Vaccine-Preventable Disease Surveillance System Assessment

Data Analysis Report

PATH

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Abbreviations

AFRO	WHO Africa Region
CBS	Case-based surveillance
DHIS2	District Health Information System 2
EWARN	Early Warning, Alert and Response Network
FGDs	Focus group discussions
HMIS	Health management information system
ICD	International classification of diseases
ICT	Information and communication technology
IDSR	Integrated disease surveillance and response
iHRIS	Integrated human resources information system
LOINC	Logical observation identifiers names and codes
KII	Key informant interview
MOH	Ministry of Health
OPSANTE	Outil de Suivi des Produits de Sante
PII	Personally identifiable information
QA	Quality assurance
SLA	Service level agreement
SNOMED	Systematized Nomenclature of Medicine
SOPs	Standard operating procedures
SORMAS	Surveillance, Outbreak Response Management and Analysis System
TOR	Terms of reference
UI	User interface
VPD	Vaccine-preventable diseases
MOHSA	Ministry of Health and Social Action
DSISS	Division du Système d'Information Sanitaire et Sociale
ZNPHI	Epidemiology and Disease Control Division and the Zambia National Public Health Institute

Executive summary

This study was conducted to assess and document the state of vaccine-preventable disease (VPD) surveillance systems across member states in the WHO African Region (AFRO). The primary goal was to provide a comprehensive understanding of how countries are transitioning from aggregate to case-based surveillance, while examining the technological and organizational environments that shape VPD data systems. By identifying gaps, needs, and opportunities, the study aims to support more effective VPD surveillance data collection, integration, and use. It also seeks to highlight promising practices and lessons learned that can inform regional collaboration and strategic planning.

The methodology combined a broad landscape analysis completed by 23 country respondents with in-depth case studies in four select countries—Mali, Senegal, Uganda, and Zambia. The landscape analysis included desk research, an electronic survey, and key informant interviews to gather information on several domains. In parallel, the case studies provide a closer look at how VPD data is managed in real time, including data flow, storage, and use in decision-making. Country selection was based on criteria such as system maturity, integration with national health information platforms, and regional representation, enabling a balanced view of overall trends and local implementation challenges.

The data from the landscape survey was analyzed using a maturity model specifically developed for this study, which calculates a relative maturity score based on responses across eight key domains. These domains include governance, technical capacity, data use, data quality, infrastructure, and others critical to the effectiveness of VPD surveillance systems. Importantly, the maturity model is not designed for ranking or direct comparison between countries, but rather as a diagnostic tool to highlight strengths, identify gaps, and inform targeted improvements. While the model offers a useful framework for generating insights and comparing general trends, it has limitations. It simplifies complex system realities and may not fully capture regional variations, country-specific contexts, or the interactions between paper-based and digital tools. Therefore, results should be interpreted in conjunction with qualitative field data and stakeholder perspectives to provide a more nuanced understanding.

The primary purpose of the maturity model is to guide decision-makers in identifying areas for additional investment, technical support, or policy development. It does not intend to judge country performance or implementation quality but rather serve as a strategic tool to support continuous system strengthening and informed planning.

The outputs of this study include a landscape report, detailed country case studies, and synthesized findings with actionable recommendations. The findings will inform strategic plans to strengthen VPD surveillance and encourage better data sharing among African countries. Ultimately, the initiative aims to enhance VPD data management and response capabilities across Africa, contributing to improved health outcomes and outbreak preparedness.

The findings across all 23 countries revealed strikingly consistent patterns, highlighting shared strengths and common gaps. Most notably, all countries face significant challenges related to infrastructure—such as limited connectivity, power supply, and hardware availability—as well as persistent issues with interoperability, which hinder effective data

sharing and system integration across health programs. Other common challenges that limit the effectiveness and sustainability of VPD surveillance systems across countries include:

- Difficulties in establishing strong governance and strategic alignment, with digital health strategies that are sometimes outdated, underfunded, or not fully aligned with surveillance goals.
- Fragmented coordination across ministries, partners, and agencies and weak stakeholder engagement.
- Workforce and technical capacity remain areas for growth, particularly at subnational levels, highlighting a need for targeted investment and training. There is often limited availability of staff with specialized training in digital health, system integration, or data management, and many frontline workers have had minimal exposure to digital tools. Technical teams are often under-resourced and lack opportunities for training.
- Insufficient system lifecycle planning and localization limit the adaptability of digital tools to local needs, languages, and workflows. Gaps in interoperability and the absence of common data exchange standards contribute to system fragmentation and duplication.
- Weak data quality assurance mechanisms include unclear standards, inconsistent data entry practices, and lack of routine quality checks undermine the accuracy and reliability of surveillance data.
- Limited data use culture constrains the impact of surveillance efforts. Without adequate capacity building, user-friendly dashboards, and regular feedback mechanisms, data often fails to drive timely and effective public health responses.

The recommendations outline actionable short-term measures and strategic medium- to long-term priorities across the eight key areas to support countries in building more resilient, efficient, and responsive VPD surveillance systems.

Immediate actions include strengthening governance through revitalized national digital health bodies, conducting rapid reviews of digital strategies, and initiating targeted training and infrastructure support, particularly through mobile and offline tools. Countries are also encouraged to assess existing systems, localize tools, standardize data protocols, and promote the use of actionable dashboards and simplified reporting to enhance data-driven decision-making.

Over the longer term, sustained progress will require embedding digital governance within public health structures, developing costed national strategies, and fostering regional collaboration. Institutionalizing digital health training, investing in local development and cybersecurity capacity, and expanding infrastructure with renewable energy solutions are also critical. Additionally, countries should prioritize full lifecycle planning for digital systems, strengthen interoperability and national data governance, and integrate data use into workforce development. Together, these measures will significantly enhance the impact and sustainability of VPD surveillance, contributing to improved health security and population well-being.

Overview

Introduction

Despite global progress in immunization efforts, many countries continue to face persistent barriers linked to the fragmentation of surveillance systems. The lack of integration between routine and case-based surveillance undermines the reliability and completeness of immunization data, hindering evidence-based decision-making and impeding progress toward national and global targets. These fragmentation challenges also affect the ability to monitor program performance and to respond swiftly and effectively to outbreaks.

Key issues include incomplete datasets resulting from unlinked surveillance systems, the underutilization of surveillance data in planning and delivery of immunization programs, and inadequate mechanisms to track progress through consistent and accurate reporting. Furthermore, inefficiencies in real-time data collection and use weaken outbreak management and delay response efforts.

The consequences of these systemic challenges are far-reaching. Countries struggle to identify immunization gaps at the sub-national level, making it difficult to target interventions and improve coverage equitably. The inability to detect and respond to outbreaks in a timely manner compromises public health outcomes and resilience. Ultimately, these limitations present significant obstacles to achieving WHO immunization goals and the broader Sustainable Development Goals.

Objective

To standardize, support, and strengthen digital VPD surveillance systems for impact and sustainability, PATH had the following objectives for this project:

1. Conduct a detailed landscape analysis of the information systems used for VPD surveillance in the 47 member states.
2. Conduct in-depth case studies to document the national VPD surveillance information system functionality and data flow.
3. Identify gaps, needs, and opportunities for addressing the fragmentation of surveillance systems across Africa.

Research questions

The three research questions that the project aimed to answer were:

1. What is the current landscape of VPD surveillance systems, and how do they function across different levels?
2. How effectively do VPD surveillance systems support data quality, timeliness, and decision-making for public health interventions?
3. What are the key challenges and opportunities for improving the integration, accessibility, and sustainability of VPD surveillance systems?

Scope and methodology

A mixed-methods approach was used to support a robust and comprehensive analysis. Quantitative data was collected through the electronic landscape survey, while qualitative insights were obtained from key informant interviews and focus group discussions. This

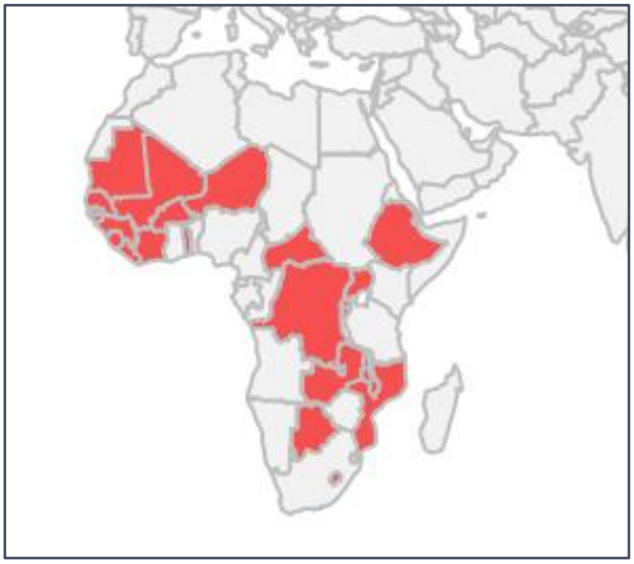
approach enabled a holistic understanding of the VPD surveillance landscape, capturing both broad patterns and nuanced national experiences.

Focus group discussions (FGDs) were conducted with national and regional-level stakeholders to efficiently gather diverse perspectives on policy decisions, system integration, and strategic challenges. In contrast, key informant interviews were held with facility-level staff to explore the day-to-day use of digital tools, data entry practices, and operational challenges in VPD surveillance. Conducting facility-level interviews separately from national and regional engagements helped ensure that participants could speak freely, resulting in more candid and detailed feedback.

Twenty-three countries responded to the landscape survey, which are listed below and grouped by region. Four of these countries (Mali, Senegal, Uganda, and Zambia) also participated in more detailed deep dive assessments.

- Congo
- Burundi
- Ethiopia
- Rwanda
- South Sudan
- Uganda
- Sierra Leone
- Niger
- Central African Republic
- Lesotho
- Malawi
- Mozambique
- Zambia
- Botswana
- Burkina Faso
- The Gambia
- Guinea
- Ivory Coast
- Liberia
- Mali
- Mauritania
- Senegal
- Togo

The landscape survey included 86 questions, including a mix of yes or no and multiple-choice questions, making them primarily quantitative. A smaller number of open-ended questions captured more qualitative or contextual information. Survey responses were mapped to indicators within specific sub-domains of a maturity model, with scores calculated for each sub-domain. These were then averaged to generate an overall maturity score for each of the eight main domains.



The deep-dive assessment followed a similar structure to the landscape survey but included more in-depth and qualitative questions designed to elicit a deeper understanding of the issues. It was built on the original survey by incorporating more probing questions. The assessment was organized into sections tailored for focus group discussions (FDG) and others more suited to key informant interviews (KII).

Key Findings

Maturity Scores

Maturity scores across the 8 major thematic areas were assessed for each of the 23 countries that participated in the landscape assessment survey (see Table 1). The scores are calculated as an average of the sub-domain scores for each thematic area. For this Table, we have depicted the scores by maturity level color. The maturity scores for all subdomains are detailed in the individual country briefs.

Foundational

Developing

Established

Table 1. Maturity scores across key domains for VPD Surveillance Systems

	Domain/Theme							
Country	**Governance and Strategic Alignment**	**Workforce and Technical Capacity**	**End-User Readiness**	**Infra-structure Readiness**	**System Lifecycle and Localization**	**Inter-operability**	**Data Standard and Data Quality**	**Data Use and Reporting**
Botswana								
Burkina Faso								
Burundi								
Central African Republic								
Congo								
Ethiopia								
Gambia								
Guinea								
Ivory Coast								
Lesotho								
Liberia								
Malawi								
Mali								
Mauritania								
Mozambique								
Niger								
Rwanda								
Senegal								
Sierra leone								
South Sudan								
Togo								
Uganda								
Zambia								

The assessment scores revealed notable variation across countries in their readiness to implement and scale digital solutions for VPD surveillance, with some domains scoring higher than others. While certain countries demonstrate strong leadership and alignment with national health priorities, many still face gaps in coordination. Workforce and technical capacity remain a limiting factor, with widespread needs for training and institutional support.

End-user readiness is mixed, underscoring the importance of equipping frontline workers with the tools and skills to effectively use digital systems. Infrastructure challenges continue to constrain functionality at the point of care. Many countries also lack full ownership of digital platforms or the ability to adapt them to local contexts, which undermines long-term sustainability. Interoperability remains one of the weakest areas, with fragmented systems and minimal data exchange. Finally, while some progress has been made in setting data standards, improving quality, and promoting data use, significant gaps still limit the effectiveness of digital health data for timely decision-making. The following sections explore these domain-specific challenges in greater detail and offer targeted recommendations to guide future action.

Challenges and gaps

The assessment of VPD surveillance efforts across multiple African countries revealed widespread gaps that hinder effective implementation and impact. These challenges, observed across diverse settings, highlight systemic weaknesses that persist despite ongoing investments. The key findings are summarized below across eight domains that collectively shape the performance and sustainability of digital surveillance systems

Governance and strategic alignment

Governance and coordination remain significant challenges across many countries. While a few have demonstrated strong national leadership and alignment of digital health efforts with broader health goals, most lack a well-defined strategy or exhibit fragmented efforts. Even where national digital health strategies exist, they are often outdated, underfunded, or misaligned with surveillance priorities. In the absence of strong leadership and a shared vision, effective collaboration among stakeholders is difficult to achieve. Fragmented coordination among ministries, partners, and implementing agencies leads to duplication, inefficiencies, and weak accountability. Inadequate stakeholder engagement, particularly from national public health institutes, further limits strategic planning and ownership. In parts of West and Central Africa, political instability and frequent leadership turnover also disrupt continuity and long-term vision.

Workforce and technical capacity

A major barrier to effective VPD surveillance and digital health implementation is the acute shortage of skilled technical personnel at all levels. Most countries are still building their technical workforce, and even where systems are operational, there are too few staff with the expertise to install, maintain, and support digital tools. Technical capacity is often concentrated at the national level, leaving subnational and rural areas with limited support. Health ministries often lack staff with adequate training in digital health systems, health informatics, cybersecurity, and system integration. While, frontline health workers frequently lack adequate training and equipment, resulting in low uptake and underutilization of available systems. Reliance on donor-funded personnel or short-term consultants further undermines sustainability and institutional capacity building. Additionally, Francophone and Lusophone countries often face linguistic and contextual barriers in accessing global training resources and standards. This persistent capacity gap continues to constrain the effectiveness and scalability of digital health initiatives.

End-user readiness

Low digital literacy among frontline health workers remains a consistent challenge. In many countries, health facility staff are unfamiliar or uncomfortable with digital tools, especially in settings where paper-based systems remain the norm. Limited hands-on training, lack of job aids, and minimal technical support result in frequent data entry errors, tool abandonment, or parallel reporting. In several settings, digital health systems are seen as additional burdens rather than enablers, due to poor change management and inadequate consultation during system design and rollout. End-user fatigue is also reported in regions with multiple overlapping tools and vertical reporting systems.

Infrastructure readiness

Infrastructure constraints, especially in remote and rural areas, continue to be a major bottleneck. Many health facilities lack stable electricity, sufficient computing devices, or reliable internet connectivity. Even in urban centers, infrastructure is often outdated, under-maintained, or unequally distributed across health programs. Power outages and weak connectivity undermine the functionality of digital systems and reduce end-user confidence. The lack of national plans for information and communication technology (ICT) infrastructure investment in the health sector, combined with fragmented donor-supported efforts, prevents countries from achieving sustainable and scalable digital health ecosystems.

System lifecycle and localization

Many countries face challenges in managing the full lifecycle of digital health systems, from design and development to implementation, maintenance, and eventual upgrades or decommissioning. These systems are often deployed without clear long-term plans for sustainability, support, or iterative improvement. A common issue is the lack of localization; global tools are frequently adopted without sufficient adaptation to local languages, health priorities, or workflows. This limits usability, reduces user acceptance, and ultimately undermines the effectiveness of surveillance systems. A lack of system ownership and adaptation remains a challenge.

Interoperability

While some progress has been made in system interoperability, many countries still struggle with fragmented digital health ecosystems that lack the ability to communicate and share data effectively. VPD surveillance systems often operate in silos from other key national health information systems, such as electronic medical records, laboratory systems, or logistics management platforms, due to the absence of interoperability standards, common data exchange protocols, and coordinated governance mechanisms. Limited technical capacity and weak data standardization further compound the issue, resulting in duplicated efforts, inconsistent data, and missed opportunities for integrated decision-making.

Data standards and data quality

Data quality remains a persistent challenge for VPD surveillance systems. Many countries lack standardized case definitions, data dictionaries, and coding systems aligned with global norms such as WHO guidelines. Inconsistent data entry, missing values, and errors in reporting undermine the reliability and comparability of surveillance data. The absence of robust quality assurance processes, regular data audits, and capacity building in data management further exacerbates these issues. As a result, decision-makers often face difficulties in using surveillance data to guide timely and effective public health responses.

Data use and reporting

Despite the collection of large volumes of surveillance data, its use for decision-making remains limited in many countries. Health workers and managers at subnational levels often lack the capacity, tools, or incentives to analyze and apply data for improving programs or responding to outbreaks. Delayed reporting, weak feedback loops, and the absence of user-friendly dashboards or automated analytics hamper timely interpretation and action. A culture of data use is often missing, as systems are perceived primarily as reporting tools for upward accountability rather than as enablers of local decision-making and service delivery improvement. As a result, countries risk becoming data-rich but action-poor.

Recommendations

Effective VPD surveillance systems are critical to safeguarding public health, enabling timely outbreak detection, and guiding immunization strategies. However, many countries, particularly in West and Central Africa, face significant challenges that undermine the performance and sustainability of these systems. To address the challenges uncovered in the analysis, we identified a set of practical short-term actions and medium- to long-term strategies across eight key thematic domains. By combining immediate improvements with long-term investments in governance, workforce development, infrastructure, and data use, countries can build more resilient, efficient, and impactful VPD surveillance systems.

Governance and strategic alignment

In the short term, countries should establish or revitalize national coordination bodies for digital health and surveillance, conduct rapid reviews of existing digital health strategies to align them with current VPD surveillance priorities, and promote stakeholder dialogues to improve coordination. In the medium- to long-term, countries should develop and implement updated, costed national digital health strategies with clear surveillance components, strengthen institutional leadership by embedding digital health governance within public health structures, and foster regional collaboration to support continuity despite political changes.

Workforce and technical capacity

Short-term actions include conducting targeted training sessions on VPD surveillance tools, mobilizing existing technical expertise within ministries, and developing quick-reference guides tailored to local contexts. In the medium- to long-term, institutionalizing digital health training in health worker curricula, building local capacity for system development and cybersecurity, and reducing reliance on donor-funded technical staff are essential for sustainability.

End-user readiness

To improve end-user readiness, countries should organize practical training for frontline workers, provide job aids and strengthen support systems, and engage end users in system improvement feedback loops. Longer-term strategies should focus on integrating digital literacy into workforce development plans, establishing continuous learning platforms, and ensuring systematic involvement of end users in system design and deployment.

Infrastructure readiness

Short-term improvements include mapping existing ICT infrastructure, providing mobile or offline solutions, and leveraging telecommunications partnerships for improved connectivity. Over the long-term, countries should develop national digital infrastructure investment plans, implement renewable energy solutions for remote areas, and standardize hardware and connectivity across the health system.

System lifecycle and localization

Immediate actions should include system assessments to identify functionality gaps, customizing tools to local languages, and providing refresher training. In the long-term,

countries should establish guidelines for full lifecycle management of digital health systems, build local technical capacity, and plan for system scalability and upgrades.

Interoperability

Short-term steps involve mapping existing systems, introducing simple data-sharing protocols, and promoting data-sharing agreements. Medium- to long-term strategies include developing national interoperability frameworks, establishing governance for system integration, and investing in shared services architecture for seamless data exchange.

Data standards and data quality

Countries can immediately standardize case definitions, implement data quality checks, and provide clear documentation for data management. Long-term efforts should focus on institutionalizing data quality audits, strengthening national data management capacity, and fostering a culture of quality and accountability.

Data use and reporting

To enhance data use, countries should develop actionable dashboards, conduct data use workshops, and simplify reporting processes in the short term. Over time, integrating data use competencies into health workforce development, institutionalizing regular data review meetings, and investing in advanced analytics will strengthen data-driven decision-making.

By adopting these targeted recommendations, countries can progressively enhance the effectiveness, sustainability, and responsiveness of their VPD surveillance systems, contributing to stronger health security and better population health outcomes.

Conclusion

Despite some variations by country or region, the findings were remarkably consistent across thematic domains. However, Francophone and Lusophone countries face additional language and contextual barriers to accessing global resources, whilst political instability and leadership turnover also hinder long-term planning in several West and Central African countries.

The analysis across 23 countries reveals a set of persistent systemic weaknesses that undermine the effectiveness of VPD surveillance. Weak governance, limited coordination, and misalignment between digital health and broader health goals persist in many settings. Only a few countries exhibit strong institutional leadership, while many struggle with fragmented implementation and poor stakeholder coordination. Technical workforce shortages, particularly at subnational levels, and gaps in digital literacy and training among frontline health workers further hinder progress. Infrastructure gaps, such as unreliable electricity, limited internet connectivity, and a lack of functional hardware, remain major obstacles across most countries, particularly in rural areas. Many systems lack sustainability plans and are not adapted to local contexts, while fragmented platforms and weak data standards contribute to poor interoperability and underuse of data in decision-making.

To address these challenges, the report outlines practical short- and long-term recommendations, including strengthening governance structures, improving infrastructure and workforce development, and building user-centered, interoperable systems. Immediate actions—such as revitalizing coordination mechanisms, delivering targeted training, and mapping existing ICT assets—can generate quick wins. Over time, countries should invest in institutional capacity, develop costed digital health strategies aligned with surveillance priorities, and build resilient, user-centered systems that are adaptable to local contexts. Promoting a stronger culture of data use and aligning efforts across countries and partners will be critical to improving VPD surveillance and driving better health outcomes.

Country profiles

Methodology

Four countries (Mali, Senegal, Uganda, and Zambia) were selected to participate in both phases of the assessment, which included a landscape analysis and a deep dive study. These countries were chosen following an initial desk review and scoring exercise that considered multiple criteria such as the level of digital maturity (including DHIS2 implementation and integration with health information systems), system transition experience (such as moving from Epi Info or SORMAS to DHIS2), geographical and epidemiological diversity to ensure representation across regions and contexts, overall health system maturity, and the willingness of national stakeholders to participate in fieldwork. This approach ensured a balanced selection of countries offering diverse perspectives on surveillance system development and implementation, providing valuable lessons for other settings.

To better understand the strengths and weaknesses of each country's VPD surveillance system, the analysis was organized around seven thematic areas: leadership and governance, capacity, data quality processes and standardization, data use, system transition, interoperability, and infrastructure and equitable access. Each theme offers a focused view of the conditions shaping a country's VPD surveillance landscape and identifies opportunities for improvement.

The landscape analysis for phase one of the assessment used a structured electronic questionnaire and an Excel-based maturity model. This phase assessed the use of digital tools such as DHIS2, Epi Info, and SORMAS, along with system functionality, governance, data quality, and integration. Findings were organized thematically to classify countries by maturity level, with results informing individual country profiles.

Phase two focused on qualitative data collection through KIIs and FDGs in each country, guided by a semi-structured protocol. These methods provided in-depth insights into governance, system functionality, data practices, training, and infrastructure. Fieldwork followed a structured schedule and adhered to standard operating procedures to ensure consistency and data quality.

Scoring interpretation and context

It is important to note that the maturity scores provided in this report represent a simplified, categorical assessment designed to enable cross-country comparisons on a standardized 0-2 scale. Narrative descriptions provide more nuanced detail, highlighting partial functionality, recent improvements, or context-specific challenges that may not be fully reflected in a discrete score. For example, a country may have initiated dashboard development but not achieved widespread use or integration, justifying a lower score while still warranting mention in the qualitative text. Similarly, references to policy frameworks or pilot activities in the narrative may reflect efforts underway that have not yet translated into fully functional, scaled interoperability or data use systems. This approach intentionally combines quantitative scoring with qualitative narrative to ensure both standardized comparison and meaningful context. Readers are encouraged to interpret scores as indicators of current, routine, system-wide functionality rather than of *all* efforts or innovations occurring in a country.

To further support accurate interpretation, the following scoring distinctions are applied:

- **0 = Absence of functionality**: A score of 0 indicates that a specific functionality, process, or system component is not present, not implemented, or not routinely used in the country. This reflects a confirmed lack of functionality, rather than uncertainty.
- **N/A (Not applicable)**: This designation is used when a subdomain or transition step is not relevant to a country's context. For example, certain implementation activities may not apply due to system design differences or alternate national strategies.
- **Missing / No data available**: In instances where there was insufficient information to confidently assign a score, the field is left blank and not scored. These instances are not interpreted as a score of 0. In the summary scoring tables, such unscored fields are excluded from the average to avoid distorting results and ensure that only well-documented areas contribute to composite scores.

This distinction ensures the integrity of cross-country comparisons and allows for both rigor and fairness in reporting.

Mali

Background

From the outset, Mali's deployment of DHIS2 has focused on integrating it with existing systems to address critical gaps. The country has successfully scaled its integrated disease surveillance system, including IDSR and EWARN, and introduced a case-based tracking system. After a period of testing and development, Mali also adopted the new WHO VPD case-based surveillance package. The first major interoperability effort began in 2016, with the implementation of interoperability between Outil de Suivi des Produits de Sante (OPSANTE), a tool used for analysis and reporting, with DHIS2 for aggregated data collection. Since then, nearly a dozen systems have been integrated into DHIS2, reflecting the strong leadership and coordination of the Ministry of Health.

The transition from Epi Info to DHIS2 has been pivotal for Mali's VPD surveillance, enabling the consolidation of both case-based and aggregate data on a single platform. This shift has significantly improved data management, supporting more timely and effective outbreak detection and response. A key achievement was the integration of routine and malaria surveillance data into the national health information system, which has enhanced the responsiveness of health authorities and strengthened the overall surveillance infrastructure.

Mali was selected to participate in this evaluation because it represents a strong example of a country that has scaled the WHO VPD case-based surveillance package nationally. Its advanced implementation status provides critical insights into how integrated VPD surveillance systems can function in resource-constrained settings. Mali's national experience offers a practical lens for understanding the operational, policy, and technical enablers and barriers of scaling case-based surveillance at a national level.

The deep dive in Mali was conducted between March 21 and April 29, 2025. The qualitative data collection included two focus group discussions, one with seven participants from the national level and another with five participants from the regional level. In addition, the team conducted 22 KIIs with stakeholders from national programs, district health offices, and health facilities. The team carried out field activities in 10 districts in the Koulikoro Medical Region, 8 districts in the Ségou Medical Region, and at the regional level in Bamako.

Maturity assessment

Table 2. Maturity scores for Mali across key domains for VPD Surveillance Systems

Theme	Subdomain	Maturity Score 0 = Foundational 1 = Developing 2 = Established
Governance and Strategic Alignment	Existence of a formal governing body	2
	Existence of a Digital Health Strategy	2
	Sustainable funding	2
	Equity infrastructure	0
	Equity policies (rural/urban)	2
	Submission to WHO AFRO regional system	2
Workforce/Technical Capacity	Dedicated VPD surveillance officer	2
	Admin/monitoring team in place	2
	Availability of monitoring tools/SOPs	2
	Software maintenance team in place	2
	Integration/interoperability tech capacity	1
End-User Readiness	End-user satisfaction	2
	End-user training	2
Infrastructure Readiness	Availability of computers	0
	Mobile devices and mobile data access	1
	Stable power/internet infrastructure	1
	Capacity to maintain infrastructure	1
	Infrastructure disparities	0
System Lifecycle and Localization	Length of time system has been in use	2
	Multilingual software maturity	2
	VPD surveillance system transition	1
Interoperability	Integration with WHO AFRO system	0
	Integration with national HIS	2
	Interoperability standards use (FHIR, ADX)	1
	Existence of national interoperability framework	0
Data Standards and Data Quality	Metadata dictionary	1
	Org units structure	2
	Compliance with WHO AFRO standardized indicators	2
	Data quality governance	1
	Data entry/management training	2
Data Use and Reporting	Data reporting needs	2
	Data sharing practices	2
	Timeliness and quality of CBS data	2
	Timeliness and quality of aggregate data	Missing/ No Data Available
	Case-based data security compliance	Missing/ No Data Available

Deep dive analysis

Mali's VPD surveillance system exhibits mid to high-level maturity across several assessed domains. According to the landscape maturity model, Mali scored a "Developing" or "Established" level in many categories, reflecting a system that has made foundational advances but continues to face significant implementation and infrastructure challenges. Governance, data quality, and reporting functions show good development, while critical domains such as interoperability, infrastructure, and system integration received the lowest scores. These findings align with qualitative insights from the deep dive assessment, which highlight mixed perceptions of system effectiveness, training limitations, and persistent resource gaps.

VPD surveillance in Mali is conducted primarily through the DHIS2 platform, which supports both aggregate and case-based reporting. This system has been operational for over two years and is complemented by tools such as ODK and KoboCollect. Offline capability and multilingual functionality were consistently cited as key strengths, particularly in low-connectivity regions. However, reliance on paper-based tools persists in many settings due to poor infrastructure and limited digital access.

Stakeholder feedback gathered through focus group discussions and key informant interviews revealed a range of opinions about the system. While users appreciated the clarity of user documentation, the availability of offline data entry, and facility-level data capture, many also voiced concerns around incomplete and inaccurate data, limited capacity for quality assurance, and insufficient training for system administrators and end users. A majority of respondents reported that site-level staff had not received adequate technical training and that system administration functions were often dependent on external support.

Critical barriers include low system interoperability, with few documented mechanisms for data exchange and limited integration between DHIS2 and other national platforms. The assessment also identified widespread infrastructure deficiencies: respondents cited a lack of computers, mobile devices, and stable power and internet as major obstacles to effective surveillance, particularly outside urban centers. These challenges are compounded by a shortage of Ministry of Health personnel available to support hardware maintenance and digital system oversight.

Despite these constraints, several system features were highlighted as best practices with potential for replication. Facility-level data capture was recognized for improving reporting accuracy and timeliness. Offline functionality and multilingual support were seen as critical enablers for system usability across diverse regions. Clear documentation also played a role in supporting user engagement in the absence of formal training.

Leadership and governance

The deep dive findings from Mali confirm the presence of a recognized governing body responsible for overseeing VPD surveillance, with most respondents validating its existence and citing regular activities such as monthly meetings and involvement in data entry and analysis. While Standard Operating Procedures (SOPs) and Terms of Reference (TORs) are reportedly available and in use, awareness and specificity varied across stakeholders.

External partners, including international and donor organizations, were widely acknowledged as playing a significant role in VPD governance, particularly in data collection, analysis, and specimen transport coordination. This indicates that while domestic governance structures exist, they remain influenced by external technical assistance. Respondents also highlighted efforts to integrate epidemiological surveillance with broader health information systems and immunization programs. This integration is viewed as important for coordination and decision-making, though details on how governance supports this integration were limited.

Overall, Mali's governance for VPD surveillance shows strong foundational progress but remains in a developmental stage. Strengthening intra-governmental leadership and clarifying roles among partners are essential steps toward establishing more strategic, systematic, and accountable oversight.

Capacity

At the Ministry level, most respondents reported that personnel are in place to manage and

monitor the system. These staff are involved in validating and implementing software upgrades, and have received some training in system administration. SOPs for backup, restore, and disaster recovery exist, although a notable minority stated otherwise, suggesting inconsistency in either availability or awareness of these procedures.

Despite these reported structures, gaps persist in terms of personnel coverage and training. Most respondents described the number of system administrators as inadequate to meet the demands of national implementation. While training was provided to many in the technical team, responses suggest variability in frequency, content, and reach. The absence of a formalized, ongoing training program limits the Ministry's ability to sustain system maintenance without external support.

Regarding software maintenance, the majority of participants viewed the internal Ministry team as generally effective, with most expressing satisfaction with their performance. However, concerns were noted about occasional lapses in responsiveness or consistency. The system appears to lack formal maintenance agreements with external vendors or support organizations, placing additional pressure on internal staff to manage updates and troubleshoot issues independently.

At the end-user level, most respondents confirmed that country-specific training is available and that many users have received general system training. However, there were indications of training gaps, with some users reporting they had not received adequate support or follow-up. Most respondents acknowledged the availability of post-training support, but some noted a lack of follow-up assistance after the training ended.

End-users also cited a need for broader support to improve the functionality and usability of the system. Commonly reported challenges included network instability, delayed access to corrected data, and difficulties with data retrieval and system navigation. These limitations suggest the need for expanded training, better documentation, and improvements in system infrastructure to fully enable end users.

In summary, while foundational capacity exists within Mali's VPD surveillance workforce, key areas require strengthening. Priorities include expanding training coverage and frequency, formalizing post-training support, ensuring sufficient technical staffing, and improving usability and reliability of the surveillance system at the point of use.

Data quality processes standardization

The deep dive assessment revealed several challenges related to data quality, completeness, and standardization, while also pointing to promising practices at the facility level that can serve as a foundation for system improvement. Respondents reported issues with the completeness and accuracy of VPD surveillance data, delays in entry, and inconsistent reporting practices, particularly at the facility level. These weaknesses are compounded by gaps in connectivity and limited technical capacity, which hinder the timely transmission and verification of data. While some internal review mechanisms appear to be in place, the use of formal data validation procedures and structured quality assurance processes remains inconsistent.

Standardization of data elements and organizational hierarchies also appears limited. There were few references to consistent use of metadata or harmonized structures across levels of the health system, suggesting that data entry fields, facility codes, and reporting timelines may vary regionally. These inconsistencies reduce the comparability and utility of surveillance outputs and make aggregate analysis more difficult at national and regional levels.

Despite these challenges, there are several areas of strength that can be leveraged. A majority of respondents emphasized the critical role of facility-level data capture, identifying it as the most important level for effective surveillance. This prioritization supports the collection of more granular, actionable data and represents a positive step toward real-time, bottom-up public health intelligence. Additionally, multiple respondents indicated that data analysis occurs at different system levels, including facilities, districts, and regions, suggesting a growing culture of data use and interpretation across the health system.

Data management and use

Mali's VPD surveillance system demonstrates an active use of data across multiple levels of the health system, though challenges with quality, coordination, and consistency persist. A majority of respondents indicated that VPD surveillance reports are regularly produced and shared, and that the data is used for public health decision-making. These uses include monthly review meetings, identifying low coverage areas, planning catch-up vaccination campaigns, and informing annual work plans. Respondents also referenced the use of surveillance data to monitor epidemic thresholds and guide response planning.

Stakeholders reported that VPD surveillance data is shared with key partners, including WHO, UNICEF, and other ministries. The presence of written data management procedures and formal data sharing agreements was noted, pointing to a relatively structured approach to data handling and coordination. However, some respondents reported gaps in coordination and delays in data transmission, which can affect the timeliness of information used for outbreak response and programmatic planning.

Most respondents reported missing, incorrect, or incomplete data, and several flagged instances of aberrant or atypical entries. Others noted internal inconsistencies and discrepancies in reporting, reflecting systemic weaknesses in data validation and supervision. These issues appear to be widespread and multifaceted, driven by insufficient analysis before entry, weak coordination, limited human resources, and inconsistent internet connectivity. Although training for data managers is generally viewed as effective, there are gaps in ongoing support and system usability, which further compound the challenge of ensuring high-quality, reliable surveillance data.

Overall, while Mali has institutionalized a culture of data reporting and use for program management and planning, significant barriers remain. These include quality assurance, feedback mechanisms, and the capacity of health workers to analyze and act upon data. Strengthening these areas could greatly enhance the responsiveness and reliability of the VPD surveillance system.

System transition

The transition from a paper-based to a digital VPD surveillance system in Mali is ongoing and characterized by a partial adoption of digital platforms, primarily DHIS2 and ODK. While many respondents associated the transition with the implementation of DHIS2, there was no clear consensus on whether the transition is complete. Several stakeholders indicated that the process is still underway, with digital reporting being adopted across most levels, but not yet fully replacing paper-based methods.

Participants expressed optimism about the shift toward digital surveillance, viewing it as positive step forward and voicing strong support for its continued implementation. Training was provided to support the shift, and most respondents confirmed that user received training after the new system was introduced. However, some also noted areas requiring further improvement, although few specific concerns were detailed.

Interoperability

Mali's VPD surveillance software demonstrates several mature system features, but gaps remain in full interoperability and integration with other platforms. Respondents largely confirmed the presence of foundational capabilities such as offline functionality, real-time feedback, duplicate record handling, and strong data validation processes. These features support system usability and can contribute to internal consistency of data across reporting levels.

The majority of respondents confirmed that the software supports multiple languages, enabling broader accessibility across diverse linguistic regions in Mali. This feature promotes equitable use and supports frontline health workers in both data entry and interpretation, particularly in settings where French may not be the primary language.

The software is also seen as customizable to country-specific needs, with most respondents noting the availability of user documentation written in clear and accessible language. However, technical documentation was less consistently available, and several respondents identified a need for clearer, more comprehensive technical guidance to support local system administration and integration.

Despite these technical strengths, the data highlight constraints that may hinder deeper interoperability. Limited access to technical documentation, concerns around scalability, and unclear benchmarking standards suggest that while the system operates effectively as a standalone tool, its ability to interface with other digital health platforms remains limited.

Infrastructure and equitable access

Infrastructure challenges continue to hinder equitable access to Mali's VPD surveillance system, particularly at peripheral levels. Respondents frequently cited issues related to network instability, unreliable internet connectivity, and system slowness, which affect both data entry and retrieval. These problems were often linked to frequent disruptions that limit timely reporting and user engagement with the platform.

Power supply also emerged as a concern in several responses, especially in rural or underserved areas, where inconsistent electricity supply was seen as a barrier to using digital tools effectively. These infrastructure constraints contribute to uneven access and reliability of the surveillance system across different geographic regions.

Hardware shortages were not directly emphasized in the responses, but limitations around device access and account availability were mentioned by some users. These limitations affect the continuity of data entry and the ability of users to interact with the system consistently.

Despite these challenges, the presence of offline capabilities within the VPD surveillance software was identified as a critical enabling feature. This functionality allows health workers to continue data entry in areas with poor or no connectivity, helping to mitigate the impact of digital divides.

Lessons learned

- ✓ *Offline capability is a critical enabler in low-connectivity settings*

Mali's VPD surveillance systems include robust offline functionality, allowing data to be entered and stored in areas without consistent internet access. This has proven essential for ensuring continuous reporting across geographically dispersed and rural regions, As countries aim to scale digital health systems equitably, offline access should be considered a

foundational feature.

✓ *Multilingual system design improves usability and equitable use*

The system's multilingual maturity supports a diverse user base and helps improve comprehension, reduce data entry errors and promote system uptake across Mali's linguistically diverse regions. Designing platforms with built-in language configurability can significantly enhance accessibility and user engagement in multilingual contexts.

✓ *User-friendly documentation supports frontline engagement*

Respondents consistently noted the availability and clarity of the user documentation. Well-designed instructional materials help users to navigate system functionalities more effectively, especially in settings with limited digital literacy or irregular training opportunities. Clear and up-to-date documentation should be prioritized as a low-cost but high-impact intervention to improve user confidence and system performance.

✓ *Structured facility-level data capture strengthens local decision-making*

Mali's focus on facility level data entry as the foundation of its VPD surveillance system enables more granular and timely reporting. This structure supports stronger local decision-making and fosters accountability at the point of care. Countries looking to decentralize surveillance systems may consider adopting a similar bottom-up approach,

Conclusion and recommendations

Mali's VPD surveillance system implementation reflects a mix of emerging strengths and persistent challenges. While the system has not yet achieved full maturity across key domains, it demonstrates promising progress in areas such as user-centered design, multilingual functionality, and facility-level data capture. The introduction of digital platforms like DHIS2 and ODK has enabled greater efficiency in data collection and reporting, particularly through features such as offline capability and customizable reporting, which are key advantages in a context marked by infrastructure constraints and linguistic diversity.

At the same time, the system continues to face limitations that impact overall effectiveness. Training coverage remains inconsistent, with gaps in both end-user preparedness and MOH-level technical capacity for system administration and monitoring. Integration with broader health information systems remains limited, with few formal mechanisms in place for data exchange or alignment with immunization registries. Challenges with data quality, including frequent reports of missing or incorrect data, further underscore the need for strengthened validation processes and routine oversight.

Despite these constraints, Mali's experience offers several important lessons that could inform system strengthening in other countries. The use of offline-enabled digital tools tailored to low-resource settings, the emphasis on clear and accessible user documentation, and efforts to embed data use at facility and district levels all highlight the potential of locally adapted approaches to improve surveillance outcomes. Moving forward, a stronger focus on infrastructure investments, recurrent training programs, system interoperability, and data quality assurance will be essential to enhance system performance and ensure sustainability.

Mali's evolving VPD surveillance system reflects both the complexity and opportunity inherent in digital transformation efforts in public health. By building on its successes and addressing critical gaps, Mali is well-positioned to serve as a model for other countries navigating similar transitions.

Senegal

Background

DHIS2 was first introduced in Senegal in 2014 to support routine health data collection and inform decision-making. It was formally adopted as the national health management information system (HMIS) in 2016. One of its most impactful applications came during the COVID-19 pandemic, when the DHIS2 Tracker platform became central to the national response—demonstrating its value for managing vaccine-preventable disease (VPD) surveillance. A performance assessment conducted during this period identified areas for improvement and recommended expanding its use to additional notifiable diseases.

Despite progress, the implementation of VPD surveillance through DHIS2 has faced persistent challenges. A major issue is the fragmentation of health information systems, with limited interoperability complicating the integration of health and human resource data. Capacity gaps among local teams also limit effective data analysis and use. Additional barriers include limited stakeholder engagement, data protection concerns, and challenges in aligning metadata to meet the diverse needs of health sector users.

To address these issues, the Ministry of Health and Social Action, with support from partners, launched targeted capacity-building initiatives including monthly trainings and self-paced learning modules—to strengthen local expertise. A phased proof-of-concept to integrate DHIS2 with iHRIS, a human resource information system, was also initiated in three regions. These efforts aimed to better align data sources and enhance visualization tools, enabling more coordinated, evidence-based decision-making across health system levels.

Senegal was selected for a deep dive due to its diverse use of digital surveillance tools, strong integration with national health information systems, and its relevance as a context balancing innovation with infrastructure and capacity challenges. The country provides valuable insights into the deployment of case-based and aggregated surveillance across urban and rural settings, and into how digital systems complement paper-based reporting and centralized versus facility-level data collection. Its experience with external data quality support also offers important lessons for cross-country learning.

The in-depth assessment took place between May 23 and June 15, 2025. Qualitative data collection included three focus group discussions (FGDs) with two national- and six regional-level participants, and 17 key informant interviews (KIIs) with stakeholders from various levels of the health system. Fieldwork was conducted across 12 districts in three regions.

Findings from both assessment phases informed Senegal's VPD surveillance country profile and contributed to broader regional comparisons. The country's experience highlights key lessons around integrating digital and paper-based workflows, improving data quality, addressing rural-urban equity gaps, and strengthening sustainable system governance and capacity.

Maturity assessment

Table 3. Maturity scores for Senegal across key domains for VPD Surveillance Systems

Theme	Subdomain	Maturity Score 0 = Foundational 1 = Developing 2 = Established
Governance and Strategic Alignment	Existence of a formal governing body	2
	Existence of a Digital Health Strategy	2
	Sustainable funding	2
	Equity infrastructure	1
	Equity policies (rural/urban)	0
	Submission to WHO AFRO regional system	2
Workforce/Technical Capacity	Dedicated VPD surveillance officer	2
	Admin/monitoring team in place	1
	Availability of monitoring tools/SOPs	0
	Software maintenance team in place	0
	Integration/interoperability tech capacity	0
End-User Readiness	End-user satisfaction	0
	End-user training	2
Infrastructure Readiness	Availability of computers	0
	Mobile devices and mobile data access	2
	Stable power/internet infrastructure	2
	Capacity to maintain infrastructure	1
	Infrastructure disparities	1
System Lifecycle and Localization	Length of time system has been in use	2
	Multilingual software maturity	Missing/ No Data Available
	VPD surveillance system transition	0
Interoperability	Integration with WHO AFRO system	0
	Integration with national HIS	2
	Interoperability standards use (FHIR, ADX)	0
	Existence of national interoperability framework	1
Data Standards and Data Quality	Metadata dictionary	2
	Org units structure	2
	Compliance with WHO AFRO standardized indicators	2
	Data quality governance	2
	Data entry/management training	0
Data Use and Reporting	Data reporting needs	2
	Data sharing practices	2
	Timeliness and quality of CBS data	Missing/ No Data Available
	Timeliness and quality of aggregate data	Missing/ No Data Available
	Case-based data security compliance	Missing/ No Data Available

Deep dive analysis

Senegal's VPD surveillance system presents a complex picture of strong foundations in some areas alongside persistent challenges that affect its overall effectiveness. Stakeholders generally expressed a measure of satisfaction with key features, particularly the system's integration with national health information platforms such as DHIS2 which enables better data sharing and supports national-level coordination of surveillance activities. The system's ability to support both case-based and aggregated data collection approaches was also viewed positively.

Training for end users was frequently cited as a success, contributing to widespread familiarity with reporting processes. Many respondents noted receiving training to support their work, although gaps in more specialized training, particularly in data quality evaluation and system administration, remain a concern. These gaps, along with insufficient personnel and limited evaluation of training effectiveness, were identified as constraints to system resilience and sustainability.

The system supports offline data capture, which has improved data consistency in areas with limited connectivity. Stakeholders also highlighted the usefulness of geographic data disaggregation for informing targeted interventions and tracking localized trends. Other strengths included the integration of laboratory systems, a regular data quality assurance framework, and dedicated data quality teams—all of which enhance the reliability of surveillance data.

Despite these positive aspects, significant challenges persist. Concerns about data quality were widespread, particularly with case-based surveillance (CBS) data. Roughly two-thirds of respondents reported issues related to accuracy, completeness, and timeliness. Stakeholders stressed the need for more granular and reliable data to better inform decision-making.

Infrastructure barriers—such as transportation delays for specimen delivery in rural areas, unreliable power, and limited hosting capacity—were also cited as key impediments. These challenges hamper timely reporting and consistent system functionality.

Equity issues were another recurring theme. Although data quality was generally seen as comparable between rural and urban areas, disparities in infrastructure, staffing, and device access hinder equitable system use. Stakeholders recommended improving access to accounts and tools, simplifying reporting processes, and enhancing user experience to support daily operations.

Finally, gaps in system security and governance raise concerns about data integrity and compliance. The lack of encryption policies, documented security plans, designated security personnel, and regular audits points to a need for stronger oversight and adherence to data protection standards.

In summary, Senegal's VPD surveillance system benefits from strong integration, established training, and adaptive features such as offline data capture. However, to fully realize its potential, targeted improvements in data quality, infrastructure, workforce capacity, equity, and security are essential. Addressing these challenges will help build a more reliable and responsive system capable of supporting timely disease detection and effective outbreak response.

Leadership and governance

The field study in Senegal reveals significant challenges in establishing the governance structures needed to guide and prioritize VPD surveillance activities. Most respondents reported that no formal governing body exists for VPD surveillance in Senegal. This lack of a designated governance structure suggests that coordination and oversight may be fragmented or ad hoc. Without a formal mechanism for regular meetings and coordinated decision-making, the system risks inconsistent prioritization of digital health initiatives and limited strategic alignment with broader health goals.

When asked about the existence of a costed work plan for VPD surveillance, participants similarly indicated its absence, suggesting that planning processes are likely to be informal

or inadequately resourced. The absence of a costed plan limits the ability of the Ministry of Health and partners to secure funding, forecast costs, and ensure sustained investment in system maintenance and upgrades.

Despite these governance gaps, there was some recognition of broader national-level planning. Respondents acknowledged the existence of a national digital health strategy, with participants even citing specific online references to the Ministry of Health's website hosting the strategy. While this shows that digital health is prioritized at the national level, it highlights a disconnect between overarching strategy and specific planning for VPD surveillance.

Funding challenges emerged as a significant governance issue. Most participants reported no dedicated funding for VPD surveillance software maintenance, indicating a reliance on unpredictable or fragmented financing sources. The responses highlighted no funding in two separate mentions. This funding gap makes it difficult to plan for necessary software upgrades, security improvements, or technical support.

Finally, respondents described the primary funding sources for VPD surveillance as coming from multiple donors rather than a unified national budget. This reliance on diverse and potentially uncoordinated donor funding underscores the importance of strong governance to align donor investments with national priorities, reduce duplication, and ensure sustainability.

Capacity

Users of the VPD surveillance system generally expressed satisfaction, but some challenges persist. The most frequent issue reported by users is unreliable internet connectivity and the need for improvement on the provision of stable and reliable internet connection, along with adequate computer equipment to support smooth system use.

The majority of users have received training on the system, though new staff, especially in rural areas, often remain untrained. While training needs are regularly identified, the delivery of training lacks a systematic approach and is heavily dependent on available funding. Additionally, no formal evaluations of training effectiveness are conducted to ensure knowledge retention or identify gaps. User manuals are generally accessible; however, some respondents pointed out that existing manuals tend to focus on monitoring processes rather than offering practical guidance on using the digital tools themselves. Support is provided by the Division du Système d'Information Sanitaire et Sociale (DSISS), team, which assists users as needed.

Although there is general training on surveillance specific training tailored exclusively to VPD surveillance is currently absent, indicating an opportunity to strengthen capacity in this area.

The Ministry of Health and Social Action (MOHSA) technical team, DSISS, includes personnel responsible for system monitoring and server management of the VPD surveillance information system; however, their numbers are insufficient to adequately manage the workload and system demands. They also have limited advanced IT knowledge, including IT Security. Respondents highlighted the absence of formal processes and tools for monitoring system performance and uptime. Additionally, there appears to be a lack of documented procedures and tools for backup, restoration, and disaster recovery. Training needs for the MOH technical team are neither regularly identified nor systematically addressed. While the team possesses some technical skills, they have limited resources to effectively maintain system integrations.

Data quality processes and data standardization

A formal data QA framework is in place for the VPD surveillance system, supported by a dedicated individual responsible for overseeing data quality management at national and sub-national levels. This includes surveillance focal points at the regional and district levels. Despite this structure, no regular training sessions on data quality are conducted for staff involved in data entry and management. Data discrepancies are actively monitored and addressed weekly through a process of data extraction followed by comparison with notification forms. However, the presence of reporting inconsistencies suggests that data quality checks may not be uniformly applied across sites.

Moreover, there are no documented SOPs covering key aspects of data management such as collection, storage, cleaning, quality control, analysis, and presentation, which may contribute to variability in data handling practices. Regarding data timeliness, some underperformance is observed, often attributed to factors including unreliable internet connectivity, intermittent power supply, and insufficient staff training.

Data management and use

Senegal's VPD surveillance system consistently reports data every week, with submissions generally made on time. Reports and dashboards are regularly produced at both national and sub-national levels, effectively meeting the information needs of the VPD surveillance program across all tiers. Facility-level staff actively utilize this data to guide follow-up actions and investigations, demonstrating the system's operational relevance.

There are established data sharing agreements with other ministries and partner organizations, facilitating coordinated use of VPD surveillance data. Respondents confirmed that data is routinely shared with WHO AFRO and various national partners to support planning, decision-making, and resource allocation efforts.

Interoperability

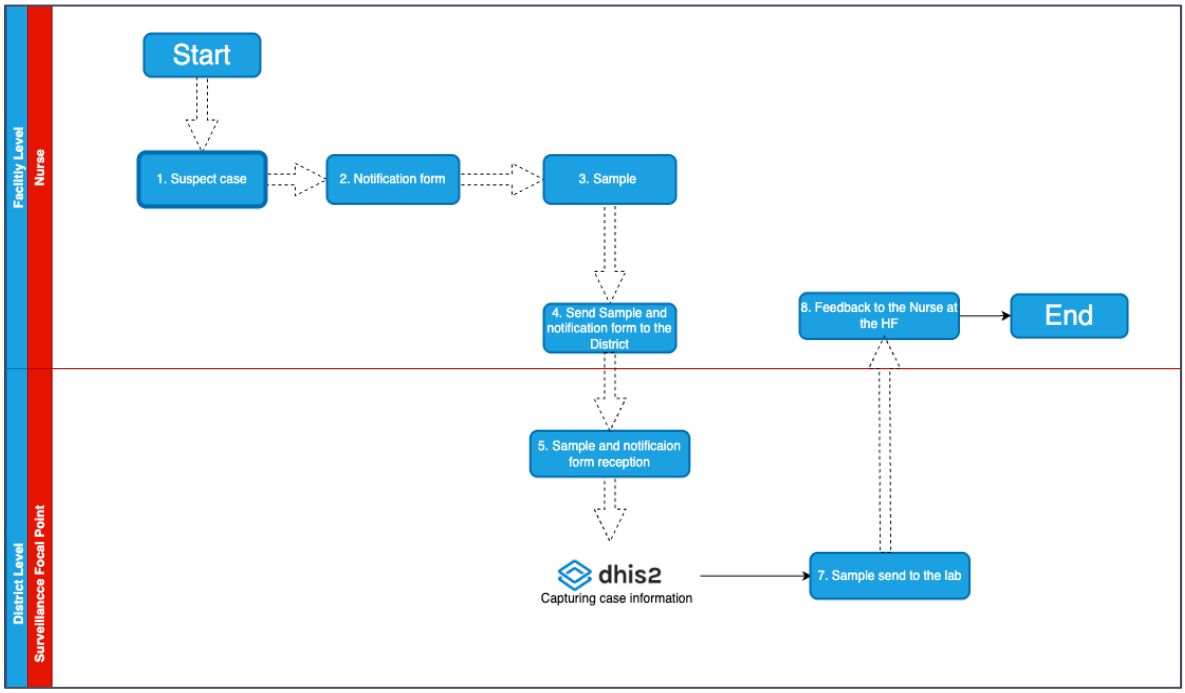
Findings from the deep dive assessment reveal that Senegal's DHIS2 platform successfully provides access to integrated data from at least two other health information systems, demonstrating progress towards a more unified digital health ecosystem. However, significant gaps remain in interoperability and seamless integration with additional platforms, limiting the system's full potential. Notably, the DHIS2 system is not directly integrated with laboratory information systems. While a laboratory component exists within the DHIS2 Tracker module, laboratory data entry does not occur at the laboratory level but is instead conducted at the district level, which may affect the timeliness and accuracy of lab data reporting.

The capacity for integration is further constrained by limited technical expertise among staff and the absence of routine, structured training programs to build and maintain these skills. Currently, no standardized data exchange protocols such as HL7 FHIR or ADX are implemented, and the national interoperability framework remains in draft form, underscoring the need for stronger governance and formalized standards. Despite these challenges, the DHIS2 platform incorporates a comprehensive metadata dictionary and maintains up-to-date facility hierarchies, enhancing data organization and consistency. Additionally, the use of WHO AFRO standardized indicators provides a solid foundation for future interoperability efforts and ensures alignment with regional health reporting standards, which bodes well for more consistent and harmonized data use across Senegal's health system.

System transition

The transition from a paper-based VPD surveillance system to a digital system is in progress, with aggregate surveillance data being entered into DHIS2 National weekly from the facility level. Since 2024, the MOHSA has deployed the DHIS2 Tracker for individual case management for VPD surveillance. Currently, data are entered at the district level from the paper form sent by the nurse at the health facility level.

Figure 1. Individual case management workflow in Senegal



Infrastructure and equitable access

Infrastructure challenges continue to constrain equitable access to Senegal's VPD surveillance system. In many parts of the country, particularly rural and remote areas, the power supply is unreliable. To mitigate this, some sites reported using generators to maintain operations during outages, though this solution is not universally available or sustainable.

Access to computers is uneven across health facilities. While some sites have sufficient hardware to meet their surveillance needs, others lack the basic equipment required for timely data entry and reporting. Respondents noted that although there is a limited budget for procuring mobile devices and supporting internet connectivity, this funding falls short of covering all surveillance points. As a result, some health workers rely on personal phones and pay for mobile data out-of-pocket to fulfill official duties, raising concerns about sustainability and the potential impact on reporting consistency.

To address intermittent internet access, offline data capture tools are used in some settings, allowing health workers to record data locally and upload it once connectivity is restored. While this offers a useful workaround, it can lead to delays or data loss if synchronization is not performed correctly or in a timely manner. Moreover, the effective use of such tools depends on adequate digital literacy and technical capacity at the local level.

Technical support for digital infrastructure also varies significantly. In some regions, health workers can access IT personnel or district-level technicians for assistance with device maintenance and troubleshooting. In others, however, structured support is lacking, resulting in prolonged downtime when equipment fails and further hindering the surveillance system's reliability.

Lessons learned

- ✓ *Rapid adaptation during public health emergencies allow for quicker response*

During the COVID-19 pandemic, Senegal successfully leveraged the DHIS2 Tracker platform for case management and surveillance. This agile repurpose of existing digital tools illustrates the value of flexible, adaptable systems that can be mobilized quickly in emergencies. One respondent noted, *"Surveillance data are collected weekly and entered into DHIS2 at the health post level by me. However, individual suspected cases are notified to the district through a paper form."*

- ✓ *Targeted capacity-building initiatives strengthen local expertise*

MOHSA and partners implemented monthly training sessions and self-paced learning modules to strengthen local expertise. This combination of structured and flexible learning formats provided health workers with ongoing opportunities to build skills.

- ✓ *Proof of concept interoperability projects are paving the way for integration*

Senegal piloted the integration of DHIS2 with iHRIS (the human resources information system) in three regions. While still in early phases, this demonstrates a commitment to testing interoperability between critical health information systems, a valuable approach for other countries considering integration.

- ✓ *Emphasis on data visualization and tools result in more coordinated, evidence-based decisions*

Efforts to improve data visualization and reporting tools were noted to have led to more coordinated, evidence-based decision-making. Investing in user-friendly dashboards and analytics supports stronger uptake and practical use of surveillance data at multiple health system levels. A respondent shared, *"VPD Surveillance data are entered into the digital system, which allows for generating reports in various formats."*

- ✓ *Focus on aligning metadata and data standards improve system consistency and usability*

Recognizing challenges with fragmented systems, Senegal has worked to align metadata across systems to improve consistency and usability. This technical focus helps reduce duplication and improve the quality of integrated data sets. According to the focal point for surveillance, *"During monthly meetings with head nurses, the district team verifies the completeness and consistency of the data collected with service providers."*

Conclusion and recommendations

Senegal's efforts to strengthen VPD surveillance through the adoption and expansion of digital tools like DHIS2 reflect both meaningful progress and ongoing challenges. By embedding digital reporting into national health information systems, the country has laid a strong foundation for integrated surveillance—enabling more timely data use, improved cross-sectoral coordination, and enhanced data-driven decision-making. The rollout of DHIS2 Tracker and the establishment of regular reporting practices illustrate the tangible benefits of digital transformation in advancing public health surveillance.

Despite these achievements, several critical barriers continue to constrain the system's effectiveness and long-term sustainability. Gaps in governance, technical capacity, infrastructure, and interoperability—along with persistent challenges in data quality—pose risks to resilience and impact. The absence of formal governance structures, insufficient skilled personnel, limited integration with laboratory systems, and stark infrastructure inequities, particularly in rural areas, remain pressing concerns.

Realizing the full potential of Senegal's surveillance system will require sustained investment and strategic action. Priorities include strengthening leadership and oversight, securing dedicated funding for maintenance and capacity-building, and advancing the use of global data standards and interoperability frameworks. Addressing infrastructure disparities and improving support for end users will also be key to ensuring reliable, equitable surveillance across all regions.

Senegal's experience offers valuable insights for other countries navigating the balance between digital innovation and on-the-ground realities. By continuing to invest in people, systems, and infrastructure, Senegal is well positioned to build a more robust, adaptive, and sustainable surveillance ecosystem—one that not only enhances outbreak preparedness but also reinforces broader health system resilience.

Uganda

Background

Uganda was selected for a country-level deep dive because it is in the midst of an important transition. The country has made notable progress in implementing integrated aggregate surveillance systems, including IDSR and EWARN. It is also testing and developing the WHO case-based tracker for VPD surveillance. As Uganda continues to shift toward a more granular, case-based system, it presents a valuable opportunity to explore the challenges of integrating reporting into an existing surveillance structure. While the country is still in a testing phase and does not yet offer the same level of system integration seen in countries like Mali or Rwanda, it offers practical lessons for others navigating similar transitions.

The landscape analysis examined the use of DHIS2, Epi Info, and SORMAS, along with system functionality, governance, data quality, and integration. A country-level deep dive was conducted between April 14 and May 31, 2025. Data collection involved two focus group discussions (four participants from the national level and five participants from the regional level), along with 16 key informant interviews with stakeholders from national programs, district health offices, and health facilities. These activities were carried out in five districts using semi-structured guides to gather qualitative insights on governance, technical functionality, training, data practices, and infrastructure. The team carried out fieldwork following a structured schedule and SOPs to support coordination and data quality.

Maturity assessment

Table 4. Maturity scores for Uganda across key domains for VPD Surveillance Systems

Theme	Subdomain	Maturity Score 0 = Foundational 1 = Developing 2 = Established
Governance and Strategic Alignment	Existence of a formal governing body	2
	Existence of a Digital Health Strategy	2
	Sustainable funding	2
	Equity infrastructure	1
	Equity policies (rural/urban)	2
	Submission to WHO AFRO regional system	2
Workforce/Technical Capacity	Dedicated VPD surveillance officer	2
	Admin/monitoring team in place	2
	Availability of monitoring tools/SOPs	2
	Software maintenance team in place	2
	Integration/interoperability tech capacity	0
End-User Readiness	End-user satisfaction	2
	End-user training	2
Infrastructure Readiness	Availability of computers	0
	Mobile devices and mobile data access	0
	Stable power/internet infrastructure	1
	Capacity to maintain infrastructure	1
	Infrastructure disparities	1
System Lifecycle and Localization	Length of time system has been in use	2
	Multilingual software maturity	2
	VPD surveillance system transition	Missing/ No Data Available
Interoperability	Integration with WHO AFRO system	2
	Integration with national HIS	2
	Interoperability standards use (FHIR, ADX)	2
	Existence of national interoperability framework	1
Data Standards and Data Quality	Metadata dictionary	2
	Org units structure	2
	Compliance with WHO AFRO standardized indicators	2
	Data quality governance	2
	Data entry/management training	2
Data Use and Reporting	Data reporting needs	2
	Data sharing practices	2
	Timeliness and quality of CBS data	0
	Timeliness and quality of aggregate data	0
	Case-based data security compliance	2

Deep dive analysis

Uganda scored at a “Developing” or “Established” level in the majority of categories, reflecting a system that is functional but still faces challenges in consistency, integration, and scale. Key domains such as system governance, data quality, and interoperability showed moderate progress, while infrastructure, technical capacity, and performance monitoring received lower scores, highlighting persistent gaps in resources and operational support. These findings align with qualitative insights from field visits and interviews, which identified variability in system use, infrastructure limitations, and unmet training needs.

VPD surveillance in Uganda is supported by a combination of digital and paper-based

systems. The primary platform in use is the eIDSR, built on DHIS2 architecture, which enables reporting of both aggregate and case-based data. The 6767 SMS platform supplements this system by allowing health workers and community members to send alerts using a short code. Additional tools such as ODK and mTrac are used for data collection, often alongside paper-based reporting at facility and district levels. This parallel structure reflects infrastructure challenges and system-specific mandates that require blended approaches to surveillance.

The deep dive assessment revealed a mix of satisfaction and concern among stakeholders engaged in system oversight, data entry, and administration. Respondents pointed to key strengths, including the software's multilingual interface, user-friendly documentation, and customizable reporting tools, which supported engagement across diverse regions. Confidence in the technical support team and the availability of training opportunities were also frequently cited as positives.

At the same time, persistent technical and operational challenges were raised. Data quality, particularly in terms of completeness and accuracy, was a recurring concern. Infrastructure limitations such as unreliable electricity, poor internet connectivity, and hardware shortages, especially in rural areas, were reported as major barriers. Additionally, the absence of system performance monitoring and regular security audits raised questions about long-term sustainability and reliability.

To address these issues, stakeholders called for increased investment in training, infrastructure, and logistical support. Strengthening specimen transport systems, institutionalizing regular data review, and expanding technical capacity were identified as key priorities. Enhanced use of reporting customization and geographic data disaggregation was seen as a way to improve local-level decision-making.

Overall, while challenges remain, several adaptable system features—such as multilingual functionality, accessible guidance materials, and flexible reporting—offer promising models for other settings.

Leadership and governance

Uganda has established formal governance structures to oversee digital health initiatives, including VPD surveillance. Respondents noted the role of designated MOH departments overseeing surveillance systems and facilitating coordination across programs. The Division of Health Information manages the eIDSR platform, while the Expanded Program on Immunization (UNEPI) and other disease control units coordinate surveillance priorities and data use.

At the national level, leadership was reported to be supportive of digital transformation, though respondents noted that decision-making processes were often influenced by partner involvement and funding availability. Highlighting the importance of partner alignment in the prioritization and rollout of surveillance tools, one participant shared,

District health teams demonstrated a sense of ownership and initiative in system oversight, often stepping in to troubleshoot issues at the facility level without waiting for formal MOH intervention. This local engagement reflects a decentralized approach to governance that can strengthen responsiveness.

However, gaps remain in formal coordination mechanisms and regular review processes. While some technical working groups exist, their functionality and frequency of engagement vary. A few respondents noted the need for clearer communication channels and routine

governance meetings to align priorities and address bottlenecks.

Capacity

Capacity limitations emerged as a key barrier to the effective implementation and maintenance of VPD surveillance systems in Uganda. Respondents across levels consistently described the need for additional technical expertise, especially related to system administration, data analysis, and ongoing software support. While many users had received general training on the surveillance tools, there were concerns about the depth and frequency of these trainings, with several indicating that refresher sessions and more advanced content were needed to build proficiency.

The availability of staff with the skills required to maintain and troubleshoot digital platforms was uneven across regions. Although there is a national technical team responsible for software support, respondents highlighted the absence of formal SLAs with external vendors or partners to ensure consistent software updates, maintenance, and system uptime. Several participants mentioned that when problems arose, they relied on informal communication channels rather than clear escalation procedures.

At the district and facility levels, technical staffing shortages were more pronounced. Many facilities lacked a dedicated information officer or system administrator, placing additional strain on clinical staff who were expected to manage data entry alongside clinical duties. This often led to delays in reporting or reduced data quality. Respondents also described logistical barriers that further constrained capacity, such as inadequate internet connectivity or power outages that made it difficult to access or submit data through the eIDSR platform.

Despite these challenges, there were examples of proactive local leadership. Some district teams had taken it upon themselves to create informal training sessions or mentorship arrangements to build internal capacity. These efforts were seen as helpful but insufficient in addressing the broader systemic needs.

Data quality processes and standardization

Data quality challenges were among the most frequently cited concerns across interviews and focus group discussions. Respondents consistently noted issues with the accuracy, completeness, and timeliness of both case-based and aggregate data. While some validation rules are embedded within the digital tools, such as eIDSR, they were not always applied uniformly or enforced through regular review processes.

Delays in data submission were common, particularly at the facility level, where internet access or device malfunctions created bottlenecks. In many cases, respondents described a reliance on paper-based records that were later digitized, introducing opportunities for transcription errors and lag times. Facilities operating in low connectivity environments also reported that data uploads were deferred for days or even weeks, undermining real-time decision making.

The structure of metadata and organization unit hierarchies also posed limitations. Some respondents noted inconsistencies in how facilities were listed or categorized in the reporting system, making it difficult to align data sources or conduct granular analysis. These discrepancies affected both the interpretation of results and the generation of location-specific reports.

SOPs for data entry and validation were described as available in theory but not always practiced. A few districts had developed internal processes for periodic data review and feedback, but these were not implemented consistently across the country. Additionally,

there was limited documentation of data flow processes or definitions, which complicated onboarding and training for new users.

While some districts demonstrated promising local practices to strengthen data reliability, the assessment highlighted the need for more structured and system-wide approaches to data validation, clearer metadata standards, and consistent review mechanisms to improve the overall integrity of surveillance data.

Data management and use

The use of VPD surveillance data for public health decision-making in Uganda varies across administrative levels. While some national-level stakeholders described using surveillance data for outbreak monitoring, routine reporting, and immunization program planning, this level of data use was less evident at regional and district levels. Several respondents noted that although data are collected regularly, they are not always analyzed or discussed in a timely manner to inform local responses.

A few facilities and districts had internal feedback mechanisms to review and act on data, including periodic meetings and WhatsApp groups for information sharing. However, these practices were not standardized, and many respondents expressed frustration that data submitted upward often did not result in visible feedback or action.

Barriers to effective data use included limited access to functional dashboards or analytical tools, as well as gaps in training around data interpretation. While the eIDSR platform is capable of generating reports and visualizations, many users lacked confidence in navigating these functions. Others noted that when electricity or internet access failed, it was difficult to retrieve reports or conduct timely analysis.

In some instances, respondents mentioned that local adaptations, such as customized Excel tools or handwritten summaries, were used to fill gaps in digital data access. These workarounds supported basic trend monitoring or outbreak detection, but their effectiveness depended on individual initiative rather than a systematized process.

Efforts to promote more active data use were observed in some pilot programs or districts with stronger technical support. Still, participants emphasized the need for greater emphasis on building a data use culture, improving access to user-friendly dashboards, and ensuring that surveillance outputs are fed back into the system for action at all levels.

System transition

Uganda is currently in the process of transitioning from a mixed system of paper-based and Epi Info-based reporting to a more integrated digital surveillance system anchored by the DHIS2-based eIDSR platform. This transition is still underway and, in many areas, remains in a testing or partial implementation phase. Respondents highlighted that the shift has not been uniform across districts, with some regions continuing to rely heavily on manual data collection while others experiment with digital tools.

One of the most cited challenges was managing parallel reporting structures. Health workers in several districts described needing to complete both paper forms and digital entries, which increased their workload and created confusion about reporting requirements. Respondents also emphasized the need for clearer guidance and communication from the national level during the rollout process. Stakeholder engagement was described as limited during the initial phases of the transition. While some orientation was provided, there was little follow-up training or technical support to manage the shift, particularly in lower-resourced areas.

Despite these issues, there were early signs of adaptation, particularly where local

champions had taken initiative to support the use of new tools. The ability to use platforms like 6767 for community alerts and integration of mobile-based reporting through tools like ODK were noted as promising directions, even if implementation varied.

Interoperability

Interoperability remains a significant challenge in Uganda's VPD surveillance landscape. While the eIDSR system is built on the DHIS2 platform and designed to support integration across programs, respondents noted that full interoperability with other digital health systems, such as immunization registries and laboratory information platforms, is limited. At both national and district levels, users described challenges in exchanging data across platforms. For instance, laboratory results may arrive via separate channels and are not automatically linked to case-based surveillance records, requiring manual reconciliation. Parallel systems like mTrac, ODK, and 6767 are also used to collect specific datasets, but coordination among them is weak. Respondents reported instances where the same data had to be entered into multiple systems depending on the reporting requirement, which increased workload and introduced risks of inconsistency.

Policy-level alignment on data standards and interoperability frameworks was described as still developing. While efforts have been made to harmonize tools under broader digital health strategies, implementation varies, and interoperability is more aspirational than operational in many settings. The absence of shared identifiers and consistent metadata structures further complicates integration.

Despite these constraints, stakeholders expressed interest in improving interoperability and saw value in consolidating tools and reducing duplication. However, they emphasized that technical integration would only be effective with concurrent investment in policy alignment, training, and infrastructure to support coordinated implementation.

Infrastructure and equitable access

Infrastructure gaps were cited as a persistent barrier to the effective use of VPD surveillance systems in Uganda, particularly in rural and hard-to-reach areas. Respondents across all levels reported challenges with unreliable electricity, limited internet connectivity, and inadequate hardware, such as computers or tablets needed for digital data entry. These constraints contributed to delays in reporting, incomplete data submissions, and continued reliance on paper-based forms. In several districts, health workers reported having to travel to areas with better connectivity or wait for electricity to return before they could upload data.

Access to devices was another limiting factor. Some facilities shared a single computer among several programs, and in cases where hardware was available, maintenance or replacements were not guaranteed. Additionally, when digital systems failed, backup mechanisms were often informal or absent, leading to gaps in surveillance coverage. These challenges also had equity implications. Facilities in more remote or under-resourced regions faced greater difficulties in maintaining consistent reporting, while urban and better-equipped areas were able to engage more fully with digital platforms. This uneven access to infrastructure created disparities in data visibility and system functionality across the country.

Respondents underscored the need for targeted infrastructure investments to ensure equitable access to surveillance tools. Recommendations included expanding device availability, improving internet and power reliability, and offering mobile solutions or offline functionality to better support health workers in lower-resourced settings.

Lessons learned

✓ *Use of SMS based alerting systems to enhance community level reporting*

The integration of the 6767 SMS platform into the eIDSR system has allowed health workers and community members to report alerts directly from the field, even in areas with limited internet access. This has helped streamline initial notification of suspected VPD cases and improve timeliness of response.

✓ *Flexibility in using multiple data collection tools*

Uganda has adopted a multi-tool approach using eIDSR, ODK, mTrac and even paper forms where necessary. This flexibility has ensured continuity of reporting and has allowed facilities to maintain surveillance operations even if digital tools are not fully operational. According to one health official, *"We can shift between tools when there are issues with the system, which helps us to avoid data loss."*

✓ *Local level adaptation and problem solving*

Respondents noted that district teams often coordinate directly with the health facilities to troubleshoot data reporting and ensure data is submitted. These informal support mechanisms, while not standardized, demonstrate strong local ownership and capacity. "*When we face challenges, the district team comes to us directly. They do not wait for a formal report,"* one participant noted.

✓ *Availability of multilingual features and clear documentation*

The VPD surveillance systems in Uganda support multiple languages and are accompanied by user-friendly documentation, this has contributed to more inclusive participation and more consistent data entry across districts. *"Even our new staff can use the system easily because the instructions are clear," explained* one respondent.

Conclusion and recommendations

Uganda's efforts to digitize VPD surveillance reflect a system in transition, functional in key areas yet still facing substantial infrastructure, capacity, and interoperability barriers. The use of multiple platforms, including the DHIS2-based eIDSR system and complementary tools like 6767, mTrac, and ODK, demonstrates adaptability but also reveals the challenges of coordinating parallel systems and ensuring data consistency. Maturity model scores and deep dive findings confirm moderate progress in areas such as governance and data standards, but also underscore persistent gaps in infrastructure, performance monitoring, and equitable access to digital tools.

Strengthening governance remains a key priority, particularly through improved coordination and clearer alignment among partners at both central and district levels. Respondents noted the presence of formal governance structures, but emphasized the need for more consistent resource distribution and decision-making authority across levels to ensure system responsiveness and sustainability.

Capacity constraints continue to limit system performance. While Uganda has made progress in developing digital infrastructure and engaging district-level teams, gaps in training frequency, technical staffing, and structured support systems persist. Investments in ongoing workforce development—especially in software administration, system troubleshooting, and data analytics—will be critical for building long-term resilience.

Improving data quality also emerged as a priority. Standardizing reporting practices, reinforcing validation protocols, and fostering a stronger culture of data use through regular

feedback loops can enhance the utility of surveillance data in local decision-making. Infrastructure improvements in underserved regions, particularly around electricity and internet access, will further support equitable system performance.

Uganda's experience offers practical insights for countries navigating similar transitions. Its early adoption of SMS-based alert systems, strong district-level engagement, and flexible use of digital tools provide adaptable models for other settings. With sustained investment and coordinated leadership, Uganda is well positioned to strengthen its VPD surveillance system and contribute meaningfully to broader regional goals for digital disease surveillance.

Zambia

Background

Zambia was not initially selected for the deep dive phase based on early desk review findings, but the decision was revisited due to the country's promising digital infrastructure, reported use of multiple surveillance platforms, and its strategic importance in representing mid-maturity contexts across WHO AFRO.

Zambia provides a valuable lens into how case-based and aggregated surveillance approaches can be integrated within dual systems (digital and paper-based), especially in settings where infrastructure varies significantly between urban and rural areas. Additionally, Zambia's commitment to digital health strategies and the use of tools like DHIS2 positions it as a practical case for understanding both the opportunities and persistent barriers in scaling VPD surveillance platforms at national and subnational levels.

Zambia's participation in both assessment phases supports cross-country learning, particularly for countries transitioning from paper-based systems toward more integrated digital platforms. Insights from Zambia offer practical lessons on adapting digital tools in resource-constrained and infrastructure-variable environments. The in-depth country assessment was conducted between April 22 and May 30, 2025. Qualitative data collection included three FGDs: one at the national level with eight participants, and two at the regional level with a total of seven participants. Additionally, eight KIIs were conducted with stakeholders across health system levels. The team carried out fieldwork in four districts across two provinces—Copperbelt Province (2 districts) and Northwestern Province (2 districts).

Zambia's experience highlights important considerations around digital system duality, the need for robust end-user support, and strategies for improving infrastructure and data quality in decentralized health systems.

Maturity assessment

Table 5. Maturity scores for Zambia across key domains for VPD Surveillance Systems

Theme	Subdomain	Maturity Score 0 = Foundational 1 = Developing 2 = Established
Governance and Strategic Alignment	Existence of a formal governing body	2
	Existence of a Digital Health Strategy	2
	Sustainable funding	2
	Equity infrastructure	2
	Equity policies (rural/urban)	2
	Submission to WHO AFRO regional system	2
Workforce/Technical Capacity	Dedicated VPD surveillance officer	2
	Admin/monitoring team in place	2
	Availability of monitoring tools/SOPs	2
	Software maintenance team in place	Missing/ No Data Available
	Integration/interoperability tech capacity	0
End-User Readiness	End-user satisfaction	2
	End-user training	1
Infrastructure Readiness	Availability of computers	0
	Mobile devices and mobile data access	1
	Stable power/internet infrastructure	1
	Capacity to maintain infrastructure	1
	Infrastructure disparities	2
System Lifecycle and Localization	Length of time system has been in use	2
	Multilingual software maturity	2
	VPD surveillance system transition	0
Interoperability	Integration with WHO AFRO system	0
	Integration with national HIS	1
	Interoperability standards use (FHIR, ADX)	0
	Existence of national interoperability framework	0
Data Standards and Data Quality	Metadata dictionary	2
	Org units structure	2
	Compliance with WHO AFRO standardized indicators	2
	Data quality governance	1
	Data entry/management training	0
Data Use and Reporting	Data reporting needs	2
	Data sharing practices	1
	Timeliness and quality of CBS data	0
	Timeliness and quality of aggregate data	2
	Case-based data security compliance	2

Deep dive summary analysis

The Zambia deep dive assessment surfaced a combination of promising practices and persistent challenges in the country's VPD surveillance system. The findings reveal a system in active transition, demonstrating important innovations in data collection and reporting, yet still constrained by infrastructure gaps and data quality concerns.

One of the strengths identified during the assessment was Zambia's widespread adoption of digital tools. Platforms such as DHIS2 and IDSR were reported as commonly used across health system levels, with mobile data entry supporting improvements in data timeliness and

quality. In some urban and high-volume facilities, the presence of backup power systems was noted as a critical enabler for sustaining reporting processes. Additionally, structured communication channels, particularly between MoH teams, IT units, and district-level epidemiology staff, were highlighted as good practices that improve coordination and support timely problem resolution.

At the same time, respondents identified several critical barriers that hinder the full realization of a robust, responsive surveillance system. Infrastructure limitations, including poor network connectivity, especially in rural areas, and inconsistent access to digital tools, were consistently mentioned. Many stakeholders reported ongoing reliance on paper-based reporting, which contributes to delayed transmission of surveillance data and limits real-time response capacity. Data quality was another prominent concern, with gaps in validation processes and irregular use of surveillance data for planning and decision making.

Several desired improvements were noted by participants. Chief among them was the need for strengthened data quality controls, including standardized procedures for data validation, cleaning, and quality assurance. Respondents also emphasized the importance of clearly defined SOPs for system backup, restoration, and disaster recovery. Suggestions for improved end-user support included the creation of a centralized help desk or feedback mechanism, alongside increased visibility and support from system administrators. Finally, gaps in training and staffing, particularly for system monitoring and maintenance, were flagged as areas requiring attention to ensure sustainability.

Overall satisfaction with Zambia's VPD surveillance system was mixed. While many respondents expressed confidence in the system's direction and acknowledged the benefits of digital reporting tools, others voiced concerns over persistent challenges. Taken together, these findings reflect the dual reality of progress and constraint, underscoring Zambia's position as a valuable case for understanding how to adapt and scale integrated surveillance models in diverse and resource-constrained settings.

Leadership and governance

The deep dive assessment in Zambia revealed a governance structure that includes both national and subnational oversight, with some degree of coordination among MoH entities and external stakeholders. However, the findings suggest that the governance landscape is still evolving, with important gaps in documentation, clarity of roles, and decision-making processes. Respondents confirmed the existence of a governing body responsible for VPD surveillance, with regular monthly meetings. The Epidemiology and Disease Control Division and the Zambia National Public Health Institute (ZNPHI) were identified as key actors overseeing disease surveillance, outbreak investigation, and public health emergency coordination. Support from external stakeholders such as WHO, CDC, Gavi, and other implementing partners was also acknowledged, pointing to a collaborative governance ecosystem. However, the degree to which these partners are involved in decision-making versus implementation support was not always clearly defined.

Despite the presence of governance structures, the availability of formal governance documentation remains inconsistent. Respondents provided mixed feedback on the existence of TORs and SOPs for the governing bodies. Some stakeholders indicated that such documents existed, while others either had not seen them or were unsure of their availability. This lack of universally acknowledged documentation may limit the ability to enforce standardized roles, responsibilities, and escalation pathways, especially across different administrative levels.

While Zambia has a national digital health strategy (2020–2024), the assessment found limited awareness or use of this strategy among VPD surveillance stakeholders. This disconnect suggests that digital health priorities may not be fully embedded within the governance frameworks guiding VPD system implementation. Strengthening the integration between disease surveillance and broader digital health strategies could help reinforce national priorities and align stakeholder efforts.

Finally, while collaboration with external partners is generally viewed as a strength, the absence of clear governance mechanisms for managing these partnerships could result in fragmented support or parallel systems. Stakeholders emphasized the need for stronger coordination mechanisms to ensure that technical assistance aligns with national goals and builds sustainable internal capacity.

Capacity

Capacity at both the MOH administrative level and among technical teams responsible for software maintenance emerged as a critical determinant of Zambia's ability to sustain and strengthen its VPD surveillance system. The deep dive findings reveal a system where capacity is uneven. While some structures are in place to support data management and system operations, there are persistent gaps in staffing, training, and technical expertise that affect overall performance.

At the administrative level, the MOH technical team reported the presence of personnel responsible for system administration and monitoring. However, respondents overwhelmingly indicated that the number of personnel is inadequate. Nine out of ten participants explicitly reported "0" or "no" when asked about the adequacy of staffing for these roles. This signals a substantial bottleneck in ensuring consistent system oversight, troubleshooting, and strategic planning for system improvements.

When exploring the availability of SOPs and continuity protocols, responses were mixed. A portion of respondents confirmed the existence of system backup, restore, and disaster recovery SOPs, but others reported that such documents were not available or not well understood. This variation suggests that even where procedures exist, awareness and implementation may be inconsistent across teams or locations.

In terms of training, the findings show moderate but incomplete coverage. While some team members were reported to have received system administration training, others had not. For example, four respondents noted that training had occurred, while three said it had not, reflecting variability in training access or delivery. A similar split was observed in assessments of training effectiveness and the identification of training needs, with many stakeholders recognizing the importance of capacity building but highlighting that it is not yet systematic.

The situation was also precarious among software maintenance teams. Although some respondents reported satisfaction with the technical team's ability to maintain software, describing them as mostly effective, there was also a notable lack of formal agreements with external entities to support software maintenance. In fact, most respondents either reported that no such agreement existed or said they were unsure. This absence of external support structures, coupled with limited internal capacity, may put the system at risk during critical updates or in the event of software failure.

Finally, a key concern raised was the lack of dedicated software maintenance personnel within the MOH. Several respondents stated that no such personnel were present, and where they were, their roles were not well defined or adequately supported. This gap

reinforces the need for investment in long-term, in-house technical capacity that is not overly dependent on short-term project funding or external consultants.

Data quality processes and data standardization

Ensuring high-quality data is essential for effective surveillance, timely decision making, and regional reporting. The deep dive assessment in Zambia provided valuable insights into how data quality is maintained in practice, revealing both strong areas of routine monitoring and persistent weaknesses in consistency, completeness, and standardization across different system levels.

Routine data quality checks are a part of Zambia's VPD surveillance operations. Respondents widely confirmed that data discrepancies are regularly monitored and addressed, particularly through monthly data reviews at district and health facility levels. These reviews often involve district health management teams and the epidemiology unit, with support from data quality audits, on-the-job training, and refresher trainings. This reflects a proactive approach to identifying and correcting issues before they significantly impact reporting or public health action.

However, when examining data completeness and comparability, especially between urban and rural areas, the findings were more concerning. A majority of respondents stated that data quality is not comparable across geographic settings, with rural areas often facing greater challenges. These include delayed reporting due to connectivity issues, lack of trained personnel, and continued reliance on paper-based systems that complicate real time data entry and validation.

Standardization efforts have been partially implemented. Most respondents agreed that WHO AFRO standardized indicators are used in Zambia's VPD surveillance system, and that there is a metadata dictionary in place to support consistent variable definitions. Additionally, respondents noted that facility organization hierarchies, referred to as organizational units or org units, are generally accurate and up to date. These components are foundational for maintaining uniformity in how data is categorized and reported across different levels of the health system.

Despite these structures, data validation and cleaning processes are inconsistently applied, particularly when data is transferred between paper-based and digital formats. Errors in data entry, inadequate checks at the point of capture, and inconsistencies between facility and district-level reports were frequently cited. Moreover, while most participants confirmed the existence of a data quality assurance framework, there was limited information on how regularly it is used or enforced, especially at lower levels of the system.

The use of external support for data quality audits was another important finding. Organizations such as WHO, CDC, Gavi, and UNICEF were all identified as key partners providing audit support. While this external engagement is a valuable asset, it may also reflect a reliance on donor-driven oversight mechanisms, which may not be fully institutionalized within the national system.

Data management and use

Data collection is relatively well established, but there are ongoing challenges with translating this data into actionable insights. The use of data for public health decision making varies across levels of the health system and is heavily influenced by access to infrastructure, training, and coordination mechanisms.

Respondents consistently reported that VPD surveillance data is collected and shared

across national and subnational levels, with tools such as dashboards, routine reports, and technical working group meetings serving as the primary channels for dissemination. National level teams, ministries, and international partners including WHO, CDC, and UNICEF were frequently cited as recipients of surveillance data. These platforms allow for the flow of information from facilities to the national level, supporting reporting requirements and planning activities.

The assessment found that data is being used for key public health actions, including outbreak investigation and response, resource allocation, and immunization campaign planning. Some respondents described how data had been used to target low coverage areas or adjust resource distribution during outbreaks. In particular, 2024 measles case data was highlighted as instrumental in guiding national planning decisions. These examples reflect the system's potential to inform real-time and strategic public health interventions.

However, the use of data is inconsistent across regions and facility levels. Many respondents noted that only a small proportion of users at the facility level actively engage with the surveillance data they report. Barriers to data use include limited access to digital devices, intermittent connectivity, and a lack of training in data analysis or interpretation. In some cases, staff were unaware of how the data they submitted was being used at higher levels, which may reduce motivation for timely and complete reporting.

Additional constraints relate to real-time data access and system responsiveness. Although systems like DHIS2 and IDSR enable digital data entry and aggregation, delays in uploading or syncing data were commonly reported. This hinders timely responses to emerging threats and weakens the system's early warning potential. Moreover, feedback loops between national and subnational levels are not always systematic, which limits opportunities for learning and performance improvement.

The presence of data sharing agreements and written procedures for data management was confirmed by most respondents, but knowledge of these procedures was not universal. This suggests that while formal systems exist, their implementation and awareness remain incomplete. Furthermore, the absence of clear guidance on how to interpret and act on data may prevent end users from fully engaging with the information they produce.

System transition

The transition from legacy surveillance platforms such as Epi Info or SORMAS to more integrated digital systems like DHIS2 has been a significant undertaking for many countries. In Zambia, this process is ongoing and reflects both progress and persistent challenges. The deep dive assessment revealed that while DHIS2 is now the dominant platform for VPD surveillance, the transition has not been uniform across regions, and the coexistence of digital and paper-based systems has created some complexity in reporting workflows.

Among the respondents, the majority identified DHIS2 as the primary system currently used for VPD surveillance. Specifically, 15 out of 18 participants mentioned DHIS2 as their core digital platform. At the same time, 9 respondents also reported the continued use of paper-based tools alongside digital systems, with many describing a dual entry process. This overlap suggests that while the transition to DHIS2 is well underway, it has not yet been fully institutionalized or harmonized across the country.

Challenges in the transition were commonly reported. Respondents described issues with hardware availability, particularly the lack of official devices provided by government channels. In many cases, health workers were using personal devices for data entry, which raised concerns about sustainability, data security, and system accessibility. Eight out of ten

respondents also noted that insufficient training had made it difficult to adapt to the new system, especially in rural settings where technical support is limited.

Despite these challenges, there were signs of adaptation and resilience. Several respondents emphasized the value of having a digital system that allows for real-time data aggregation and reporting. In urban areas and high-volume facilities, backup power systems and internet connectivity were leveraged to maintain regular reporting through DHIS2. These local innovations reflect the importance of flexibility and infrastructure in supporting digital transitions.

The transition also affected data quality. Participants noted that moving from paper to digital entry introduced both improvements and risks. On one hand, real-time validation rules in DHIS2 helped reduce errors at the point of entry. On the other hand, parallel systems and manual data transfers increased the risk of data duplication and inconsistency. Five respondents highlighted that data discrepancies between paper and digital records were still common and posed a barrier to reliable reporting.

Stakeholder engagement during the transition varied. While some central-level staff were closely involved in planning and rollout, facility-level health workers often felt left out of decision-making processes. This disconnect contributed to uneven uptake and lower system ownership at the frontline. Three respondents specifically mentioned that having greater input from end users would have improved system design and usability.

Interoperability

Interoperability between VPD surveillance systems and other digital health platforms is essential for improving data flow, minimizing duplication, and enabling a more integrated approach to public health decision-making. In Zambia, the deep dive assessment found that while some elements of interoperability exist, there are still significant technical and institutional barriers preventing seamless data exchange between systems.

Most respondents acknowledged that multiple systems are in use across different surveillance functions, including DHIS2, IDSR, and other program specific platforms. When asked about the number of systems in place, all respondents confirmed that they primarily use a single digital platform for VPD surveillance, typically DHIS2. However, further discussion revealed that data is often transferred manually or in parallel with paper-based systems, suggesting that functional interoperability is still limited.

In regard to data sharing across platforms or levels, six respondents described using CSV file imports or manual data transfers to integrate facility-level data into national systems. While this method allows for basic data consolidation, it does not represent real-time, automated interoperability. Instead, it creates additional burdens on staff and increases the risk of errors during data entry or aggregation.

In terms of healthcare worker data and metadata linkage, the situation was mixed. Two respondents confirmed the existence of a national Master Healthcare Worker Register, while others were either unaware or unsure of how health worker data is integrated into surveillance systems. Only one respondent confirmed that health worker data was linked to facility records in the VPD surveillance platform, highlighting a significant gap in interoperability between human resource systems and surveillance databases.

Participants also gave mixed responses on the presence of standardized organizational units and metadata structures that support interoperability. Two respondents stated that facility organization hierarchies and metadata dictionaries were accurate and available.

However, others noted challenges in aligning these structures across systems, particularly when transitioning from legacy systems or when integrating data from newly established facilities.

When asked specifically about the use of WHO AFRO standardized indicators across systems, respondents confirmed their use in VPD surveillance, indicating a degree of harmonization at the indicator level. However, the ability to apply these standards consistently across platforms remains limited due to differences in data collection tools, inconsistent training, and the absence of centralized governance for data integration.

Several respondents raised concerns about the lack of formal interoperability protocols or policies. Without clear guidance or technical frameworks, staff are often left to develop informal workarounds for data sharing. This has led to inconsistent practices, particularly in rural areas where internet connectivity is unreliable and staff capacity is limited.

Infrastructure and equitable access

The deep dive assessment in Zambia revealed persistent infrastructure disparities between urban and rural settings that affect system performance, data quality, and equitable access to digital tools for VPD surveillance. Limited or unreliable internet connectivity was the most commonly cited challenge. Of the 10 participants who discussed infrastructure, 8 identified poor connectivity as a constraint, especially in rural areas. These network issues contributed to delays in reporting, failed data syncs, and in some cases, forced reliance on paper-based reporting. Power availability was also uneven. Urban and higher volume facilities were more likely to have backup systems such as generators or inverters to maintain regular data entry, while rural facilities frequently experienced outages, resulting in delayed submissions and prolonged gaps in data availability.

Device availability was another barrier. Several respondents reported that health workers in some districts were using personal smartphones or laptops for data entry because government issued hardware was not provided. Five out of eight participants noted the lack of official devices as a consistent challenge. This reliance on personal equipment raises concerns about data security, user burden, and standardization of system use. These infrastructure constraints also limited participation in training and access to technical support. In areas with poor connectivity and few devices, end users were unable to join virtual trainings or reach help desk resources. Four respondents noted that training sessions had been launched but could not be effectively implemented in poorly resourced regions.

The combined effects of poor connectivity, power instability, and device shortages significantly impacted data timeliness and completeness. In many cases, rural health workers accumulated paper forms and traveled to central facilities with working internet to upload data into DHIS2, introducing delays of several days and inconsistencies in national reporting. Some urban and better resourced areas developed interim solutions, such as creating data entry hubs with stable power and network access where nearby facilities could submit data for digital entry. While effective in the short term, these hubs are not yet scaled or standardized across the country.

Lessons learned

- ✓ *Routine data quality review mechanisms strengthen system integrity*

Zambia has established monthly data review meetings at district and facility levels, often involving district health teams and epidemiology units. These regular reviews are paired with on-the-job and refresher trainings, creating a structured process for identifying and

correcting data issues in real time. This embedded approach to quality assurance offers a replicable model for countries seeking to institutionalize routine data validation.

- ✓ *Data entry hubs offer an innovative workaround to infrastructure gaps*

To overcome connectivity and power challenges in rural areas, some districts created centralized data entry hubs where facilities submit paper forms to be digitized at a location with stable infrastructure. This practical and locally led solution enhances data completeness and timeliness and can be adapted by other countries facing similar rural infrastructure limitations. According one respondent, *"There is a bias in equipment distribution - more devices are given to urban areas because of higher populations."*

- ✓ *High uptake of WHO standardized indicators and metadata improves alignment*

Zambia has demonstrated consistent use of WHO AFRO indicators and metadata structures, supporting data harmonization across systems and enabling easie integration with regional and global surveillance frameworks. This alignment strengthens Zambia's capacity for cross country comparison and participation in broader health security reporting.

- ✓ *Effective data use for decision making drives system relevance*

VPD surveillance data is actively used to inform outbreak response, immunization targeting and rescue planning for example, 2024 measles data guided national planning efforts. This shows how embedding data into public health action reinforces the value of surveillance systems and motivates continued investment and reporting across all levels.

- ✓ *Strong coordination between MOH and subnational teams enables system responsiveness*

Zambia's regular communication between national level IT and epidemiology teams and sub national health staff has supported faster issue identification. Clearer system governance and shared ownership. This coordination fosters trust and enables a more responsive and collaborative surveillance mecosystem. One respondent noted: *"In 2024, there were high numbers of measles cases and the [VPD surveillance system data] helped the national level to plan how much was needed, what campaigns to run, and what strategies to implement."*

Conclusion and recommendations

Zambia's VPD surveillance system demonstrates meaningful progress toward digital integration, anchored by strong national leadership, structured data governance, and the adoption of DHIS2 as the primary surveillance platform. The country's alignment with global standards—such as WHO AFRO indicators and metadata structures—and its effective coordination between national and subnational levels have enabled consistent data reporting and fostered a growing culture of data use, particularly for outbreak response and immunization planning.

However, the deep dive assessment revealed several persistent challenges. Infrastructure gaps—such as unreliable internet, power outages, and limited access to digital devices—continue to hinder participation in rural and underserved areas. At the same time, insufficient end-user training and limited support during system transitions have affected data quality and slowed the effective uptake of digital tools. Interoperability across health information systems also remains limited, constraining integrated analysis and decision-making.

To build on current progress, Zambia should prioritize investment in three areas: expanding digital infrastructure in underserved regions, scaling capacity-building efforts for frontline staff, and enhancing interoperability through clear policies and technical solutions.

Leveraging existing governance mechanisms—such as centralized data entry hubs and routine data review processes—will be essential to maintain momentum and drive sustained improvements.

With continued investment and strong coordination, Zambia is well-positioned to develop a more inclusive, resilient, and responsive VPD surveillance system—one that meets national needs while contributing to regional digital health goals.

Maturity Model

Use and limitations

The maturity model provides a framework for identifying strengths and gaps in a country's VPD surveillance system across eight key domains, each with multiple sub-domains.

However, the model simplifies complex realities and may overlook regional variation, country-specific context, and the interplay between paper-based and digital tools. Results should be interpreted along with field insights and stakeholder input.

The maturity model intends to show opportunities for improvements and additional investment or technical assistance and is not intended as a critique of the implementation or system.

Table 5. Maturity Level of VPD Surveillance Systems

Domain /Theme	Sub domain	Indicator Number	Foundational / Not yet established	Developing / In progress	Established / Fully operational
Governance and strategic alignment	Existence of a formal governing body	8	No formal governing body exists to oversee VPD surveillance information system implementation, development, or maintenance.	A formal governance body is planned or being established but is not yet functional.	A formal governance body is fully established and operational, overseeing system implementation, development, and maintenance.
	Existence of a Digital Health Strategy	9	There is no national digital strategy for HMIS.	A draft national digital strategy for HMIS exists but has not yet been approved.	A national digital strategy for HMIS is approved and actively guiding implementation.
	Sustainable funding	10,11,12,65	The VPD surveillance system is funded by a single source, with no long-term financial sustainability plan.	The VPD surveillance system is funded by multiple sources, but funding may be ad hoc or lack a costed workplan.	The VPD surveillance system has a costed workplan and is funded by multiple sources, including dedicated funding for software maintenance.

	Equity policies (rural/urban)	44,45	Significant disparities exist in infrastructure, mobile device access, and/or staffing levels between urban and rural areas, negatively affecting system effectiveness. There are no policies, guidelines, or strategies in place to promote equitable access to VPD surveillance services across rural and urban areas.	Some disparities remain in infrastructure, mobile device access, or staffing between urban and rural areas, which partially affect system performance. Draft or preliminary policies exist that aim to address equity in VPD surveillance access, but they are not yet approved, implemented, or widely applied.	Infrastructure, mobile device access, and staffing levels are equitably distributed across urban and rural areas, with no significant impact on system effectiveness. Approved and implemented policies or strategies are in place to ensure equitable access to VPD surveillance in both rural and urban settings.
	Submission to WHO AFRO regional system	7,57	VPD surveillance data is not available for submission to the WHO AFRO region system.	VPD surveillance is available for submission to the WHO AFRO region system through a manual entry process.	VPD surveillance is available for submission to the WHO AFRO region system automatically through system integration.
Workforce /Technical Capacity	Dedicated VPD surveillance officer	1	There is no designated individual responsible for managing VPD case surveillance at the national level.	Responsibility for managing VPD case surveillance at the national level is shared across multiple individuals or departments, with no clear focal point.	A dedicated individual is formally assigned and actively responsible for managing VPD case surveillance at the national level.
	Admin/monitoring team in place	13,14,17,18	There are no MOH personnel responsible for system administration and monitoring of the VPD Surveillance system, or staffing levels are insufficient. Training needs are likely unmet.	Sufficient MOH personnel are in place for system administration and monitoring, but key technical processes such as backup, restore, disaster recovery, or monitoring tools are not yet implemented or are insufficiently addressed.	There are sufficient, trained MOH personnel responsible for system administration and monitoring. All key technical tools and processes—including backup, restore, disaster recovery, and system monitoring—are fully in place.

				training needs may not be adequately addressed.	
	Availability of monitoring tools/SOPs	15,16	There is no system monitoring tools or processes, and no standard operating procedures (SOPs) for backup and restore processes.	Some system monitoring processes and/or tools are in place, and SOPs for backup and restore exist, but may not yet be tested or routinely followed.	System monitoring tools and processes are fully operational, and backup and restore procedures are in place and tested periodically to ensure readiness.
	Software maintenance team in place	19,20,21	The MOH lacks in-house staff for maintaining the VPD Surveillance System software, and there is no formal service-level agreement (SLA) with a third-party provider for its maintenance	The MOH either has in-house staff responsible for maintaining the VPD Surveillance System software or has a formal service-level agreement (SLA) with a third-party provider for its maintenance. However, high-priority software issues are not always effectively dealt with.	The MOH either has in-house staff responsible for maintaining the VPD Surveillance System software or has a formal service-level agreement (SLA) with a third-party provider for its maintenance. High-priority software issues are effectively dealt with.
	Integration/interoperability tech capacity	59,60,61	No MOH person/team responsible for integrations; MOH team is reliant on external parties to manage or provide support for integrations	MOH team exists with some skills and limited resources but not to a level that can manage all integrations.	MOH team is confident they have the requisite skills and resources to manage all integrations between systems.
End-User Readiness	End-user satisfaction	22	The level of end-user satisfaction with the VPD Surveillance System is currently unknown or is low.	The overall level of end-user satisfaction with the VPD Surveillance System is mostly satisfied.	The overall level of end-user satisfaction with the VPD Surveillance System is very satisfied.

	End-user training	23,24	End users do not receive regular training on the VPD Surveillance Information System	End users receive regular training (when they start using the system or when new system features are introduced)	End users receive regular training (when they start using the system or when new system features are introduced) and training is assessed and improvements made based on the assessment findings.
Infrastructure Readiness	Availability of computers	49	Sites that are capturing or using VPD surveillance data are not sufficiently equipped with computers.	Some sites that are capturing or using VPD surveillance data are equipped with computers.	All or most sites that are capturing or using VPD surveillance data are equipped with computers.
	Mobile devices and mobile data access	51,52	There are not sufficinent mobile devices for use with the VPD surveillance system.	End users must use their own mobile devices and/or have to pay for mobile data in order to use the VPD Surveillance system.	End users are provided with computers or mobile devices with mobile data that enables use of the VPD Surveillance system.
	Stable power/internet infrastructure	53	In the majority of sites, the system infrastructure is not stable enough for the users to be able to submit the VPD data when required.	The majority of sites have stable infrastructure but there are major disparities between urban/rural sites or different regions.	In the majority of sites, the system infrastructure is stable enough for the users to be able to submit the VPD data when required.
	Capacity to maintain infrastructure	54	No, there are no MOH staff to maintain hardware and infrastructure at the majority of sites.	There are MOH staff available but not in sufficient numbers and they may not have access to all the skills training or resources they need to be able to effectively maintain the hardware and infrastructure at sites.	There are sufficient MOH staff with the requisite skills and resources to be able to maintain and provide support for the VPD surveillance system at sites.

	Infrastructure disparities	44	There are major disparities in infrastructure, mobile device usage and/or staffing levels between urban and rural areas that impact system effectiveness.	There are some disparities in infrastructure, mobile device usage and/or staffing levels between urban and rural areas that impact system effectiveness.	There are no disparities in infrastructure, mobile device usage and/or staffing levels between urban and rural areas that impact system effectiveness.
System Lifecycle and Localization	Length of time system has been in use	4	Digital VPD surveillance has been in operational use for less than 1 year.	Digital VPD surveillance has been in operational use for 1 to 3 years.	Digital VPD surveillance has been in operational use for over 3 years.
	Multilingual software maturity	56	VPD surveillance system's user interface (UI) and documentation is not available in your preferred languages.	VPD surveillance system's user interface and some documentation is available in your preferred languages.	VPD surveillance system's user interface and all documentation is available in your preferred languages.
	VPD surveillance system transition	55	The system is not currently in transition.	The VPD surveillance system is currently in the process of transitioning from a paper-based system to a digital system.	The VPD surveillance system has completed the transition or is currently in the process of transitioning from one digital system to another digital system.
Inter- operability	Integration with WHO AFRO system	57	VPD surveillance system is not integrated with the WHO AFRO regional system.		VPD Surveillance system is integrated with the WHO AFRO regional system
	Integration with national HIS	58	VPD surveillance system is not integrated with any other information systems.	VPD surveillance system is integrated with one other information systems.	VPD surveillance system is integrated with two or more information systems.
	Interoperability standards use (FHIR, ADX)	62	VPD surveillance system does not use any data exchange standards.		VPD surveillance system uses HL7 FHIR, ADX or another standard to exchange data with other systems.

	Existence of national interoperability framework	63	No national interoperability framework or guidance currently exists.	Draft framework or guidance exists but is not yet approved or is approved but not yet fully implemented.	National interoperability framework or guidance is fully implemented.
Data Standards and Data Quality	Metadata dictionary	25	Do not know if a metadata dictionary exists for VPD surveillance data OR there is no metadata dictionary.		A metadata dictionary does exist for VPD surveillance data.
	Org units' structure	26	The state of the facility organization hierarchy information is not known.	The facility organization hierarchy information is not up to date.	The facility organization hierarchy information is mostly up to date.
	Compliance with WHO AFRO standardized indicators	27	Use of WHO AFRO surveillance indicators is unknown or None of the WHO AFRO surveillance indicators are included in the VPD surveillance system.	Some of the WHO AFRO VPD surveillance indicators are included in the VPD surveillance system.	All of the WHO AFRO VPD surveillance indicators are included in the VPD surveillance system.
	Data quality governance	29,30	There is no dedicated person responsible for data quality management for VPD surveillance data at the national or sub-national level. No formal data quality assurance (QA) framework exists.	There is a dedicated person responsible for data quality management for VPD surveillance data at the national or sub-national level. No formal data QA framework exists, or it is still being drafted.	There is a dedicated person responsible for data quality management for VPD surveillance data at the national or sub-national level and formal data quality assurance (QA) framework exists and has been implemented.

	Data entry/management training	31,32	Staff responsible for data entry and management do not receive regular training on data quality.	Staff responsible for data entry and management do receive regular training on data quality.	Staff responsible for data entry and management receive regular training and training is assessed and improvements made based on the assessment findings.
Data Use and Reporting	Data reporting needs	33,34	The VPD surveillance system does not produce the reports and dashboards needed by the VPD surveillance program at national level.	The VPD surveillance system does produces some of the reports and dashboards needed by the VPD surveillance program at national level.	The VPD surveillance system produces all the reports and dashboards needed by the VPD surveillance program at national level and this information is demonstrably used in the planning and resource-allocation processes.
	Data sharing practices	35,36	No VPD surveillance data is shared with other ministries or international partners.	Data sharing agreements are under negotiation.	VPD surveillance data is shared with other ministries or international partners in accordance with the data sharing agreements in place.
	Timeliness and quality of CBS data	39	There are known issues with data quality and timeliness of the CBS data.	There are some known issues with data quality and/or timeliness of the CBS data.	There are no major issues with data quality and timeliness of the CBS data.
	Timeliness and quality of aggregate data	41	There are known issues with data quality and timeliness of the aggregate data.	There are some known issues with data quality and/or timeliness of the aggregate.	There are no major issues with data quality and timeliness of the aggregate data.

	Case-based data security compliance	38	VPD surveillance data is not case based.	VPD CBS data is not fully compliant with national regulations and policies for data security and privacy for personal identifiable information (PII).	VPD CBS data is hosted on secure servers that are compliant with national regulations and policies for data security and privacy for personal identifiable information (PII).

Table 6. Example of questions with indicators and scores mapped to domains.

Question	Indicator	Scoring		Sub domain	Domain
Are there data sharing agreements in place with other ministries or other partners/organizations?	35: Presence of data sharing agreements	Yes = 2 No = 0 In Progress = 1	If score = 0 then Not Yet Achieved; If score = 1 then Early Progress; If score = 2 then Satisfactory	Data sharing practices	Data use and reporting
Is VPD surveillance data shared with other ministries or international partners? Data sharing practices	36: Presence of data shared with other entities	Yes = 1 No = 0			

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