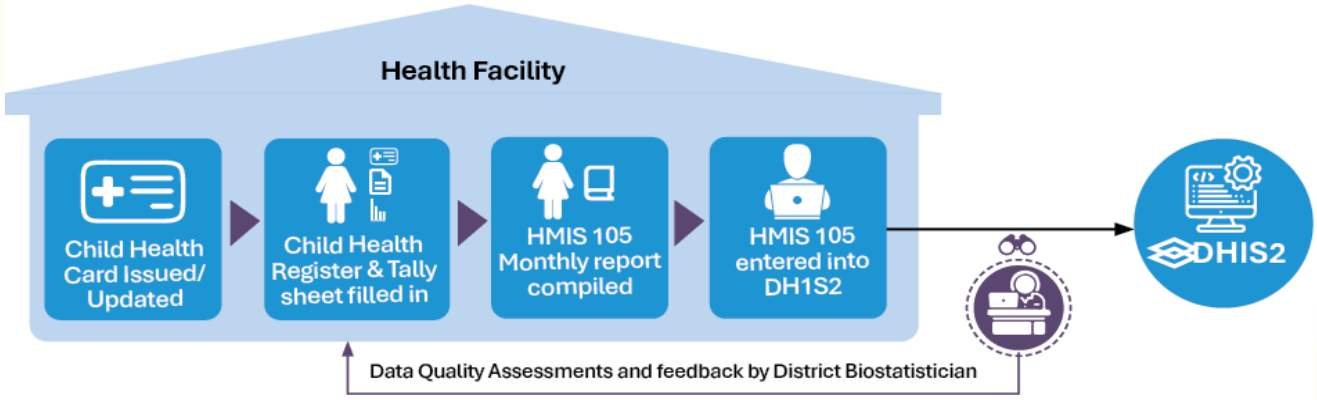
For each health facility (up to Health Center III (C III), each service department is provided with HMIS forms or registers which are used to record service utilisation data at every service delivery point – whether it is Out-Patient Department (OPD), Maternity, In-patient Department (IPD), etc. The data is then summarised and reported monthly. Immunisation data is part of service delivery/utilisation data that is captured by the standardized HMIS tools or registers. The HMIS-105 records data on all the particulars of the child including immunisation antigens or doses utilised by the child, among others (see Table 2). Immunisation utilization data is disaggregated by static and or outreach modes of delivery on the tally sheets. Beyond the tally sheets, the disaggregated data by mode of delivery can also be accessed in the DHIS2 system.

Table 3: Immunisation and other child health indicators recorded on HMIS Forms

Child number	Dates of DPT-HepB+Hib (1st, 2nd, 3rd dose)
Name (child, mother, father)	Dates of PCV Vaccine
Village	Dates of Rota Virus
Sex	Dates of Measles
Weight	Weight at measles vaccination
Age	Under-weight (below 2SD line) on Child health card
Date of Birth	Over-weight (above 3SD line) on child health card
Date of BCG	Fully immunized by 1 year
Protection at birth for TT	Vitamin A administration dates
Date of Polio	Deworming

At the facility level, the HMIS registers from the different departments are collected by a facility HMIS focal person (or M&E focal person in some cases) or submitted to the records department and then entered into the DHIS2 system using a computer. All facility data has to be entered into the DHIS2 system by the 15th of every month. After data entry, data cleaning and validation is conducted to ensure accuracy and completeness. The data flow process from the health facility to the DHIS2 can be visualized in Figure 3.

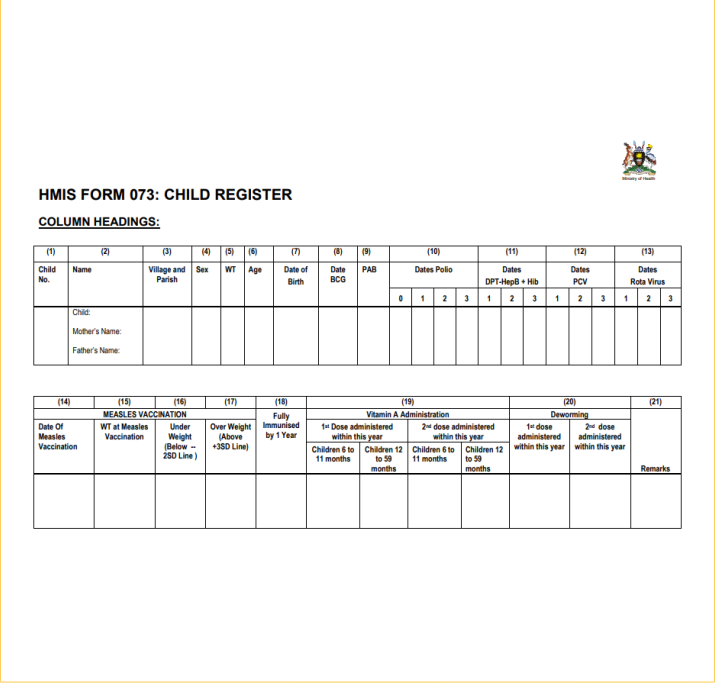
Figure 3: Data flow from the health facility to the national (DHIS2) system



The DHIS2 has integrated and embedded validation processes and dashboards that ensure data consistency, accuracy, and utilization for effective decision making. For any particular period, maps, charts, reports, tables, etc. can be generated from DHIS2 to aid data visualization and data use. For example, usually at the end of the month, a summary is generated of eligible children who have received a particular antigen (in the case of immunisation indicators), for example, children aged < 1 year who have not received (DPT1 & DPT3) as a measure of zero-dose or under-immunized.

> *"For DHIS2 we just give aggregates that these are the total number of people we have immunized, these are the vaccines we have used, such things. These are the ones we have done in static; these are the ones we have done in outreach and we end there."* ***(KII, Partner organisation).***

Figure 4: Child Register (Left) and Tally Sheet (Right)

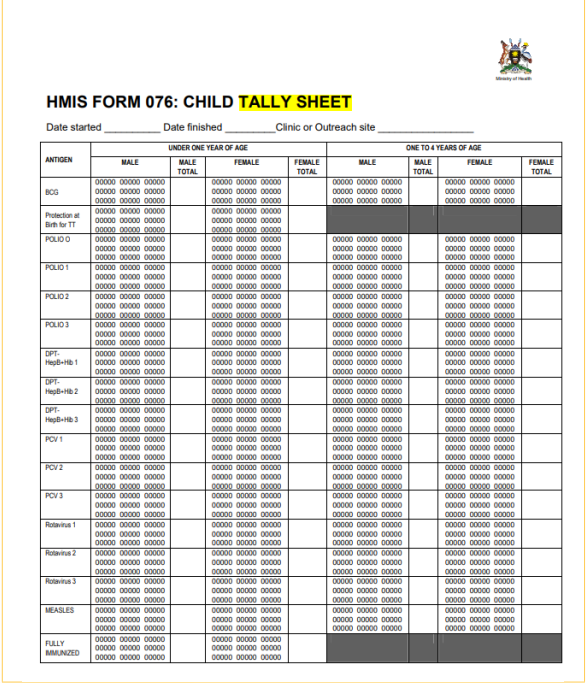


HMIS FORM 073: CHILD REGISTER

COLUMN HEADINGS:

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)				(11)			(12)			(13)		
Child No.	Name	Village and Parish	Sex	WT	Age	Date of Birth	Date BCG	PAB	Dates Polio				Dates DPT-HepB + Hib			Dates PCV			Dates Rota Virus		
									0	1	2	3	1	2	3	1	2	3	1	2	3
	Child: Mother's Name: Father's Name:																				

(14)	(15)	(16)	(17)	(18)	(19)				(20)		(21)
MEASLES VACCINATION					Vitamin A Administration				Deworming		
Date Of Measles Vaccination	WT at Measles Vaccination	Under Weight (Below -- 2SD Line)	Over Weight (Above +3SD Line)	Fully Immunised by 1 Year	1st Dose administered within this year		2nd dose administered within this year		1st dose administered within this year	2nd dose administered within this year	Remarks
					Children 6 to 11 months	Children 12 to 59 months	Children 6 to 11 months	Children 12 to 59 months			



HMIS FORM 076: CHILD TALLY SHEET

Date started _____ Date finished _____ Clinic or Outreach site _____

ANTIGEN	UNDER ONE YEAR OF AGE				ONE TO 4 YEARS OF AGE			
	MALE	MALE TOTAL	FEMALE	FEMALE TOTAL	MALE	MALE TOTAL	FEMALE	FEMALE TOTAL
BCG	00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000	
Protection at Birth for TT	00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000					
POLIO 0	00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000	
POLIO 1	00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000	
POLIO 2	00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000	
POLIO 3	00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000	
DPT-HepB+Hib 1	00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000	
DPT-HepB+Hib 2	00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000	
DPT-HepB+Hib 3	00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000	
PCV 1	00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000	
PCV 2	00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000	
PCV 3	00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000	
Rotavirus 1	00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000	
Rotavirus 2	00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000	
Rotavirus 3	00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000	
MEASLES	00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000	
FULLY IMMUNIZED	00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000					

Once immunisation data has been entered in the HMIS Form 073 (Child Register), it is then summarized in HMIS Form 076 (Child Tally Sheet) – which reflects the aggregate number of children who have received a vaccine or antigen. For immunisation, tallying will happen every time the vaccine is given to avoid the inconvenience of extracting the information from the register at the end of the month. After tallying, the aggregated data is then entered into the DHIS2 system and the data can be reflected in the system. The district Statistician or DHI team can access the data at the back end to review facility performance. As part of the Data Quality Assessment (DQA) process, the district biostatistician may also periodically flag data quality issues and refer them back to a specific facility for corrective action.

iii) Geographical coverage and stage of deployment:

The DHIS2 is deployed and implemented nationwide at various levels up to the health sub-district as the lowest Unit. However, the HMIS system that provides the source data for DHIS2 is used at all (public) facilities up to HCII. At the moment, HC IIs and some HC IIIs (lower-level facilities) do not enter their data directly into DHIS2. Instead, HMIS registers from those lower-level facilities are collected and entered into DHIS2 at the Health sub-district (HC IV) although the data still reflect the individual facility codes (data accounts) in the DHIS2 system – meaning that it is still possible to identify data collected from a specific HC II or HC III. Some private health facilities have also been onboarded onto the DHIS2 system and can now report their data directly into the DHIS2. Plans are also underway to extend the system up

to the lower-level facilities, although this will require a comprehensive rollout plan with an embedded capacity-building component for those facilities.

iv) Data accessibility and use:

The DHIS2 system data can be accessed and analysed at various levels. For example, the district statisticians reported that they normally access the data at the back end and do quality checks, as well as run basic analyses to generate summary reports which are used for different purposes including surveillance, identification, and response to emergencies, as well as that appreciating the performance of the health facilities. Beyond the facility, the analyses are also shared in DHT meetings or district data review meetings where performance gaps and action areas can be identified. However, more often than not, decisions made from the review meetings are never followed up by roll bearers and the anticipated changes are never realised. Some respondents acknowledged that DHIS2 as a system had made health-related data accessible, timely, storable, and traceable.

> *"Just imagine if we had only a child register and the tally sheet. We didn't have the DHIS2; how difficult was this going to be every month to move around the entire country to go and ask or you're picking a phone to call? It makes work easier and you can get the data as and when you need it and even you can go back to the previous years. I don't need to be here maybe when DHIS2 started but I can go back to the time we started, and I can still get the data because it is kept in a safe repository, and I can get it at any time."* ***(KII, MOH official).***

At the national level, the DHIS2 data was reported to be used for planning service delivery by identifying which indicators are not doing well and sharing feedback to inform implementers to address the service delivery gaps identified in the data. Data has also been very key during the process of developing funding concepts and proposals, development of policy briefs, and bulletins, updating different websites, using forums to share the performance of the EPI, as well as an accountability mechanism on how and whether the funds provided to the ministry were used as planned.

> *"We have statutory reports that we must produce by law, quarterly reports, and annual reports. This data is well utilised in that context. What do these reports serve for? Accountability. If the government of Uganda gave you money to do work, at the end of the year you must produce an annual report for the sector."* ***(KII, MoH official).***

> *"We use it in grant applications; we use data in writing concepts and of course, as we are looking for funding to bridge the gaps in data. We also use it in writing program documents like the national immunisation strategy communication strategy, and M&E plan strategy so different strategies we do a lot of data sharing there, and of course, we use it to publish different bulletins. We do update the different websites and other publicity forums that we get to share some of the performances of the program."* ***(KII, MoH official).***

Partners working in the EPI space also find this data critical for their planning and program implementation activities.

> *"Other partners who are also working on zero doses, sometimes UNICEF is working, PATH, etc., can request some data which we give to show where the partners could focus their attention."* ***(KII, MoH official).***

However, it was reported that data use is sub-optimal at facility, district, and national levels. It was reported that in some meetings, the deliberations are not informed by data. Additionally, it was mentioned that it was difficult to track individual-level data given the use of population-level estimates from UBOS, which sometimes may not be accurate.

"We are giving them access right now so that they can be in a position to check on their data so when you go to their facility you see now, they have retrieved the data and made a graph which you can put on the noticeboard so show how they are performing as a facility, health facility." ***(KII, DHT).***

v) System interoperability:

It was noted that DHIS2 is the main data capture system within the health sector and is designed to receive data from other data systems within the sector. As such, DHIS2 is interoperable with other data systems like mTRAC (although mTRAC and EMRs do not currently capture childhood immunisation data). The DHIS2 data can be accessed (read-only mode) by the public for research or any legitimate purpose once access rights have been granted through a formal process.

"mTRAC and DHIS2 are interoperable because when you enter mTRAC you use your phone 6767 so you can just send your information and it goes to the mTRAC and then it is pulled to the DHIS2 as HMIS-033B so they have linked the two… For the community, the data goes through the EMR and then goes to DHIS2. SPT is also linked with DHIS2, the linking is done at the server at the ministry." ***(KII, MoH official).***

"We have had an interoperability agenda and the system is linked to the DHIS2 through the database, so the aggregate reporting happens automatically, but we have also been having integrations in terms of linking this to the community health workers' registry." ***(KII, MoH official).***

However, there are reported concerns that DHIS2 is only confined within the health sector and is not well linked with other data platforms in other government Ministries, Departments, and Agencies (MDAs) as well as the national level platforms such as National Identification and Registration Authority (NIRA) and Uganda Bureau of Statistics (UBOS), Learners Identification Number (LIN) and Logistics Management Information Systems (LMIS). Yet this interface would be key in ensuring that health sector data coming through DHIS2 is widely used for broader planning beyond just health service provision, but it also facilitates easy tracking of individual-level disaggregated data for possible action at both macro and micro levels.

"…when you look at the system currently, it's a system of the department. It operates in such a manner that it's only being used by the health department. That's one of the challenges that it does not feed into other systems of government. So, it's an isolated item of which the users or the developers only focus on the health department, yet the information it has is very important for the entire district." ***(KII, DHT).***

b) Smart Paper Technology (SPT)

i) System Design:

The Smart Paper Technology (SPT) solution is a hybrid innovation used to capture and digitize service utilisation data at the health facility, to ease data entry and use. The SPT solution has two components – the paper-based component (using Smart Paper Forms (SPFs)) and the digital component. The SPT solution was designed to digitally capture, store, and analyse routine vaccination data generated under the National Expanded Program on Immunisation (EPI). Shifo Foundation in collaboration with the Government of Uganda through the Ministry of Health (MoH) and Gavi implemented SPT for the Expanded Program on Immunisation (EPI) services in Uganda using a phased approach. As part of the 1st phase, the SPT Solution was implemented for EPI services in 10 districts in Uganda in February 2022. The SPT system was piloted from 2013 to 2020 when the Ministry of Health recommended its rollout. With SPT, the details of each child seeking immunisation are captured on the Smart Paper Forms (SPF) and the child is given a unique identification number (ID) which is written on the child's health card. The unique ID is then used to identify the child on their next visit to ascertain what immunisation antigen the child

is due for, or what immunisation antigen might have been missed. If the child is transferred (migrated) to another district, the unique ID would still help to track the child and ascertain the vaccines that have been utilised and the vaccines that are due – if the child migrates to another SPT implementation district.

ii) Data captured and processed:

The SPT is a hybrid solution that combines the use of normal A4 printing paper with the technology or software. At the facility level, when a child comes to seek immunisation, the vaccinator at the health facility records the child and the parents' bio-data on a Smart Paper Form (SPF). The SPT system has three key forms – including a modified child register, a tally form, and a vaccine control book. The tally sheet (SPF) captures data and assigns a unique ID to the child. It also captures the antigens given to the child. All children's information including the antigens (including DPT1 and DPT3 for children < 1 year) administered/utilised at the point of service and their corresponding doses are recorded. The balances of the vaccine doses are also physically counted and recorded at the end of a period, usually a month. In places where SPT was piloted, the use of child registers was phased out and SPT forms were embraced to compile the information. The SPFs with recorded data are then scanned using a scanner 'mounted' onto a computer/laptop and uploaded for processing or conversion into electronic records. The SPT system will digitally aggregate the immunisation service utilisation data and then allocate a Unique identification number (unique ID) to each beneficiary. The digitally aggregated periodic data is later synchronized and 'read into' the DHIS-2 system. The SPT solution has a MYSHIFO App function which allows a health worker to view and edit their data entered, more especially if their handwriting has not been detected by the system.

> *"About 3 months ago we had a similar training in Hoima training on SPT to see how we can retrieve the data, follow up, when the C4 team presented Lira alone lost 13,000 immunisation data, and Lira city lost 14,000 immunisation data. We now requested them how can we retrieve lost data? So that we can perform well our coverage looks a bit better because it affected our quarterly coverages which translated into very poor performance at the end of the financial year. So, we have been losing this data every month you know month scanned not all the data that are scanned on SPT gets into the systems sometimes you find only half of it, sometimes only a quarter of it gets synchronized into the system then much of it is left out, so that was a big challenge faced with Smart Paper Technology."* ***(KII, DHT).***

The unique ID given to each child can help to easily trace the beneficiaries' details for example their immunisation patterns and status even when a beneficiary migrates to a different district as long as the new district still implements the SPT system. Using the unique IDs, the system also generates a list of defaulters who may not have come back for the next expected dose of the vaccine – a practice that could allow health workers to trace the defaulters and bring them back into the system. The SPT system was designed in such a way that it can operate within and without internet connectivity.

> *"If the child was vaccinated and that unique number has been written on the child's health card when this child comes back, they rewrite the unique number and give the subsequent antigens. So, for the health worker searching for a child, it has been made very easy."* ***(KII, DHT Official).***

iii) Stage of deployment:

The SPT system was largely operated under a pilot mode in 11 districts, including; Koboko, Masindi, Lira, Dokolo, Moroto, Tororo, Jinja, Mukono, Mbarara, Isingiro, and Kabale; and two cities (Mbarara and Masindi). The start dates for using the SPT system varied by district, for example, SPT was rolled out in Lira district in 2021. For routine vaccination, the SPT system was used country-wide during campaigns and during the COVID-19 vaccination under pilot mode, supported by project/donor funding.

> *"It's still in the pilot so we are not yet in a place where we can say that this is something that we can say we shall formally adopt..."* ***(KII, MoH official).***

Even for the piloting districts, not all facilities were covered by the system infrastructure. For example, in some districts, some lower-level health facilities will gather their data forms and scan them at a Health Sub-District where the scanning infrastructure is situated.

> *"The scanning facilities, [in Mukono district] we started with HC IIIs and above, all those facilities have scanners, and we have a minimum of 20 scanning points at least. So, the HC IIs don't have the scanners, but they take to the nearby HC III for the scanning".* ***(KII, DHT Official)***

In some districts, the SPT system is implemented in both public and private facilities. For example, in Mukono and Lira districts, some private health facilities were trained on the use of SPT and accredited to offer immunisation services.

> *"We are using private health facilities to be what we call an outreach site for a nearby public health centre. We trained all the known private health facilities within Mukono district to use SPT. Those who visited were accredited to vaccinate. We can't give you vaccines when you don't know how to use SPT including those that we gave our fridge"* ***(KII, DHT Official Mukono).***

iv) Data accessibility and use:

The SPT system digitalizes paper-based data and thus enables quick analysis and use of the data collected. Additionally, TSTP has a defaulter tracking system that is easier to use because it is linked to a unique identifier that is easily traceable. SPT data is also used to monitor vaccine stock given that the control book/form can synchronize the used vaccine doses and the physical balances. –

> *"I use that data I have collected; to update the vaccine control book because once they find it not updated you are in great trouble. Two, I use this information to know how many people are missing for example if last month I immunized let's say 1000 children we usually give these people a return date of at least 4 weeks- that means next month I expect some of these people so whilst I see the numbers decreasing, I have a job to follow up and know what is the problem".* ***(KII, Health worker).***

> *"While the data is utilised at the health facility level, there is demand from high-level stakeholders such as the district and various implementing partners such as the environment committee, UNICEF, AFENET, etc. that are usually interested in finding gaps to support immunisation coverage. Data is also utilised during quarterly meetings, review meetings with health facilities to support microplanning and is displayed on notice boards at health facilities. I got feedback this month because AFENET has been using SPT data generated from the year 2022 to follow-up these clients. After all, the system generates a defaulter list. So, they have access they can follow-up a facility and they also know which village to go to because the system generates all this information, it's derived from the registration form."* ***(KII, SPT National level).***

v) Geographical coverage:

It was reported that the SPT system is still limited to district boundaries, such that if a beneficiary crosses to another geographical area where a different system is used, the SPT system loses track of that beneficiary and may present as never having been immunized for vaccines.

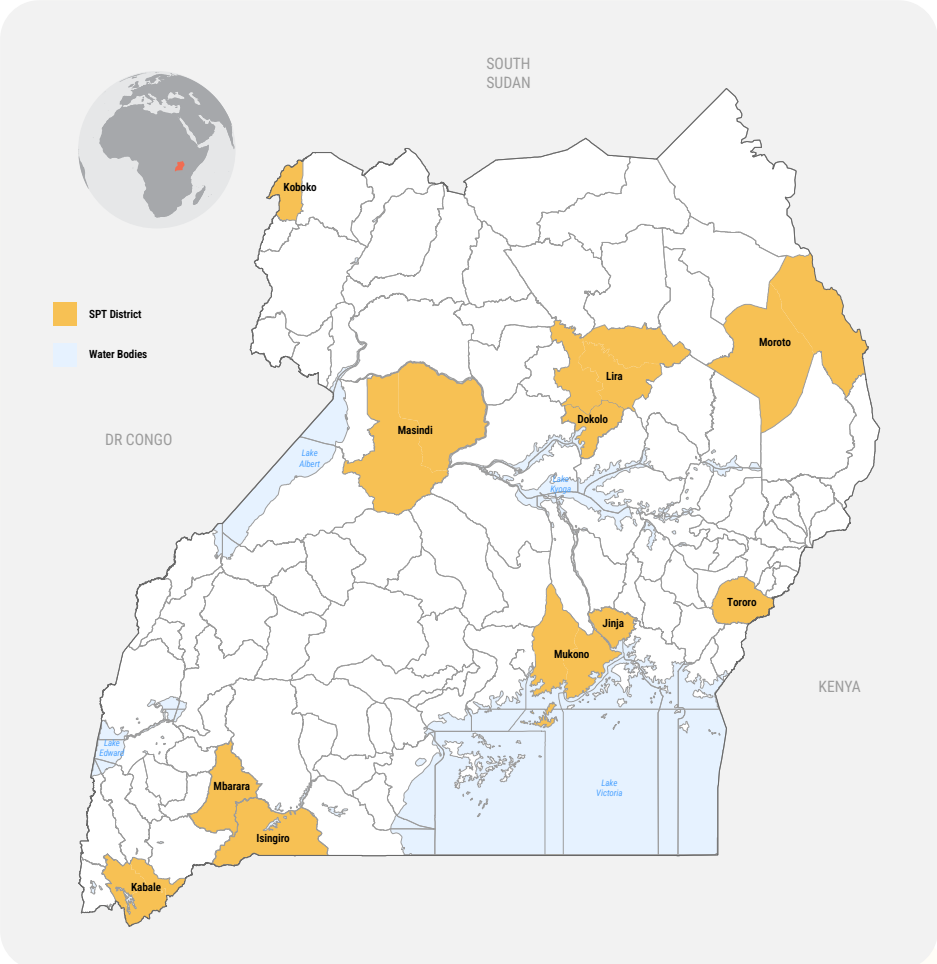
> *"...a child moving between districts may lose tracked status and become "zero dose" due to lack of system linkage. The SPT system is only confined to those districts, so when you cross you go to the paper register system. So, you can only access digital when you are in the premises of the district. So, if the SPT was at scale, then even if we crossed, we use those unique numbers, say we cross from here to Kotido. The Kotido person will go in the system and update you from there; but currently, you cannot trace a person. You cannot have*

evidence even if you cross from this facility and you go to a neighbouring facility a stone-throw away, you are zero dose here." ***(KII, M&E National Level).***

Additionally, there were reports that the synchronization between SPT and DHIS2 is not yet streamlined. There were notable losses of significant data at the point of synchronization occasioned by the strictness of the SPT solution to capture 'neat' data and drop some data that may be related to unrecognizable handwriting, or omissions, or over-written digits. This results in a mismatch between data reported on the physical tally sheet at the facility and the eventual data that is 'read into' the DHIS2, leading to reported underperformance of the districts. To address this challenge of discrepancies, the facilities now do the scanning but also generate monthly reports from the hardcopy tally sheets which places an additional burden on health workers for double reporting.

"Before, data from the SHIFO system was being pushed to the DHIS2, but we were seeing gross discrepancy between what was on the ground and what was in the system. We would go to a facility to find out if I take an antigen like DPT, DPT1 you reach a facility and ask like in this month what was your DPT1 and verify with the physical forms and they tell you it was 130. You go to the system you find 65. So, such discrepancies even the time we would share data, the data they push to the DHIS2 they would clearly tell you that is not my outputs. Even the district output so low yet people immunized the children, so that is when we decided much as you're scanning you still write on the monthly report until that time when we see that the data is 98%" ***(KII, DHT official).***

Figure 5: Map of Uganda showing SPT pilot districts



c) National Electronic- Community Health Information System (eCHIS)

i) System Design:

The Electronic Community Health Information System (eCHIS) is a mobile-based application that was initially developed to aid the VHTs to deliver integrated health services at community level through strengthening the capture and use of community data in the planning for community-based service delivery. Under the eCHIS, the VHTs members are trained and provided with mobile phones installed with eCHIS system App that is used to record data on households within that community (View B, Figure 7). Initially, VHTs are allocated 'operational' or catchment areas that constitute several households to manage. Each VHT then registers all households and their members in the mobile application.

Once the households have fully been registered into the system, the VHTs then make monthly home visits to assess the health status of household members against the service indicators, such as health service utilisation, health conditions (illnesses), health prevention and preventive activities, etc. The immunisation status of children in a household is just one of the elements of the routine household assessments. The eCHIS is designed to capture data on a child from pre-birth to childhood. Once the household assessment is complete, the data is transmitted directly to a central server at the Ministry of Health.

> *"In every month we have to move round in all these households given to me like the one I am working. I need to check what is happening, is there any challenges, is there any fever occurring in some produced so when I move around in case, I come across, so we have to return if we don't have the treatment for that one. Where we can treat where there are drugs given, we can treat where we cannot treat, we always what, refer we treat first then refer to the health facility. So that is what we are always doing."* ***(KII, VHT)".***

ii) Data captured and process:

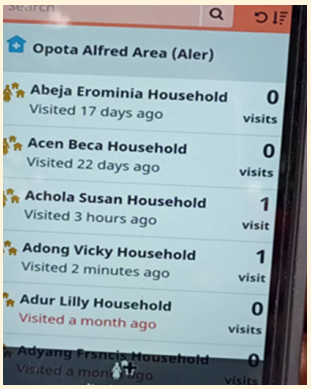
The eCHIS is not only designed to capture immunisation status data, rather it is part of the broader package of essential health services assessed – including prenatal, antenatal, postnatal, nutrition, immunisation, Integrated Community Case Management (iCCM), malaria, HIV and TB health services, among others. When a mother is pregnant, they are registered by the VHT, and supportive care is provided during that pregnancy period including discussions on how the mother is prepared for delivery. After delivery, the VHT must conduct a newborn visit, and the newborn child is then recorded in the system for onward assessment.

For childhood immunisation, once a child's age is selected on the tab, the probable immunisation antigens 'pop-up' (View C, Figure 7) and the VHT asks the caregiver whether the child has been immunized for an antigen. This must be confirmed by observing the immunisation card if it exists. If the child has not been vaccinated for an antigen, the VHT then advises the caregiver on a referral to the nearest health facility for vaccination. The VHT is equally able to track the referral on her next visit to the household.

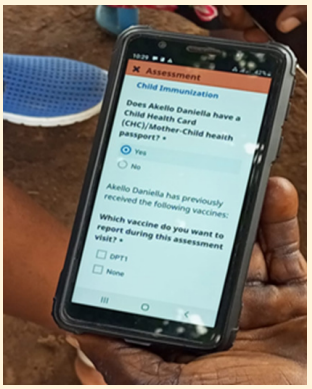
Figure 7: Indicative Data Collection Process for eCHIS

View A

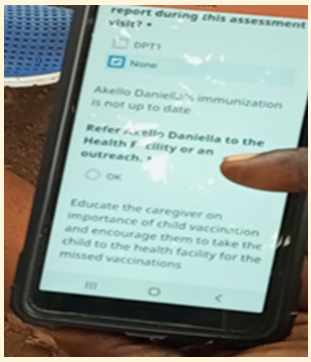
View B



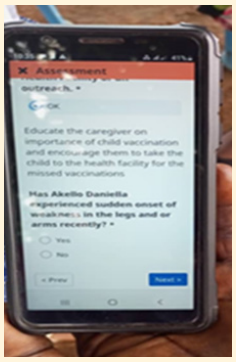
View C



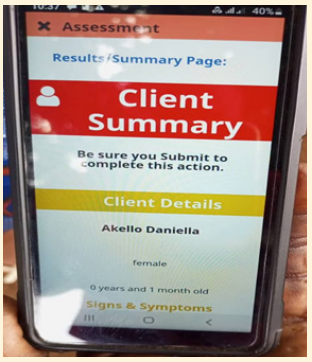
View D



View E



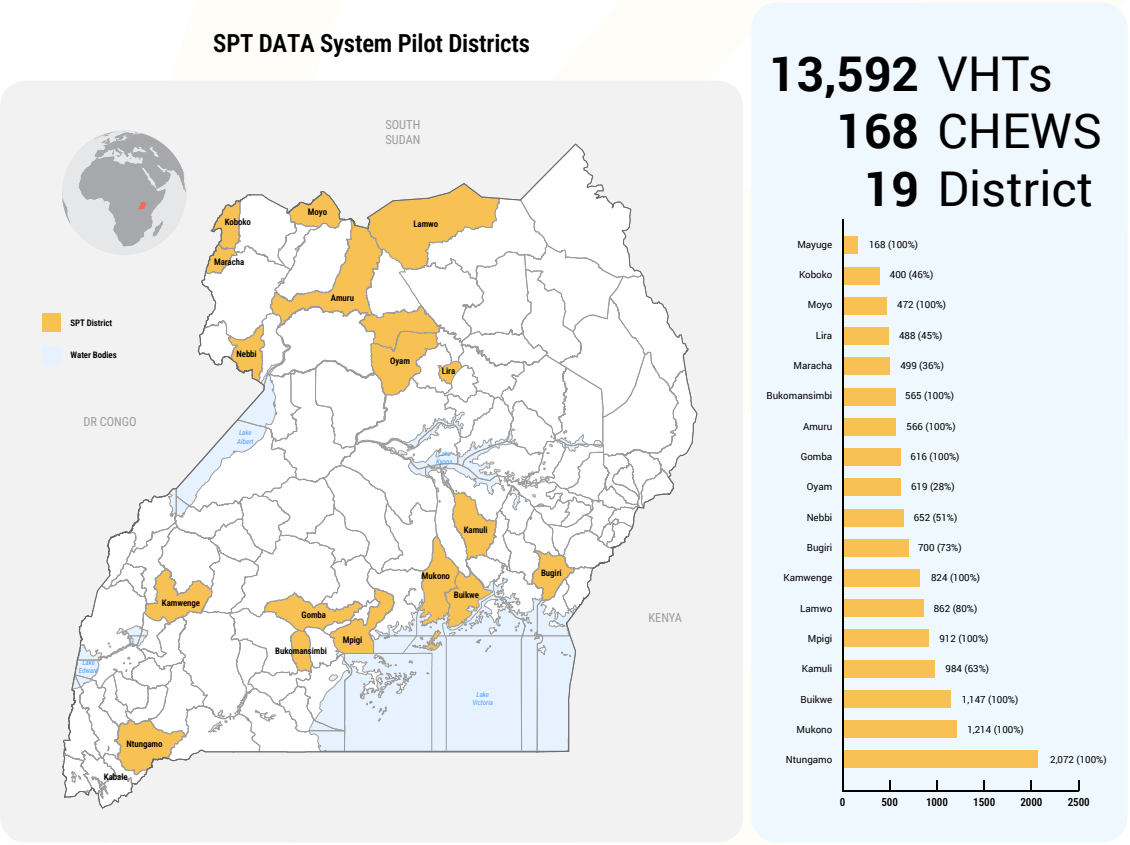
View F



The assessments made periodically can be aggregated and summary data for that catchment area can be generated (View F, Figure 7).

iii) Geographical coverage and stage of deployment: As of May 2024, the eCHIS platform has been rolled out to 19 districts in Uganda.

Figure 8: Map of Uganda showing eCHIS implementation districts



The rollout is supported by different implementing partners, including: UNICEF, Word Vision, BRAC, The Global Fund, Living Goods, USAID, Rockefeller Foundation, Nama Wellness community centre, JSI, UNCDF, AMREF, Malaria Consortium, Medic Mobile, DataKind, TASO, etc.

Different partners support different components -ranging from training and capacity building for VHTS, actual deployment of VHTs, support supervision and monitoring, Data quality, etc. For example: Medic Mobile, the digital partner, supports the system maintenance. UNEPI, USAID/UHSS, Global Fund and Living Goods are supporting the implementation and scale-up of eCHIS including VHT training and deployment; BRAC supports the supervision and fieldwork, among other partners.

There are plans to extend this system to additional districts because of the profound benefits in the realm of community health.

iv) Data accessibility and use:

Respondents noted that the utility of eCHIS goes beyond mere data collection. It acts as a catalyst for informed decision-making across all levels of the healthcare system. The insights derived from eCHIS data are used at district and national level for planning e.g. grant applications, driving strategic initiatives to improve health outcomes and enhance service delivery.

> *"When they want to trace certain conditions from the community reported through that system, it is easy for them to trace. I remember there was an outbreak in [Name, village] of measles. They got about 2 cases that were reported by the community. Our surveillance team was not yet on the ground, but the community was the one who reported directly and gave us a copy so when we saw the copy, we sent the surveillance team to go there to check. The team from the ministry was also calling and asking if we had reached there. They asked if it was true that that area lacked immunisation posts. And how far the nearest immunisation post was, and outreach post in that place, and if many children from there were not immunized at all."* ***(KII, DHT).***

While data is sent directly to the MoH, copies of the same are available to health in-charges of the catchment health facilities, as well as district biostatisticians. Data captured through eCHIS has also been presented at the national level during performance reviews and immunisation technical working group meetings. Most importantly, the design of the eCHIS enables quick follow-up and action, for example, whenever a child who is zero dose is registered in the system, the system loads a task or a reminder so that after a week it will remind the VHT to check on the child and a referral will be made for this child to the health facility where they will be vaccinated.

> *"When you register a child who is zero dose, it loads a task; a reminder so that after a week it will remind the VHT to check on that child. Because when you find a child who is zero dosed and under-dosed you refer them to a facility and it sets a reminder to the community health worker to check if that child has been immunized or visited a facility"* ***(KII, MoH officials).***

v) System interoperability:

The eCHIS system can be accessible anywhere if an individual has an email login that is linked to the system. Additionally, by its design, the eCHIS system is supposed to be linked with the DHIS2. Currently, the eCHIS data is treated as private data and only sent directly to the central Ministry of Health where it can be accessed upon grant of permission from the Department of Community Health. Additionally, there are reported bugs that are technically constraining from integrating eCHIS data into DHIS2.

> *"Currently the data from eCHIS is private and has not yet been integrated with the DHIS2. So, what we do is that this is like a pipeline that when the VHT does the work, it comes to the servers, and then the analytics generate reports that are given to the field officers."* ***(KII, Partner organisation).***

Table 4: Summary of key data platforms and descriptive indicators

Indicator	Data Platform		
	DHIS2	SPT	eCHIS
What and how indicators are captured for the estimation of zero-dose	All antigens are captured including DPT1 and DPT3 for ZD and UI respectively. Data for every child attending immunisation at a facility or outreach is entered in HMIS forms and later transferred into the DHIS 2 system and transmitted to the center.	All antigens are captured including DPT1 and DPT3 for ZD and UI respectively. Data for every child attending immunisation at facility or outreach is entered on SPT forms which then are scanned into the SHIFO system and transmitted into the DHIS2.	All antigens are captured into the mobile APP used by VHTs who conduct house-to-house registration. When the age of a child is entered in the application during assessment, a vaccine due to that child pops up and the child is assessed for whether they received it or not to ascertain vaccination status.
How is zero-dose burden estimated	Children who have received DPT1 within a particular period for a particular facility catchment area are compared with the estimated eligible (target) population from UBOS to ascertain the ZD Burden	Children who have received DPT1 within a particular period for a particular facility catchment area are compared with the estimated eligible (target) population from UBOS to ascertain the ZD Burden	Children who have received DPT1 within a particular community are compared with all eligible children for that community (who are all registered by the VHT) to ascertain the ZD and UI burden.
Quality of data captured	Only children attending facilities and outreaches are recorded. Workload issues at facility level sometimes compromise data entry from HMIS forms to DHIS2 as well as its timeliness. It is not uncommon to find discrepancies in data entered in DHIS2 compared to what is in the primary tools at the source.	Only children attending immunisation at facilities and outreaches are recorded. The system is sensitive to the quality of handwriting. Poor handwriting sometimes results in loss of data (over-writing), meaning that sometimes data mapped into DHIS2 may have discrepancies with what is on the primary forms.	All children within a particular community (households) are registered into the eCHIS Mobile App and assessed periodically by the VHT including for immunisation status. The data doesn't depend on the facility to access rather it is picked from children at the household level.

Indicator	Data Platform		
	DHIS2	SPT	eCHIS
Interoperability of the system	DHIS2 is the main system for the Health Sector. While other secondary platforms are linked to it, the DHIS2 itself is yet to be linked with other national level platforms such as NIRA, UBOS, etc.	The SPT system is linked with the DHIS2 system and all data collected through SPT can be accessed through the DHIS2 system at facility, district, and national level	Currently, the eCHIS data is not yet integrated into the DHIS2 system. It is transmitted separately to the MoH (DHIS2) and can only be accessed with special authorization.
Geographical coverage and stage of deployment	DHIS2 is the nationally used data capture system for the health sector. It is deployed at all health facilities in Uganda.	As of 2023, SPT is implemented in 11 districts across the country. Even within those districts, not all health facilities are covered. It is yet to be rolled out in the country.	As of 2023, SPT is implemented in 18 districts across the country. Even within those districts, not all sub-counties are covered. It is still under pilot implementation mode.

d) Other Data Systems

i) House-to-house registration of children less than five years by VHTs

Since 2021, UNICEF has been providing ZD support in selected districts. The support was first rolled out in Kamuli and Wakiso districts and was then cascaded to Mukono and Kampala districts. These districts were chosen based on their large numbers of unimmunized children, ii) continuous measles outbreaks and iii) representation of urban, peri-urban, and rural settings. The four districts were also estimated to have 71% of the national burden of ZD children.

Figure 9: VHT Immunisation Register (Left) and VHTs (Right)

VHT immunisation register

VHTs after the Training

The main purpose of UNICEF's ZD support to Uganda is to strengthen the EPI's capacity to identify ZD children, support targeted demand creation and strengthen reporting and quality of data in national and community health information systems. To identify and immunize ZD & UI children, UNICEF supported VHTs to conduct house-to-house registration of children and their immunisation status within their zoned villages of operation (see Figure 9). After the registration, the registers are collected, and data is entered into an Excel-based tool for purposes of aggregation and reporting. This data is retrieved and stored in a standalone database that is not yet linked to the national DHIS2 platform. The LH is currently evaluating this program to examine its reach, effectiveness, implementation and maintenance/sustainability. Some of the emerging challenges with data quality include inaccurate data, difficulties in data analysis and challenges with referring the identified ZDC for vaccination.

ii) UgaVax.

With support from MedRef Health Bridge, UgaVax is a digital solution that helps to track defaulters to reduce dropout rates. The system has both a mobile application and a web application which can be used to identify areas with a high risk of having unvaccinated children so that specific focus is placed on those areas. The system has a digital register, digital vaccination cards and digital child health monitoring cards which can be accessed by health workers and the caretaker to help to monitor the immunisation status of the baby from zero to 35 years. The system also has an HPV vaccination registry which runs from 12 years to 35 years. The system has been developed to cover the life cycle of vaccines which is important in following up an individual. The system also has an embedded mechanism that ensures that the mother or caregiver has access to their child's digital health vaccination cards, their information, their appointments and their next schedules. There are also SMS and automated call reminders that ensure information on schedules and appointments is provided on a timely basis to the caregivers especially reaching out to areas without smartphone access.

> *"... for the villages where we cannot reach without mobile phones, we are trying to use the SMS and automated call reminders to make sure that this information reaches to the last person who doesn't have a smartphone. And on the national level, we have a dashboard, which focuses on dropout rate, the default rate, and coverage. We break the coverage down by dose and by village to make sure that we really identify the areas that might be at risk of being unvaccinated or being left out."* ***(KII, Partner organisation).***

It is envisaged that, once deployed, the system will decentralize the data and information, making it readily available at health facility level to facilitate real-time decision making. The UgaVax system ensures that data is not confined to central research institutions but is available at the grassroots level, aiding better and real-time decision-making and interventions. Respondents noted that UgaVax was designed to complement existing systems like DHIS2 rather than duplicate efforts, however it is still unclear how it complements existing systems. UgaVax is currently in the early stages of development and pilot testing. At the time of data collection, the system was at initial phases and conversations were on-going on how this digital solution could be deployed in the health care system and be used by the MoH.

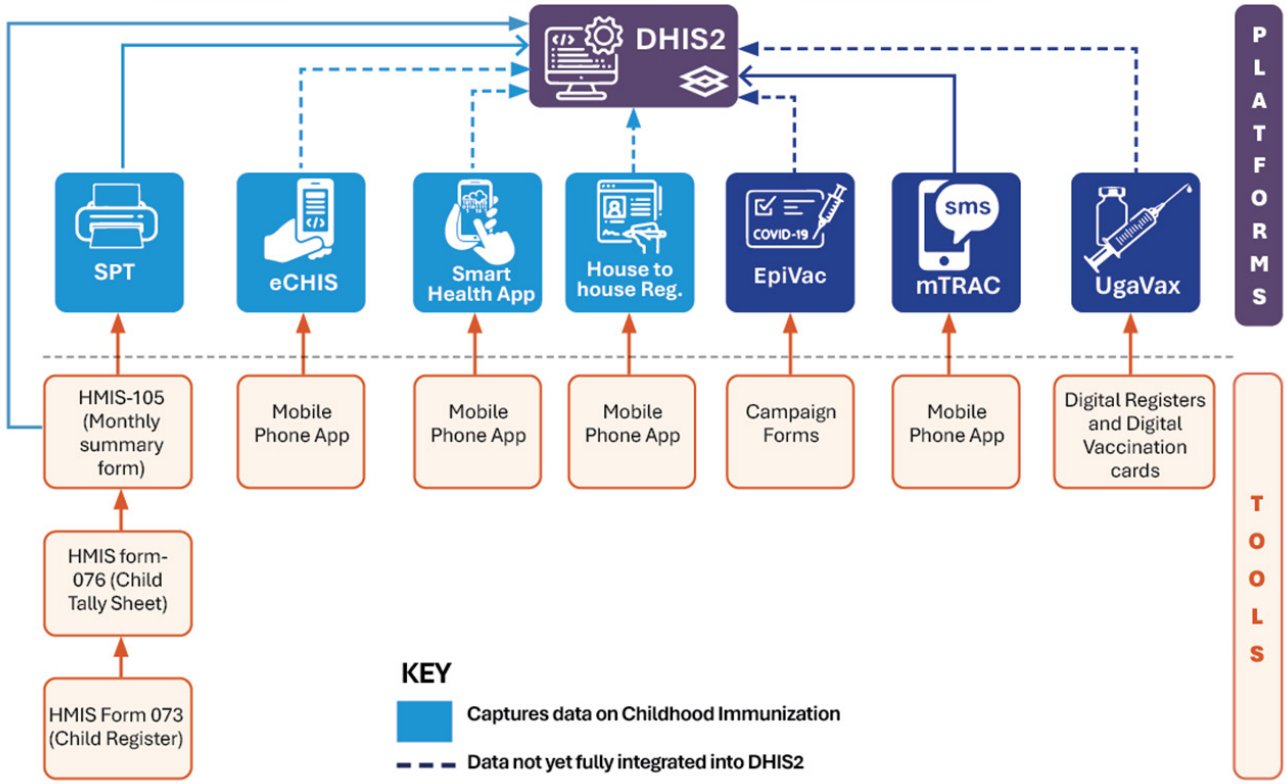
iii) EpiVac

The EpiVac is a data tool that was developed by the World Health Organization (WHO) mainly to capture data for tracking COVID-19 vaccine roll-out. It was utilised across the country to enter COVID-19 vaccination data. It captures the details of the individual vaccinated, the type of vaccine administered, and vaccine stocks in the district. EpiVac is used to monitor COVID-19 vaccine coverage nationally as an online public vaccination platform. EpiVac has also been adapted for monitoring the progress of program campaigns for yellow fever, polio and Measles-Rubella (MR), however, it is not integrated with DHIS2.

3.1.3 Linking tools and data capture platforms in Uganda

Several tools support the variously discussed data capture platforms and these can be visualised in figure 10.

Figure 10: Linkages of the data capture platforms and tools



Partner Intervention Tools

i) Village child tracking template for immunisation (House -to- house register):

This tool is used by community resource persons like VHTs to record details of immunisation status of every child from birth up to the time of the assessment. The tool is kept by the VHTs and information is linked to the nearby health facility to monitor immunisation access for a given community. This tracking system is supported by UNICEF as part of the house-to-house registration programme in four districts – Mukono, Wakiso, Kampala and Kamuli districts

ii) Reaching Every Child (REC) micro planning tool:

The REC micro planning tool is informed by the WHO Reaching Every District (RED) strategy whose overall aim is to ensure that every infant is fully immunized with all vaccines included in the national immunisation schedule of the respective countries. It is a nationwide strategy used for microplanning for immunisation service delivery. In Uganda's context, the tool has been adapted for use at the health facility level to plan for immunisation service delivery at the beginning of every financial year. RED/REC has a costed microplan but it is unclear if it translates to actual budgetary allocation. It is implemented nationwide in all districts. The tools used to operationalise the REC micro planning tool include:

i. The RED/REC categorization tool – this is a performance review tool usable at the health facility and district level. At the health facility, the tool captures immunisation performance data on a quarterly basis. By using the tool, health workers can understand their immunisation performance in relation to coverage, dropout rates, and implement actions towards addressing their performance gaps.

ii. Vaccination monitoring charts- The charts aid computation of the number of children reached and not reached with immunisation services monthly. The charts are useful in tracking the monthly utilisation patterns, to guide the operational teams on taking informed action.

iii. Performance based agenda- This tool is mainly an accountability tool. It is used to compel health workers to focus on targets, data analysis and guide decision making. The tool holds health facility departmental heads accountable and responsive consequently helping them align their work outputs to desired performance.

iv. Leadership report template- This is an empowerment tool primarily aimed to keep leaders informed regarding immunisation performance of their respective communities and inspire leaders to act accordingly. The template is used to generate a report that is presented at respective community engagement sessions like sub-county Technical Planning Committees (TPCs), Health Unit Management Committees (HUMC), and the District Executive Committee and community dialogues.

3.2 Linking zero-dose burden & data systems

Table 5: Key immunisation indicators

Indicator	Indicator definition
DPT-1 Coverage < 1year	Measure of the percentage of children under 1year who received DPT-1 doses.
DPT-2 Coverage < 1 year	Measure of the percentage of children under 1year who received DPT-2 doses.
DPT-3 Coverage<1 year	Measure of the percentage of children under 1year who received DPT-3 doses.
DPT1-DPT3	Under-immunized. This measures the dropout rate of children under 1year who started DPT-1 dose but never completed DPT-3.
DPT3 - Measles	Measure of the dropout rate of children under 1 year who received DPT-3 dose but never received the measles vaccine.

3.1.2 How Zero-dose burden is estimated by different data systems

It was noted that different data systems or platforms estimate zero-doze burden differently. It is therefore not uncommon for the ZD burden estimates to differ sometimes significantly across the systems, with potential implications on decision-making and EPI programming.

a) District Health Information System (DHIS2) – Under the DHIS2 system, the zero-dose or under-immunized status of children below one year (< 1 year) reflects the receipt of DPT1 and DPT 3, respectively. At the end of a period, children who have been vaccinated with DPT1 and DPT3 (whether during facility vaccination, through outreach, or campaigns) are summed up to generate

the total number of eligible children who have received DPT1 or DPT3 (numerator). The total number of eligible children (denominator) who have been vaccinated with DPT1 or DPT3 is compared with the projected number of eligible children for those antigens within the facility catchment area as estimated by the Uganda Bureau of Statistics (UBOS).

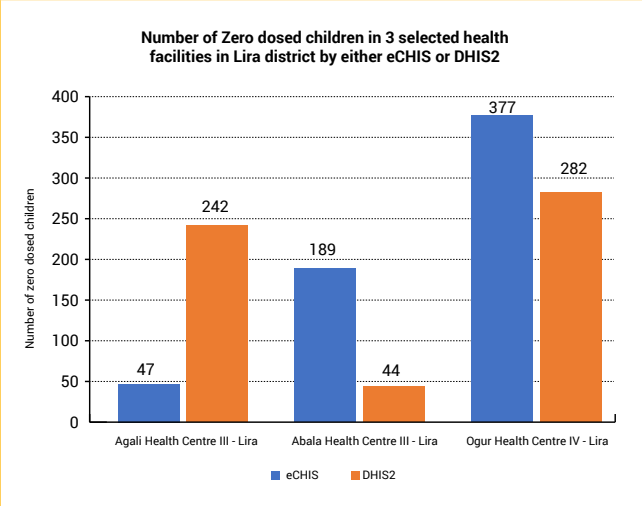
b) Smart Paper Technology (SPT) – Under the SPT, tally sheets are used to summarise all children who have received DPT1 and DPT3 < 1 year. The tally sheet captures only children who have visited the health facility or have reported for an outreach program or through a campaign. This is also compared to the projected UBOS estimates of the eligible population to estimate the ZD or UI children for a catchment area.

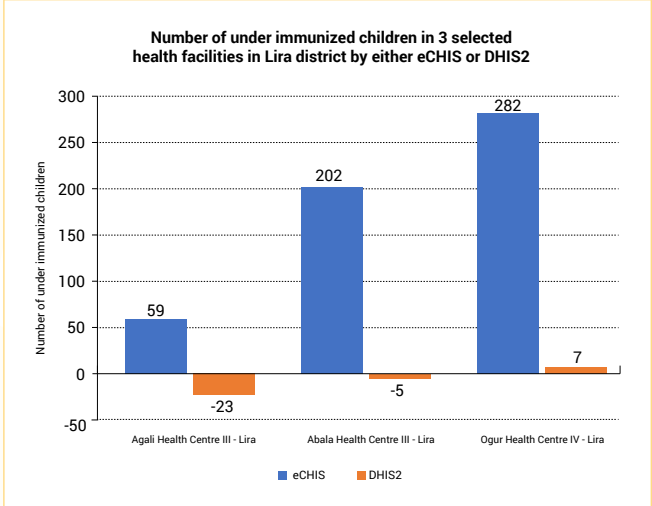
c) Electronic Community Health Information System (eCHIS) – Under the eCHIS, all children at the household level are registered and periodically assessed for immunisation status. The total number of assessed children who have utilised DPT1 or DPT3 is aggregated (numerator) and compared with all registered and eligible children (by their age) who have been assessed during that period (denominator).

3.2.2 Comparing zero-dose estimates across data platforms

Section 3.2.1 above demonstrates that different data capture systems estimate the zero-dose burden differently, mainly by the nature and source of the data used in the estimation. However, the DHIS2 and SPT largely use the same process and both capture data from children who interface with the health facility, either through routine immunisation or outreach services. The denominator used for eligible catchment populations arises from the UBOS projections. Additionally, in places where SPT was used, it doesn't work alongside DHIS2, rather it is the only system relied upon to transmit data into DHIS2. In Figure 4 below, we only compare DHIS2 and eCHIS systems because they have been deployed alongside each other in certain areas.

Figure 11: Comparison of zero-dose estimates as captured through eCHIS and DHIS2





From Figure 11 above, the burden for ZD estimated through eCHIS was higher than the estimates under DHIS2. For example, for the period under consideration (September -December 2023), for Abala HC III in Lira District, the DHIS2 estimated 44 ZD children, while eCHIS estimated 189 ZD children for the same period. For Ogur HCIV, the DHIS2 estimated 282 ZD children while eCHIS estimated 377 ZD children (left Graph). The estimates for Agali HC III are treated as 'outlier' against the general trend of data (the result could be related to DHIS2 data quality issues). In terms of under-immunised, for Ogur HCIV, only 7 children were UI according to DHIS2, yet eCHIS estimated 282 UI children. The negative DHIS2 values for Agali HCII and Abala HC III indicate that more children received DPT3 compared to the target population, which reflects gaps in the estimation of the target population (denominator).

From the Lira experience, it is clear that DHIS2 estimates are lower than eCHIS estimates. This could be attributed to several possibilities as described below.

a) Data quality challenges with the HMIS/DHIS2 system. In some facilities, it has been reported that sometimes vaccines dispensed are found to be more than the children recorded (at the point of stock-taking) in the HMIS forms. This results in inaccurate data being posted into DHIS2 and subsequently inaccurate estimates. This has largely been attributed to the heavy workload that health workers have resulting in some data not being recorded. For districts that were piloting SPT, there were notable discrepancies between the data on the hardcopy forms that were scanned and the data that was entered into DHIS2. In many cases, the SPT scanning system could not read data which was either recorded in bad handwriting or had been over-written. Consequently, the data extracted from the SPT had lower estimates compared to what was available at the health facility in hard copy.

> *"...so, when we scan the SPT, some data was rejected, it did not synchronise into the system and it would take long, if you scan like today it takes some time to see that data. Sometimes it takes one week, others two weeks. Sometimes forever you don't see that data. Lira alone lost 13,000 immunisation records and Lira city lost 14,000 immunisation records."* ***(KII, DHT).***

b) The DHIS2 estimation of ZD is based on UBOS projections of eligible populations. However, some districts argue that these projections are inaccurate because they are based on national demographics, and do not consider local/community level population dynamics. As a result, the inaccurate denominator based on UBOS projections affects the ZD estimates.

> *"Some of these denominators from UBOS are unreliable; they give us some abnormal coverage for some districts..... you find a district with 170% and others very low coverage and when you compare the surveys that we do you find that ZD exists where they are estimated not to be because you are using the UBOS denominator."* ***(KII, MoH official).***

c) The variation in estimates for eCHIS and DHIS2 could be attributed to the fact that eCHIS only captures a segment of the population in a facility catchment area as opposed to DHIS2 which is expected to capture all population and immunisation activities. A meaningful comparison, however, would require a further interrogation of data to ascertain if the ZD definitions are harmonized across the systems. For example, if ECHIS uses children from 6 weeks to 52 weeks to define ZD, certainly the estimate would be higher than DHIS2 because untimely immunisation is much more common than no immunisation in the first year.

3.2.3 Other challenges or gaps with immunisation data

There are other notable challenges or gaps experienced across the EPI data ecosystem which certainly influence the quality of data collected and ultimately the quality of ZD estimates. A number of these challenges have also been highlighted in MOH data quality assessment reports and the EPI data quality improvement plan. These gaps are highlighted below:

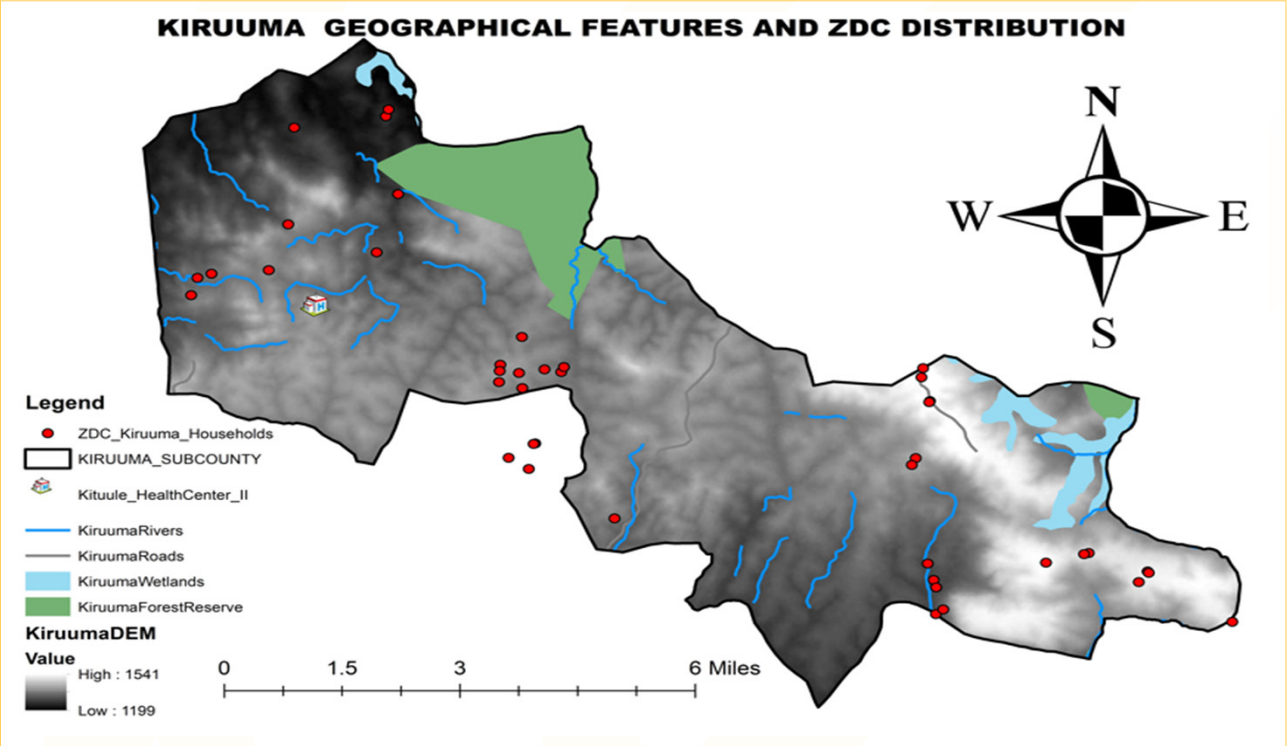
1. Limited funding flows especially at the subnational level to support data management activities including procurement of data management tools, support supervision, incentivization and motivation of staff involved in data management, and continuous data quality assessments and improvement. While partner support has noticeably been critical, it has been observed that it is unevenly distributed across regions, besides the support being intermittent.
2. Human resource challenges – particularly related to persistent knowledge gaps resulting from inadequate training; and understaffing which culminates in heavy workload, risks of errors, and data entry delays. This is coupled with uneven distribution of staff not only across geography but also facility level.
3. Absence of a clear framework for data tracking and triangulation to improve the reliability of data for the estimation of the zero-dose burden.
4. Inconsistences in the use of standardized EPI data collection tools at the facility level coupled with the deployment of outdated tools without provisions for new vaccines results in data loss and inconsistencies which compromise data quality for accurate ZD estimation.

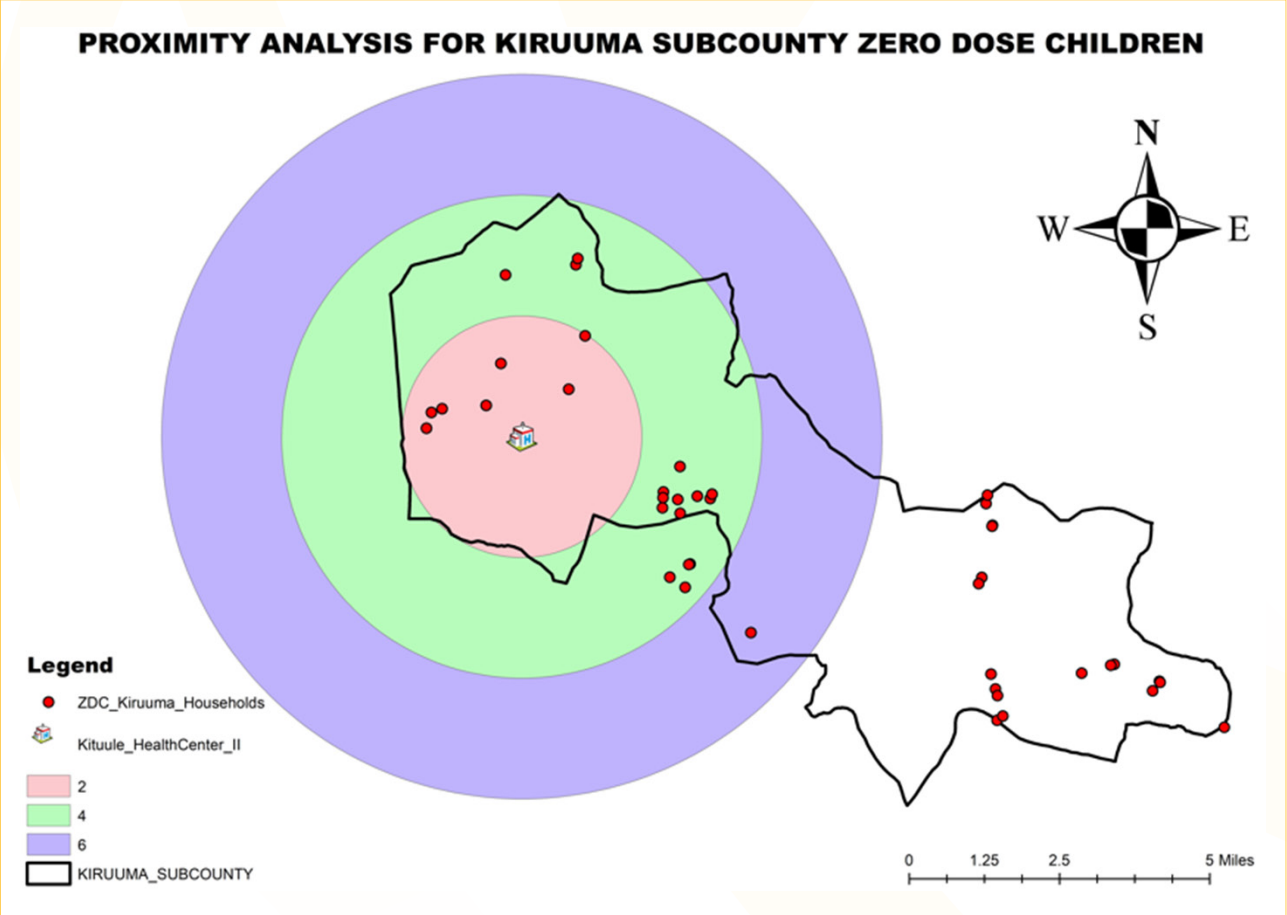
3.2.4 Zero-dose burden beyond data systems: reflections from study districts

It was noted that whereas data capture systems and data quality issues are key in the ZD burden discourse in Uganda, other insights need to be brought to the fore. That is, the ZD burden may not fully be addressed by merely streamlining the EPI data system, but also reflecting on other emerging issues. In this context, we report here below some key insights that emerged from the study areas:

a. Challenges with limited physical access to immunisation sites/services – experiences from Mubende District following engagements with the district health team demonstrate that the estimated high burden of ZD was largely linked to access challenges. The district has a limited number of health facilities, and the existing ones are in distant places from community settlements. This implies that caregivers have to travel long distances coupled and incur high travel costs. Besides, some areas in the district are mountainous, hard-to-reach, and have a transient population such as pastoralists. Figure 12 shows the GIS for Kiruuma Sub- County (for example) in Mubende District which is a sub-county that has the highest burden of zero-dose (17.9 %) of the three surveyed sub-counties under the targeted survey. In this sub-County, 44.2% of the households with ZDC beyond 9.7 3.2km of a health facility, and 37.2% lived between 3.2 – 6.4km of a health facility. This coupled with the complicated terrain of the sub-county demonstrates that physical access to health services is strongly associated with zero-doze burden.

Figure 12: Geographical distribution of ZD and UI burden for Kiruuma Sub-County





b. Myths and misconceptions about child immunisation – It was noted from the study areas that several beliefs ranging from cultural, religious, to community, undermine demand for and utilization of immunisation services. These myths and beliefs especially from emerging religious sects and movements create fear and mistrust among caregivers and undermine uptake of immunisation services.

c. Persistent home-based deliveries – while the government had banned the practice of Traditional Birth Attendants (TBAs), it has been noted that home deliveries – whether with TBAs or not still prevail. Once a home delivery has occurred, caregivers are reluctant to visit health facilities for immunisation for fear of reprisals from health workers. This is a key influence in understanding the prevailing ZD burden, particularly in the study areas.

d. Limited targeted outreaches – it was noted that owing to limited financial resources, health facilities do not conduct regular but also targeted outreaches. Yet in settings like Mubende with hard-to-reach challenges coupled with transient populations (pastoralists) who are always on move, outreaches would significantly increase service utilization.

3.3 Challenges & opportunities

3.3.1 Challenges in estimating zero-dose and under-immunised across platforms

a) DHIS2:

- The standard HMIS forms and registers whose data is entered into the DHIS2 only record children who access the health system (health facilities) through routine and outreach services, leaving out several children in communities.
- HMIS forms (child register and tally sheets) are manually filled. This requires manpower over and above the routine work of health workers. For understaffed facilities, health workers are too overwhelmed to vaccinate as well as fill out the forms. It is not uncommon to find that vaccination occurs but the HMIS forms have not been filled or to find that only a few records have been captured. The records sometimes do not correspond with the vaccine stocks dispensed. This means the timeliness, completeness, accuracy, and quality of immunisation data reported through the DHIS2 is compromised. In general, the denominator used for estimating ZD is based on UBOS projections of the eligible population in the catchment area which sometimes may not be an accurate estimate because it does not cater for local population dynamics such as mobile populations and migrations. Additionally, there is no standard way of estimating target populations at the district and catchment populations at the health facility level.
- Stock out of HMIS tools. Some respondents noted that sometimes the data capture tools are not available which hinders data collection and hence data loss.

> *"But other areas had a critical lack of HMIS tools. We used exercise books to capture some indicators … However, we did not record all the indicators, so we lost data. And as we talk now, we have a scarcity of registers."* ***(KII, DHT).***

- Technical issues – it was reported that sometimes the DHIS2 system slows down due to data overload, especially during downtime. Notably, it tends to shut down all other systems related to it. Relatedly, it requires internet bundles, yet these are not provided to the facilities.

> *"One it (DHIS2) consumes bigger data (internet) bundles. Two, when the system is overloaded, slows down. Three, sometimes it is off due to the downtiming of the system. When there's a down timing, all the systems hosted on the system switch off* ***(KII, DHT).***

b) Smart Paper Technology:

- The SPT forms and tally sheets are manually filled and scanned into the system and are ultimately integrated into DHIS2. With this system, the health worker workload issues may not completely be surmounted, and this may compromise data quality.
- The SPT system sometimes will not scan and record data on forms which have been 'over-written' or not well written. It was observed that sometimes there is a mismatch between the SPT data mapped into the DHIS2 and the data on the forms left at the health facility.

Figure 13: Comparing data SPT data (SHIFO Clarity) and DHIS2 forms – Mukono General Hospital for October 2023

October 2023 - Mukono General Hospital

	105-CL01 BCG	105-CL03 Polio 0	105-CL04 Polio 1	105-CL05 Polio 2	105-CL06 Polio 3	105-CL07 IPV	105-CL08 DPT-HepB+Hib 1	105-CL09 DPT-HepB+Hib 2	105-CL10 DPT-HepB+Hib 3	105-CL11 PCV 1	105-CL12 PCV 2	105-CL13 PCV 3	105-CL14 Rotavirus 1 Vaccine	105-CL15 Rotavirus 2 Vaccine	105-CL16 Measles (MR1)	105-CL17 Measles 2 (MR2)	105-CL18 Fully immunized by 1 year
<1Yr, Static	792	810	342	263	239	342	342	263	239	342	263	239	230	190	274		274
1-4Yrs, Static																66	
<1Yr, Outreach	65	70	123	118	117	136	137	108	124	138	142	137	81	68	160		160
1-4Yrs, Outreach																75	

Data from Physical HMIS forms at the facility

CL01. BCG	UNIQUE CLIENTS
Under 1, Static	122
Under 1, Outreach	25

CL02. Protection at birth for Td (PAB)	UNIQUE CLIENTS
Under 1, Static	52
Under 1, Outreach	3

CL03. HepB 0	UNIQUE CLIENTS
Under 1, Static	9
Under 1, Outreach	0

CL04. Polio 0	UNIQUE CLIENTS
Under 1, Static	110
Under 1, Outreach	19
1-4 Years, Static	0
1-4 Years, Outreach	0

CL05. Polio 1	UNIQUE CLIENTS
Under 1, Static	44
Under 1, Outreach	36
1-4 Years, Static	0
1-4 Years, Outreach	0

CL06. Polio 2	UNIQUE CLIENTS
Under 1, Static	42
Under 1, Outreach	18
1-4 Years, Static	0
1-4 Years, Outreach	0

CL07. Polio 3	UNIQUE CLIENTS
Under 1, Static	29
Under 1, Outreach	11
1-4 Years, Static	0
1-4 Years, Outreach	0

CL08. IPV 1	UNIQUE CLIENTS
Under 1, Static	45
Under 1, Outreach	39
1-4 Years, Static	0
1-4 Years, Outreach	0

CL09. IPV 2	UNIQUE CLIENTS
Under 1, Static	31
Under 1, Outreach	14
1-4 Years, Static	0
1-4 Years, Outreach	0

CL10. DPT-HepB+Hib 1	UNIQUE CLIENTS
Under 1, Static	45
Under 1, Outreach	37
1-4 Years, Static	0
1-4 Years, Outreach	0

CL11. DPT-HepB+Hib 2	UNIQUE CLIENTS
Under 1, Static	44
Under 1, Outreach	20
1-4 Years, Static	0
1-4 Years, Outreach	0

CL12. DPT-HepB+Hib 3	UNIQUE CLIENTS
Under 1, Static	30
Under 1, Outreach	15
1-4 Years, Static	0
1-4 Years, Outreach	0

CL13. PCV 1	UNIQUE CLIENTS
Under 1, Static	45
Under 1, Outreach	38
1-4 Years, Static	0
1-4 Years, Outreach	0

CL14. PCV 2	UNIQUE CLIENTS
Under 1, Static	41
Under 1, Outreach	20
1-4 Years, Static	0
1-4 Years, Outreach	0

CL15. PCV 3	UNIQUE CLIENTS
Under 1, Static	31
Under 1, Outreach	15
1-4 Years, Static	0
1-4 Years, Outreach	0

CL16. Rotavirus 1	UNIQUE CLIENTS
Under 1, Static	22
Under 1, Outreach	23

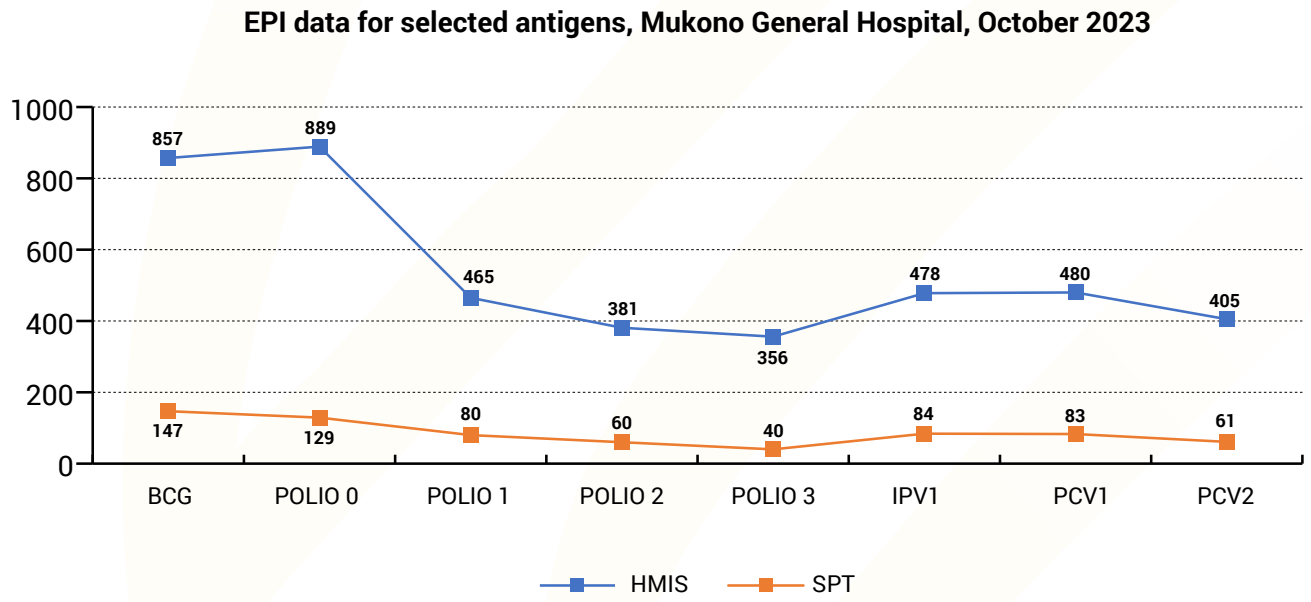
CL17. Rotavirus 2	UNIQUE CLIENTS
Under 1, Static	18
Under 1, Outreach	11

CL18. Measles (MR1)	UNIQUE CLIENTS
Under 1, Static	37
Under 1, Outreach	18
1-4 Years, Static	0
1-4 Years, Outreach	0

Data from SHIFO Clarity

There is variability in the data reported on the physical HMIS forms at the health facilities compared to data reported through SPT. For example, Figure 13 shows that in October 2023, the immunisation data reported on the physical HMIS forms at Mukono General Hospital was higher compared to SPT data. SPT is sensitive to the quality of handwriting which can result in loss of data (over-writing). Figure 14 further demonstrates with clarity the variations for selected antigens which indicates the likelihood of data loss under the SPT reporting system.

Figure 14: Comparing SPT data and facility-level HMS forms



The observable variations could be explained by some of the following reasons:

- The SPT system also records children who have interfaced with the health system through routine or outreach modalities, leaving out several children in the community, implying the estimates may not be very accurate.
- The denominator used for estimating zero-dose is based on UBOS projections of eligible population in the catchment area which sometimes may not be an accurate estimate because it does not cater for local population dynamics such as mobile populations and migrations, etc.

  "Data estimates are also not very accurate, sometimes they are high. During the mass immunisation, we vaccinated almost all children and they used the same population data to calculate the number of vaccines that we were supposed to use. We went to each house for polio vaccination, but they still reported that there were children that were not vaccinated." ***(KII, Lira district).***

- At the time of data collection, the scanning infrastructure was not yet rolled out at lower facilities. Some HC IIs and HC IIIs used HCIV as scanning centres and yet there is unstable electricity and internet.

  "Scanning is quite tedious. HCIIs have no scanners and yet they have to travel long distances to bring the forms and yet there are issues of transport. Not all our facilities have access to electricity, most of them don't have power, so they use solar. But also, we have facilities which don't have access to the internet." ***(KII, Mukono district).***

MOH TEMPORARILY HALTS SPT IMPLEMNTATION

Stakeholders have been engaged in conversations about the SPT under pilot, more especially, reflecting on the benefits and challenges of the SPT system. One key challenge has been the notable significant discrepancy between data on the physical HMIS forms at the facility and the data integrated in DHIS via SPT.

In May 2024, the MoH issued a memo and guidelines to all districts and health facilities on the migration from SPT to paper-based system for EPI data management. In other words, the implementation of SPT has been temporarily halted to allow a comprehensive evaluation of the system and if gaps can be addressed.

c) Electronic Community Health Information System (eCHIS):

- It is hard to ascertain the vaccination status of children who may not have vaccination cards. In this case, the VHTs only rely on responses provided by the caregivers which may be laced with social desirability biases.
- Data Quality and literacy issues. The proficiency of community health workers in literacy and technical skills plays a pivotal role in maintaining data quality. Continuous validation and clean-up procedures underscore the ongoing challenge of inaccurate or incomplete data entries, potentially compromising the system's reliability, as noted by a respondent.
- "You find that sometimes we have data quality issues because the community workers' literacy levels are not very high, so we must validate and clean up. Colleagues are quite stretched and busy and there are so many systems. So, some struggle to ensure that they interface with this data and the data is in a consumable format, so it is hard to get the implementing people to appreciate data." (KII, MoH official)
- Device loss and maintenance. There were reports of frequent losses and malfunctioning of devices, compounded by constrained district budgets and insufficient maintenance protocols, as mentioned by the respondent. Some gadgets had faulty chargers prompting them to purchase new ones. Others mentioned that the gadgets became hot and froze often and the application failed to operate as intended.

  "You buy phones today tomorrow 10 are lost; you buy a phone today tomorrow it is lost I don't know how insurance can help us. Tomorrow 10 of them are faulty so how do we handle some of those maintenance? The budget for the district is very small so we must maybe look at the maintenance policies of the government." ***(KII, MoH official).***

  "Let me say when I work with it for 10 houses, the phone becomes very hot. Then at times, the apps can fail to work when you are here in the field. When you touch it, it cannot show anything and cannot even indicate anything." ***(KII, Lira district).***

- Gender dynamics and device ownership. A notable obstacle encountered in deploying the eCHIS involves socio-cultural factors, particularly gender dynamics and device ownership issues. A respondent cited an example from Ntungamo to illustrate how traditional gender roles and disputes over device possession hinder efficient data collection and utilisation.

*"I recently went to Ntungamo to see how they are using it, to see the data they are collecting and see if it is making sense like a performance review. But the entire day we were discussing the issue of forms, "For me my husband took my form" Then we must first look for the husband then get the police then the husband must plead with you, "Don't arrest him where am I going to eat?" Because now they say how can I be having a small buttoned phone and my wife has a smartphone and, in the villages, they say, "Me I am the boss of this family" and the woman will just say, "It is here" so how do you deal with such issues. So, as we go digital, we have those challenges we must battle with." **(KII, MoH official).***

- VHTs reported a lack of facilitation (motivation) and continuous capacity building. Currently, VHTs implementing the system rely on the support from implementing partners when they attend workshops, which may not be sustainable. VHTs are expected to work voluntarily yet they are the anchor on which the system is built. VHTs reported finding challenges with resources to even recharge their phones and buy internet bundles to aid data synchronisation.

*"Charging this one here, charging this phone needs money at first during the training they told us that they were going to give us internet on our phones for syncing… **(KII, Lira district).***

*"VHTs are not in our structure if they are not facilitated, they don't submit the reports. And for all these years since we lacked facilitation to VHTs they have not submitted very few submitted the reports and that's why we scored only 25% out of 100 meaning that many of the reports were not submitted and we had no control over them **(KII, DHT).***

3.3.2 Opportunities for improving data capture systems

a) eCHIS

i) Data quality assurance mechanisms

One significant opportunity within the eCHIS lies in its robust data quality assurance mechanisms. Respondents highlighted various strategies employed to ensure data accuracy and completeness.

*"So that is what we are pursuing but while we have these, we have mechanisms of data quality assurance. We do data validation at points of data entry, right now a bit of consistency checks." **(KII, MOH official).***

*"We do reviews later; we have scripts that run through the system looking for outliers for selected variables with missing data and give feedback on a continual basis to districts…." **(KII, MOH official).***

*"We conduct data quality assessments to monitor the quality of data and see if there are problems that we could fix that could either come with training and so on." **(KII, MOH official).***

ii) Capacity Building Initiatives

A respondent mentioned that continuous training initiatives are being implemented to enhance user capacity and ensure the effective utilisation of the system.

*"We conduct continuous training where we feel there is need for capacity building." **(KII, MOH official).***

iii) Division of labour ensuring efficiency

One respondent mentioned that eCHIS enabled the VHTs to work in their subzones using the same gadget, which made work more manageable.

> *"We subdivided this village into two according to the number of households that we have. Here we have around 150 households divided between my colleague and I who have about 70 households. I am always committed to these 70 households. So, in this system, we always try to register all the members in each household".* ***(KII, DHT)***

b) UgaVax

i) Integration with the National Identification System

A respondent highlighted that UgaVax offers an opportunity to enhance data accuracy and address denominator issues by using unique identification numbers. This approach aims to establish robust data linkage mechanisms, minimise errors in denominator estimation, and improve the precision of immunisation coverage calculations.

> *"Since we are creating unique identification numbers while also keeping in mind the national identification number with the digital birth registry coming in, we can improve the denominator issue."* ***(KII, Partner organisation).***

ii) Training Tool for Health Service Providers

a) A respondent mentioned that UgaVax offers opportunities beyond data management, serving as a comprehensive training tool for health service providers. By facilitating changes in conventional workflows and providing hands-on training experiences, UgaVax empowers health service providers to adapt to new technologies and practices effectively.

> *"We have made sure that it becomes like a training tool also for those, health service providers that are in places of management because it comes with changes in conventional workflows. So those changes, if they are not affected by it, health systems become a barrier towards the landscape they're trying to establish. So, I see it as a tool that can work, that is a double-edged, both as an intervention and as a training tool and also as proof of concept of what we're trying to be..."* ***(KII, Partner Organisation).***

b) Proof of Concept for Policy Implementation

Additionally, UgaVax serves as a tangible proof of concept for policy implementation, signalling advancements in immunisation strategies and healthcare delivery models. By demonstrating the feasibility and effectiveness of data-driven interventions, UgaVax reinforces policy objectives and fosters alignment between operational practices and overarching healthcare goals.

4.0 KEY LEARNINGS

1. Different data capture systems generate different zero-dose estimates and this is largely attributed to discrepancies in not only the numerator data but also the source of data for the denominator used in the estimation.

2. The quality of immunisation data – completeness, timeliness, completeness, comprehensiveness, validity, consistency, and integrity – is very critical in accurate and reliable estimation of the burden of ZD and UI children.

3. Facility-based data capture systems may not accurately determine the burden of ZD and UI children, because they leave out children who do not interface with the health system.

4. Determining eligible populations from community (household) level records or data could be a more reliable approach to estimating the burden of ZD and UI children compared to relying on UBOS population projection data which may not consider the ever-changing factors within communities.

5. An immunisation data capture system is a key influence on the prevailing burden of ZD and UI children, but it is not the panacea. High Risk Communities (HRCs) still play a crucial role in influencing the burden of ZD and UI in many districts in Uganda.

6. Identifying the ZD or UI child through a data system is a starting point but not an end in itself in addressing the challenge. Additional effort must focus on tracking and bringing the children into the system to complete their schedules, in addition to addressing the obstacles to immunisation uptake.

7. Except DHIS2, most existing immunisation data capture systems are currently implemented as pilots and largely financed and supported by implementing partners which pauses concerns about their deployment, roll-out and institutionalisation beyond the initial funding modalities.

8. Lack of systematic triangulation of coverage data with other systems such as financial, human resource, health facility capacity, and surveillance, constrains the potential to generate a better and actionable perspective on key bottlenecks to reach ZD communities.

9. It is still challenging to link children who need immunisation services from communities to health facilities. Under the eCHIS system, VHTs are required to refer children to health facilities if they find that the child has missed their vaccination schedule during home visits. However, there is also no system to monitor whether the child was taken to the facility or if indeed they received the required vaccine.

10. Lack of a national-level health indicators tracking system that is linked to the NIRAs civil registration system implies that it is not easy to track vaccination schedules for children wherever they are located, making it hard to estimate with certainty the ZD burden and UI in Uganda.

5.0 CONCLUSION

Immunisation data is key in guiding immunisation programs to identify, reach, and monitor the ZD and UI children. This study mapped the ecosystem for immunisation data in Uganda, specifically to i) identify and characterize the existing immunisation data systems in Uganda, ii) demonstrate the link between the data systems and the zero-dose burden, and iii) understand the challenges and opportunities for the immunisation data ecosystem in Uganda. From the findings of this study, the following conclusions can be drawn:

- There are multiple systems and related tools used for identifying, reaching, and monitoring zero-dose and under-immunized children in Uganda, each at different stages of maturity, implementation, and geographical coverage, including DHIS2, SPT, eCHIS, Community Registration (UNICEF), UgaVax, EpiVac, Smart Health Application, among others.
- The DHIS2 is the predominantly used system across the health facilities in the country. It is well-developed, tested, and interoperable with other data systems within the health sector.
- Each immunisation data capture system has challenges (limitations or gaps) in estimating the burden of zero-dose and under-immunized children. However, the systems also have opportunities that could be leveraged to improve immunisation data in Uganda for better and more reliable estimates.
- There is uncertainty about the current burden of zero-dose and under-immunized children in many parts of the country owing to the challenges and gaps related to data and the data capture systems currently in use.

6.0 RECOMMENDATIONS

Near Term:	
1.	Ministry of Health should conduct frequent data triangulation exercises to address the unreliable denominator estimates. Alternative sources of data for triangulation include immunisation coverage surveys, censuses, Lot Quality Assessments (LQAs), etc.
2.	Ministry of Health should conduct a systematic triangulation with systems whose data may not necessarily be included in the DHIS2, for example, financial systems, human resource systems, among others.
3.	Ministry of Health should conduct regular targeted assessments in specific and priority ZD communities, (e.g. using BeSD and other demand-related tools) to systematically collect any emerging and context-specific evidence on immunisation coverage.
4.	To improve data quality of the DHIS2, the Ministry of Health should; i) consider building the capacity of frontline health workers for data collection, reporting, real-time data analysis, and use for real-time action and, ii) conduct more routine, rapid data quality assessments

Medium Term:	
1.	Ministry of Health should invest in and deploy a functional digitised system, at community level to collect household-level data, which can improve the accuracy and quality of immunisation data.
2.	Ministry of Health should develop a national-wide tracking system where every child registered at birth can be tracked to ascertain their immunisation status irrespective of where they seek health care services. This system could be linked with the civil registration system and interoperable with other existing systems within the health sector.

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7.0 APPENDICES

Appendix 1: EPI data tools used to capture and report Zero children

Appendix 1.1: HMIS Form 073 Child Register

HMIS FORM 073: CHILD REGISTER

COLUMN HEADINGS:

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)				(11)			(12)			(13)		
Child No.	Name	Village and Parish	Sex	WT	Age	Date of Birth	Date BCG	PAB	Dates Polio				Dates DPT-HepB + Hib			Dates PCV			Dates Rota Virus		
									0	1	2	3	1	2	3	1	2	3	1	2	3
	Child: Mother's Name: Father's Name:																				

(14)	(15)	(16)	(17)	(18)	(19)				(20)		(21)
MEASLES VACCINATION				Fully Immunised by 1 Year	Vitamin A Administration				Deworming		
Date Of Measles Vaccination	WT at Measles Vaccination	Under Weight (Below -- 2SD Line)	Over Weight (Above +3SD Line)		1st Dose administered within this year		2nd dose administered within this year		1st dose administered within this year	2nd dose administered within this year	Remarks
					Children 6 to 11 months	Children 12 to 59 months	Children 6 to 11 months	Children 12 to 59 months			

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Appendix 1.2: HMIS Form 105 Health Unit Outpatient Monthly Report

Ministry of Health

HMIS FORM105: HEALTH UNIT OUTPATIENT MONTHLY REPORT

Page 3

2.9 TETANUS IMMUNISATION (TT VACCINE)			
Doses	Pregnant women	Non-pregnant women	Immunisation in School
T1-Dose 1			
T2-Dose 2			
T3-Dose 3			
T4-Dose 4			
T5-Dose 5			

2.10 HPV VACCINATION	
Vaccination of girls	Number
V1-HPV1-Dose 1	
V2-HPV2-Dose 2	
V3-HPV3-Dose 3	

2.11 CHILD IMMUNISATION				
	Under 1		1-4 Years	
Doses	Male	Female	Male	Female
I1-BCG				
I2-Protection At Birth for TT (PAB)				
I3-Polio 0				
I4-Polio 1				
I5-Polio 2				
I6-Polio 3				
I7-DPT-HepB+Hib 1				
I8-DPT-HepB+Hib 2				
I9-DPT-HepB+Hib 3				
I10-PCV 1				
I11-PCV 2				
I12-PCV 3				
I13-Rotavirus 1				
I14-Rotavirus 2				
I15-Rotavirus 3				
I16-Measles				
I17-Fully immunized by 1 year				
I18-DPT-HepB+Hib doses wasted				

3. HIV/AIDS COUNSELING AND TESTING (HCT)

Category	No. of individuals 0- <2 years		No. of individuals 2-<5 years		No. of individuals 5 - <15 years		No. of individuals 15 - 49 years		No. of individuals >49 years		Total
	M	F	M	F	M	F	M	F	M	F	
H1-Number of Individuals counseled											
H2-Number of Individuals tested											
H3-Number of Individuals who received HIV test results											
H4- Number of individuals who received HIV results for the first time in this financial year											
H5-Number of Individuals who tested HIV positive											
H6-HIV positive individuals with suspected TB											
H7-HIV positive cases started on Cotrimoxazole preventive therapy (CPT)											
H8-Number of Individuals tested before in this financial year (Re-testers)											
H9-Number of individuals who were Counseled and Tested together as a Couple											
H10-Number of individuals who were Tested and Received results together as a Couple											
H11-Number of individuals with Concordant positive results											
H12- Number of individuals with Discordant results											
H13-Individuals counseled and tested for PEP											
H14-Number provided with Safe Male Circumcision											

4. OUTREACH ACTIVITIES

Category	Number Planned	Number Carried out
OA1-EPI outreaches		
OA2-HCT outreaches		
OA3-Environmental health visits		
OA4-Health education/promotion outreaches		
OA5-Other outreaches		
Marternal & Perinatal Death Audits		

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Appendix 1.3: HMIS Form 076 Child Tally Sheet

Ministry of Health

HMIS FORM 076: CHILD TALLY SHEET

Date started _____ Date finished _____Clinic or Outreach site _____

ANTIGEN	UNDER ONE YEAR OF AGE				ONE TO 4 YEARS OF AGE			
	MALE	MALE TOTAL	FEMALE	FEMALE TOTAL	MALE	MALE TOTAL	FEMALE	FEMALE TOTAL
BCG	00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000	
Protection at Birth for TT	00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000					
POLIO O	00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000	
POLIO 1	00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000	
POLIO 2	00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000	
POLIO 3	00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000	
DPT-HepB+Hib 1	00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000	
DPT-HepB+Hib 2	00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000	
DPT-HepB+Hib 3	00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000	
PCV 1	00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000	
PCV 2	00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000	
PCV 3	00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000	
Rotavirus 1	00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000	
Rotavirus 2	00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000	
Rotavirus 3	00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000	
MEASLES	00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000	
FULLY IMMUNIZED	00000 00000 00000 00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000 00000 00000 00000					

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