Palladium
MAKE IT POSSIBLE

KeHMIS III

PROJECT PERFORMANCE EVALUATION REPORT

Published: June 2026

KeHMIS
Kenya Health Management Information Systems

TABLE OF CONTENTS

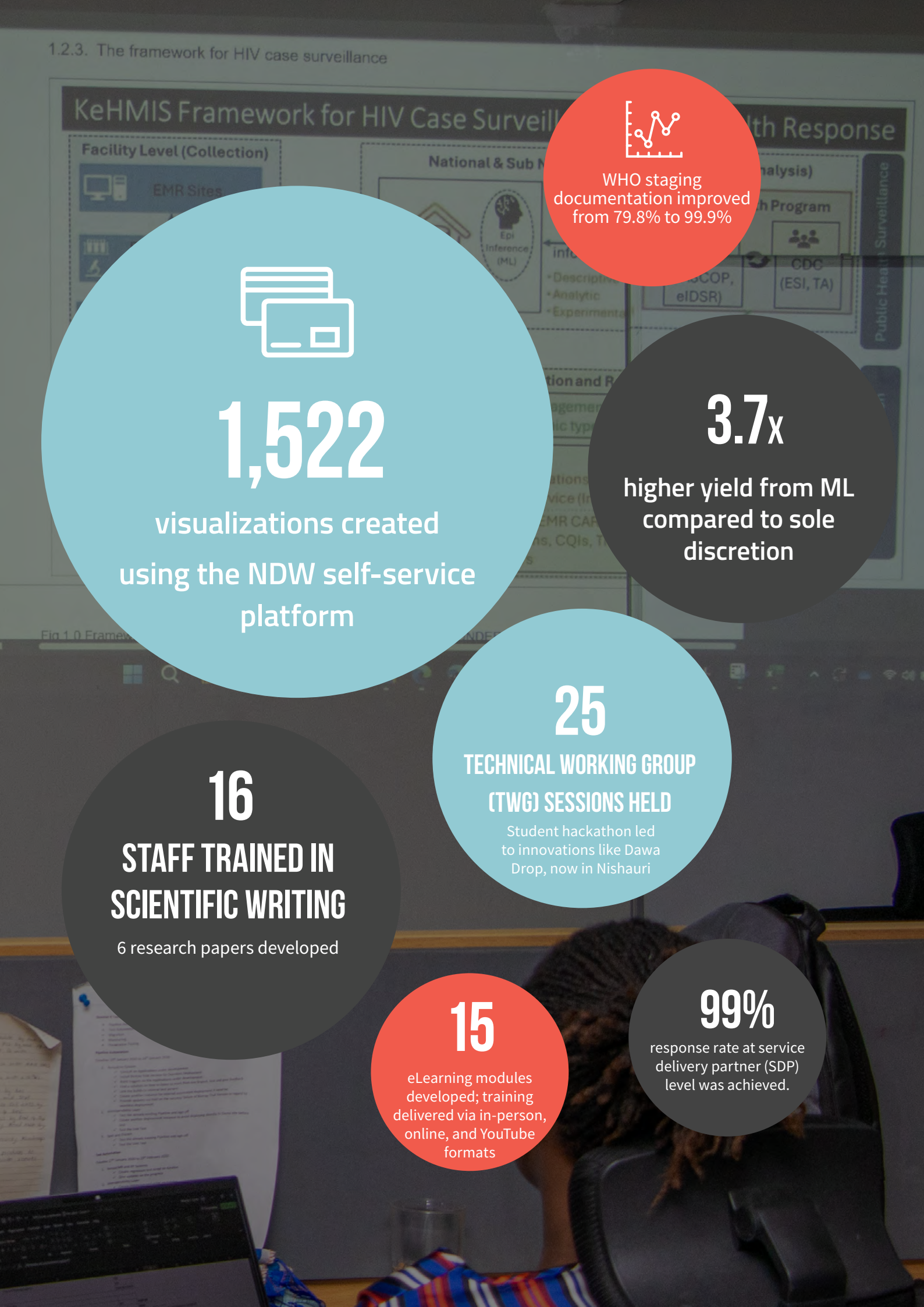
LIST OF TABLES & FIGURES

List of Tables

List of Figures

LIST OF ACRONYMS

KeHMIS	Kenya Health Management Information System
PEPFAR	President's Emergency Plan for AIDS Relief
CDC	Centers for Disease Control and Prevention
MOH	Ministry of Health
HIS	Health Information Systems
EMR	Electronic Medical Records
CHMT	County Health Management Team
SDP	Service Delivery Partners
NDW	National Data warehouse
DWAPI	Data warehouse API
ART	Antiretroviral therapy
ETL	Extract, transform and load
AHD	Advanced HIV Disease
TxCurr	Current on Treatment
COP	Country Operational Plan
NCD	Non-communicable Diseases
CGA	Capacity Gap Assessments
TOT	Training of Trainers
PMTCT	Prevention of Mother to Child Transmission
PrEP	Pre-Exposure Prophylaxis
SMS	Short Message Services
CALHIV	Children and Adolescents living with HIV
ODS	Operational Data Store
JKUAT	Jomo Kenyatta University of Agriculture and Technology



WHO staging documentation improved from 79.8% to 99.9%

1,522

visualizations created using the NDW self-service platform

3.7x

higher yield from ML compared to sole discretion

25

TECHNICAL WORKING GROUP (TWG) SESSIONS HELD

Student hackathon led to innovations like Dawa Drop, now in Nishauri

16

STAFF TRAINED IN SCIENTIFIC WRITING

6 research papers developed

15

eLearning modules developed; training delivered via in-person, online, and YouTube formats

99%

response rate at service delivery partner (SDP) level was achieved.

EXECUTIVE SUMMARY

Introduction

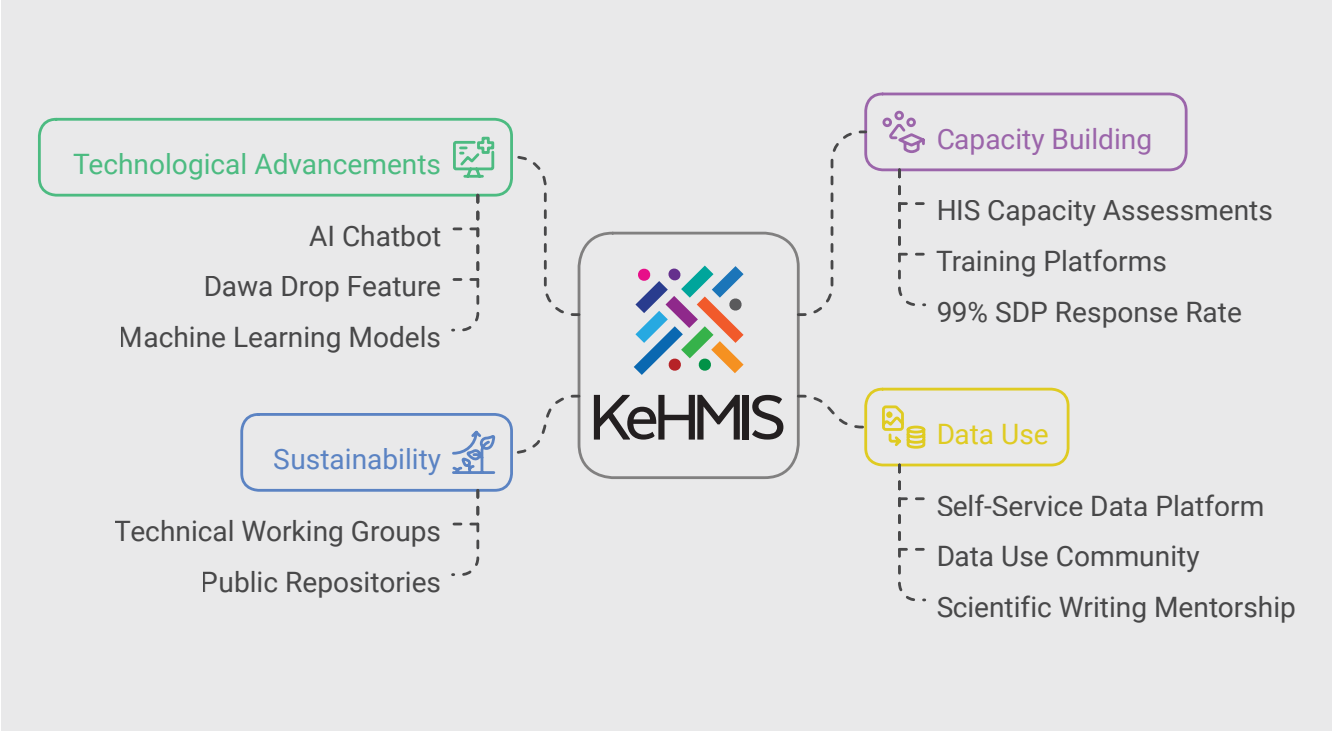
The KeHMIS III project aims to enhance health information systems (HIS) to support Kenya's Ministry of Health (MOH), County Health Management Teams (CHMTs), and Service Delivery Partners (SDPs) in achieving and sustaining HIV epidemic control. This evaluation assesses the progress of KeHMIS III in achieving two key objectives: 1) to evaluate the project's support in developing and maintaining HIS innovations in Kenya, and 2) to assess the impact of technological evolution on quality of care and data utilization for programmatic decision-making in HIV care.

Methods

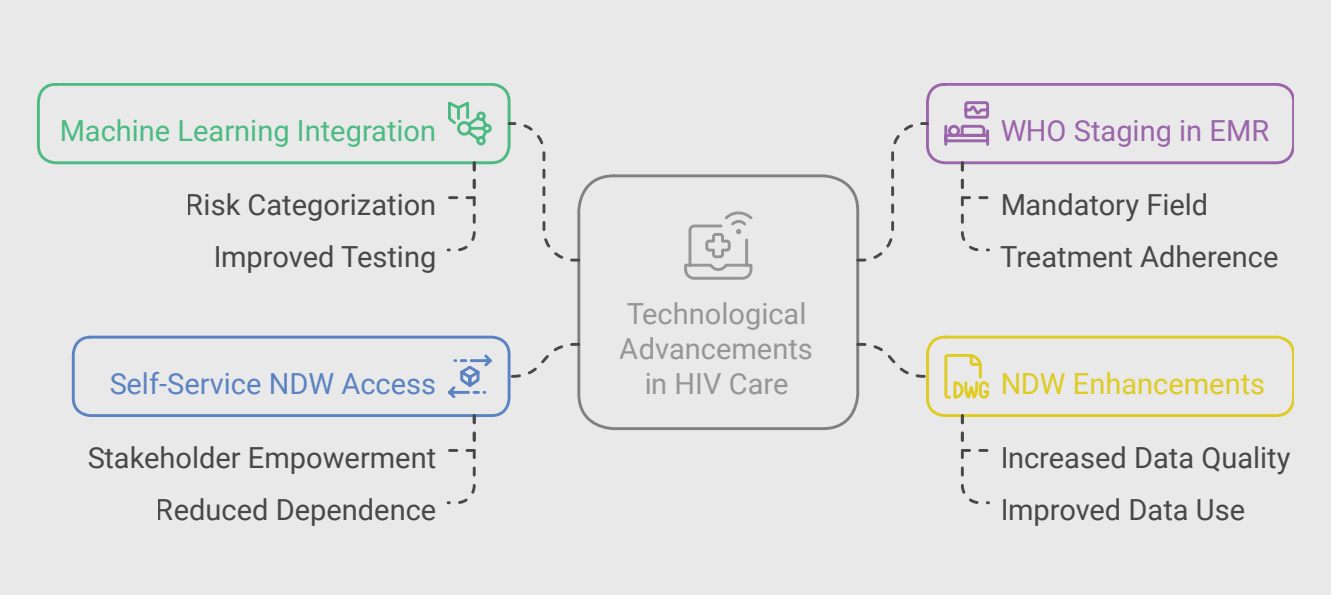
A mixed-methods evaluation design was employed, incorporating both qualitative and quantitative approaches. A comprehensive desk review of project documentation and reports was conducted, along with content and narrative analysis of service desk tickets. Quantitative data was abstracted from the National Data Warehouse (NDW). Data analysis involved both descriptive and comparative techniques to assess project outcomes. Additionally, a theory of change framework was applied to understand the influence of machine learning (ML) algorithms and the self-service functionality of the NDW. Stakeholder engagement was integrated throughout the evaluation process.

Findings

Objective 1: To evaluate the project's support in developing and maintaining HIS innovations in Kenya



Objective 2: To assess the impact of technological evolution on quality of care and data utilization for programmatic decision-making in HIV care



Conclusion

KeHMIS III has successfully advanced the development and application of HIS innovations, supporting the MOH and partners in strengthening health systems for HIV epidemic control. The project's contributions to technological evolution have enhanced data quality, service delivery, and programmatic decision-making, particularly through the integration of machine learning and self-service tools. However, challenges remain in ensuring the long-term sustainability of these innovations and continuing to build capacity at the local level to maximize their utility.

Recommendations

- Continue investing in capacity-building for stakeholders to ensure sustained HIS innovations.
- Expand training on emerging HIS technologies and data use for programmatic decision-making, to further empower local stakeholders.
- Refine ML algorithms and explore their potential applications beyond HIV case finding and treatment interruption to address broader public health challenges.

1. INTRODUCTION

1.1 Project background

The Kenya Health Management Information System (KeHMIS) III project is a President's Emergency Plan for AIDS Relief (PEPFAR) funded cooperative agreement between the Centers for Disease Control and Prevention (CDC) Kenya and Palladium Kenya running from 9/30/2021 – 9/29/2026. Palladium Kenya and its KeHMIS III project partners are mandated to support Kenya's Ministry of Health (MOH) at National and County levels to achieve sustainable implementation of Health Information Systems (HIS) innovations based on MOH standards and guidelines. KeHMIS III project was awarded under CoAg Number GH21-2114 as a follow-on grant to build on the achievements of KeHMIS II Project that was implemented jointly with other partners from October 2016 to September 2021.

The project scope encompasses the development, support and maintenance of HIS products and technologies used by HIV, TB and maternal child health programs (MCH) such as mobile health (mHealth) applications, Electronic Medical Records (EMRs), Health Data Exchange solutions, unique patient identification solutions, and data repositories for health data and business intelligence (BI) tools, and other types of information and communication technology (ICT) tools used at multiple levels of Kenya's health pyramid. The project scope also includes implementation of activities towards strengthening the capacity of HIV stakeholders to adopt & use HIS, drive the demand for data, information use for decision making and creating mechanisms of sustaining HIS beyond PEPFAR support. The project is mandated to rapidly evolve technology/digital health solutions to improve data collection, transmission, and utilization to meet the needs of HIV/TB program in Kenya.

The Evaluation Standards of Practice (ESoP) guidelines call for periodic evaluations of PEPFAR funded projects. These standards play a crucial role in ensuring high-quality evaluations within PEPFAR context. The KeHMIS III project is currently in its 3rd year of implementation. The evaluation aims to determine the extent to which technological evolution activities have contributed to quality of care and use of data to inform programmatic direction. This report details the evaluation findings on the project's progress in technological evolutions and their effect on quality of care and use of data for HIV/TB testing and treatment services to inform HIV/TB programming and planning.

The evaluation focused on the digital health solutions managed by the KenyaHMIS III project for the collection of data from patients seeking HIV/TB testing and treatment services. These solutions include EMR systems, mHealth applications, the national data warehouse (NDW) and data warehouse API (DWAPI) for data transmission. The results from this evaluation will provide an opportunity to make modifications and contribute to better informed decision-making, foster an environment of learning, and promote greater accountability for performance within the lifetime of the project.

1.2 Evaluation objectives

The evaluation was conducted under two broad objectives:

1. To assess the progress of the KeHMIS III project in supporting the MOH, County Health Management Teams (CHMTs), and Service Delivery Partners (SDPs) in developing and maintaining HIS innovations in Kenya.

2. To assess the effect of technological evolution on quality of care and use of data to inform programmatic direction to achieve and sustain HIV epidemic control.

2. METHODOLOGY

2.1 Evaluation design

This evaluation employed a desk review based mixed methods approach. This approach combined elements of both qualitative and quantitative research, leveraging existing data and literature to answer evaluation questions. The evaluation began with a comprehensive literature review of project documentation and technical reports to gather existing information after which a study design incorporating both qualitative and quantitative components was developed. Qualitative methods used included content analysis of information from the reviewed reports and narrative analysis of the contents of the tickets raised from the service desk. Quantitative analysis included analysis of data abstracted from NDW which contains data from KenyaEMR and other EMRs.

The evaluation was considered under the two broad objectives discussed in Tables 1 and 2. Tables 1 and 2 detail the evaluation questions for each evaluation objective including the data sources and indicators tracked for the evaluation.

Objective 1: To assess the progress of supporting the MOH, CHMT, and SDPs in developing and maintaining HIS innovations in Kenya.

Evaluation Question	Data Sources	Indicators
1. To what extent has the project supported technological evolution of eHealth, mHealth and data warehousing systems to meet program and strategic information needs?	Technical Reports	▪ No. of new technologies ▪ Enhancements ▪ Reduction in ETL time ▪ Data transmission rates ▪ Number of bug fixes ▪ Number of Ushauri SMS reminders sent ▪ Creation of a service desk
2. How effective has the project been in strengthening the capacity of county teams and SDPs to scale up and utilize HIS for improved service delivery?	Technical Reports Training Logs	▪ Capacity gap assessment ▪ Number of courses developed and deployed ▪ Number of trainings held ▪ Number of participants trained ▪ Uptake of HIS solutions
3. To what extent has the project strengthened data analysis and use to inform programmatic direction to achieve and sustain HIV epidemic control?	Technical Reports	▪ Number of information products developed ▪ Number of users requesting for and reporting data from NDW ▪ Number of webinars (dissemination) ▪ Formation of Data Use CoP ▪ Utilization of the Self-Service Portal

4. What sustainability structures have been implemented by the project to support MOH for maintaining HIS interventions, and how effective are these structures?	Technical Reports	▪ Development of CoP ▪ Student bootcamps ▪ Capacity building for SDPs (e.g. GIS Training) ▪ Technical Assistance (Service Desk) ▪ Migration of source codes to public repositories ▪ Creation of application catalogues

Table 1: Evaluation questions, data sources and indicators on evaluation objective 1

Objective 2: To assess the effect of technological evolution on quality of care and utilization of data to inform programmatic direction to achieve and sustain HIV epidemic control.

Evaluation Question	Data Sources	Indicators
1. What is the effect of integration of machine learning-powered prediction scores into the EMR had on HIV case finding efforts?	NDW	▪ Positivity ▪ Number of clients linked to preventive services
2. To what extent has the enhancement of EMR to include WHO staging as a compulsory field improved compliance with HIV treatment guidelines?	NDW	▪ Number with a documented WHO stage ▪ Number of clients with an AHD diagnosis
3. How has the enhancement of the NDW through improvements in the Extract, Transform, Load (ETL) process and Data Warehouse API (DWAPI) influenced the quality and utilization of data for informing programmatic direction?	NDW	▪ Number of cumulative visits ▪ Number of clients actively on treatment ▪ TX_CURR concordance
4. How has the enhancement of the NDW with self-service functionality affected stakeholders' access to and utilization of NDW data for decision-making?	NDW	▪ Number and % of stakeholders accessing data sets through the self-service platform against the total number of stakeholders expected to access the data ▪ Number and % of datasets accessed through self-service platform against all the availed datasets ▪ Number of visualizations created by the stakeholders using the NDW data

Table 2: Evaluation questions, data sources and indicators on evaluation objective 2

2.2 Data processing and analysis

This evaluation employed a mixed-methods approach, where both quantitative and qualitative secondary data were collected. Both content and narrative analysis were used to synthesize information gathered from technical documents and summaries of requests from the service desk to identify patterns, themes and relevant information in addition to creating a comprehensive overview of existing information.

Content analysis involved coding of relevant sections of text, grouping of similar codes into themes and identification of existing patterns, contradictions and gaps. The process of narrative analysis involved identification of relevant documents and data sources, data extraction, data grouping and comparison and development of a narrative that synthesized the main findings, highlighting similarities, differences, and gaps.

For quantitative data, the evaluation used descriptive and comparative analysis to quantify certain indicators and measure the effects of different interventions. In addition, for objective two, theory of change was also used to describe the outputs of the ML algorithm implementation and measurement of the effect of the enhancement of the NDW with the self-service functionality to stakeholders. All the information gathered was synthesized and triangulated to generate the findings discussed in section 3. Charts and tables were used for data visualization.

2.3 Stakeholder engagement

Internal / External	Stakeholder	Stakeholder Interests	Evaluation Planning	Evaluation Implementation	Recommendations	Review	Use (link to dissemination plan)
Internal	KeHMIS developers (eHealth, mHealth and NDW developers)	Understand progress of project implementation and areas of improvement	Ensure define questions capture all relevant technological evolutions	Identify key informants to be interviewed on the specific technological evolutions	Co-create the recommendation with evaluator	Review recommendations and planned actions	Implement relevant findings related to technological evolutions
	KeHMIS data use and M&E experts	Understand progress of project implementation and best practices in tracking change	Define evaluation questions	Analyze the data Engage stakeholders Write report	Participate in co-creation workshop	Review recommendations	Implement relevant findings related to data use and M&E
	KeHMIS project management	Understand progress of project implementation and best practices in tracking change	Review evaluation questions	Engage stake-holder Write report	Participate in co-creation workshop	Review recommendations	Lead an event to review the findings with stakeholders
External	NASCOP	Understand the effectiveness of the project in supporting HIS innovations and strengthening capacity at the national and county levels	Review evaluation questions	Review findings Write report	Participate in co-creation workshop	Review recommendations	
	CDC	Understand the impact of their investments in digital health solutions and HIV epidemic control	Review evaluation questions	Review findings Review report	Participate in co-creation workshop	Review recommendations	

Table 3: Summary of stakeholder engagement in the evaluation activities

2.4 Ethical considerations and assurances

This evaluation involved monitoring the progress and impact of the project using routinely collected data. The data used from the NDW for measuring data quality and quality of care is de-identified. The project has obtained a non-research determination from the CDC (CGH-KEN-1/18/23-8faf7), which allows the use of this data without requiring additional consent. Additionally, the project has received ethical approval from JKUAT ethics review committee (JKU/ISERC/02316/0880) and a research permit from the National Commission for Science, Technology, and Innovation (NACOSTI) (NACOSTI/P/23/27455).

An internal stakeholder engagement interactive meeting, sharing expertise, sparking ideas, planning and reviewing the project evaluation.

The Quality Assuarnce team walks participants through a technical showcase of KenyaEMR's updated features and dashboards.

A showcase of the solar-powered IoT solution for deploying KenyaEMR in remote healthcare facilities using a Raspberry Pi as the primary server with cellular connectivity.

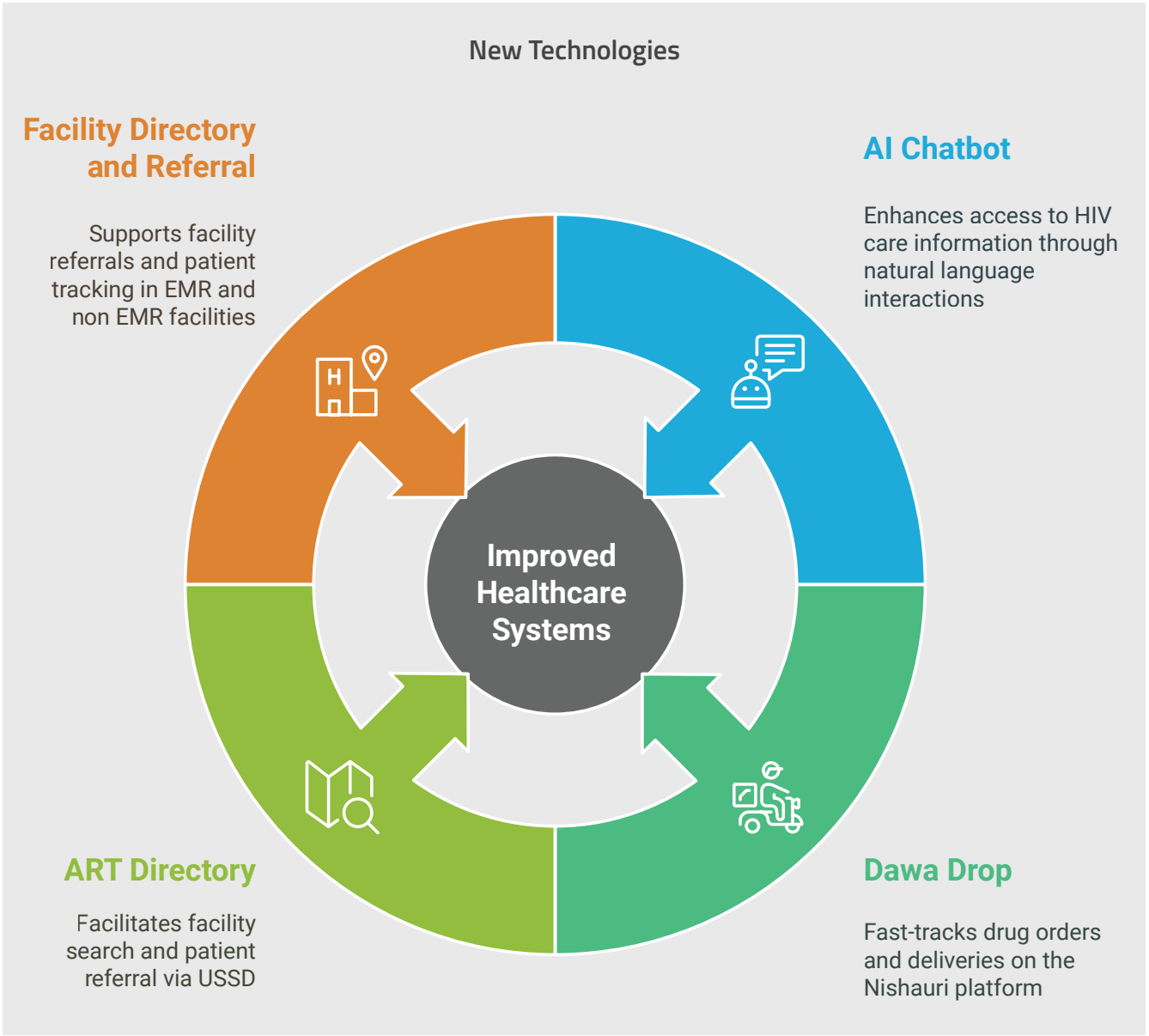
3. FINDINGS AND DISCUSSIONS

The findings of this evaluation are presented and discussed based on the evaluation objectives and address specific questions within each specific objective. The first sub-section focuses on evaluation questions addressing the first objective, to assess the progress of supporting the MOH, County Health Management Teams (CHMT), and Service Delivery Partners (SDPs) in developing and maintaining HIS innovations in Kenya. The second sub-section focuses on evaluation questions addressing the second objective to assess the effect of technological evolution on quality of care and use of data to inform programmatic direction to achieve and sustain HIV epidemic control.

3.1 Objective 1

a) The extent to which the project has supported technological evolution of eHealth, mHealth and data warehousing systems to meet program and strategic information needs?

The HIS ecosystem in Kenya is characterized by fragmented systems that are often hosted in environments with frequent downtimes, severely affecting the reliability and availability of crucial data services. To address this the project has developed several measures. These include.



New enhancements

The project introduced several enhancements that aimed at reducing the ETL Time, reducing the transmission rates. Enforcement of data security concepts and best practices, Ushauri, PSurvey, mLab and Service Desk.

i. The NDW revamp (ETL Improvements): Significantly reduced ETL time from over 40 hours to less than 7 hours.

ii. In line with the digitalization agenda of healthcare in Kenya, KenyaEMR was enhanced with additional functionalities that support all services in a facility with patient focused design. These enhancements include OPD/IPD, billing, special clinics, stock management, patient service queue management module among others to a facility wide utilization.

iii. DWAPI Enhancements: Which boosted data transmission rates by suppressing incomplete uploads, reducing amount of data transmitted, and enforcing data quality checks at source before transmission, Notable enhancements include differential loading, boardroom uploads, blocking stale databases among others.

iv. Enforcement of Data security concepts & Best Practices: Introduction of federated access to data systems and applications. Pseudonymization of sensitive personal data. Encryption of data at rest, Automated backup. Hashing of sensitive data. Encryption of data.

v. P survey: It was enhanced to support cohort-based survey and offline capabilities enabling access and use by other stakeholders across different sectors.

vi. Nishauri: The existing application was unified and customized into a health app that supports other programmatic areas like tracking client's appointment, request for VL results from mLab, request for appointment rescheduling, take part in patient survey via pSurvey, and chat with Chatbot. The chatbot was trained on the existing HIV guidelines for accurate responses to the FAQs.

vii. Machine learning models: HTS and IIT models were developed to help in predicting patients' risk of turning HIV positive and risk of interrupting in treatment.

viii. Service Desk: The project introduced a service desk to address enquiries and issues as reported by stakeholders utilizing our technological tools. Additionally, the service desk plays an instrumental role in ensuring system users are offered support on demand, furthering the project's sustainability. Table 4 below summarizes its utilization.

Year	Issues Reported	Issues Resolved	Issues Outstanding	Remarks
1	2,363	2,240	123	Open issues were either bugs or enhancements
2	4,099	4,087	12	Open issues were either bugs or enhancements

Table 4: Summary of service desk utilization by HIS users

ix. Ushauri: There were multiple upgrades on Ushauri that included SMS delivery tracking to document SMS delivery status, incorporation of NUPI into Ushauri for unique patient identification and configuration of the application to receive registration and appointment messages from KenyaEMR via the OpenHIM platform. Figure 1 below describes the uptake of Ushauri in the year 2024.

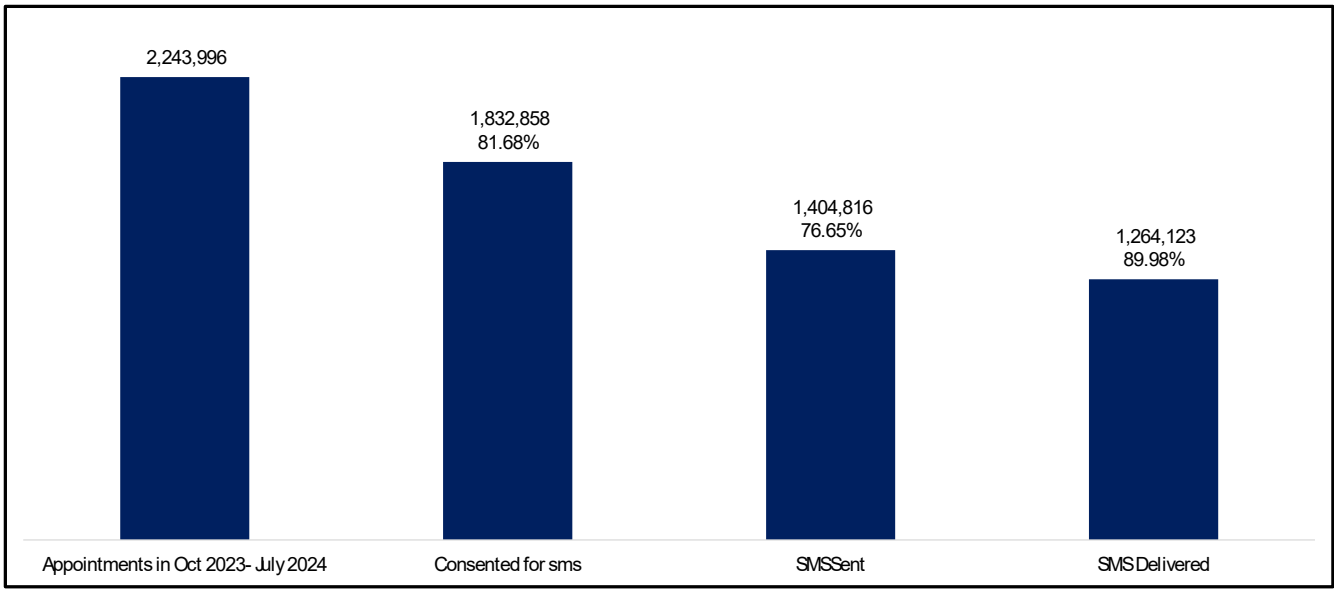


Figure 1: Utilization of Ushauri (SMS Appointment reminders system)

x. EMR data collection enhancements: There were several enhancements in the KenyaEMR to capture data as defined in the MER guideline. One was addition of mandatory fields to capture patient's height, weight, and WHO stage during every clinical visit made by respective patients.

b) Effectiveness of the project in strengthening the capacity of county teams and SDPs to scale up and utilize HIS for improved service delivery?

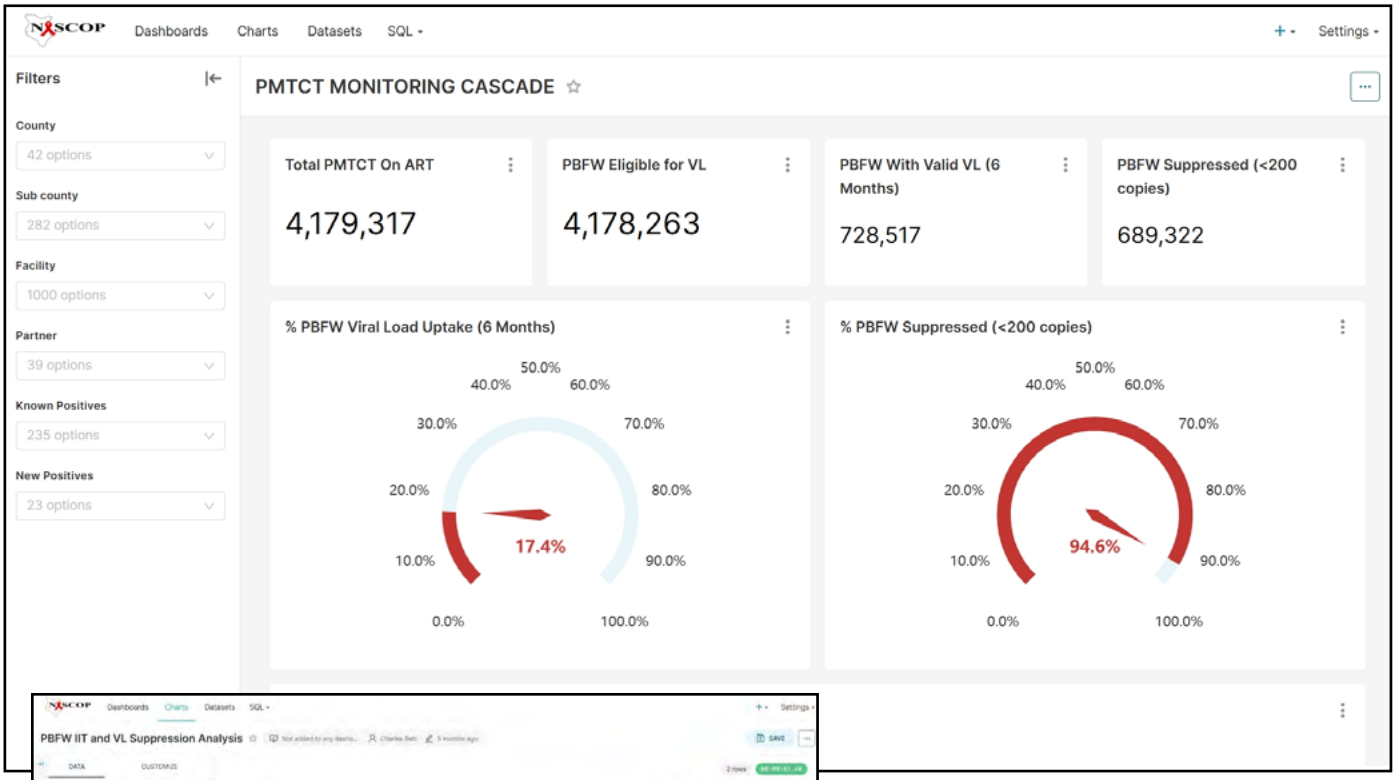
The project endeavored to improve service delivery through strengthening capacity for county teams and SDPs to scale up and utilize HIS. Capacity gap assessments were conducted annually to identify training needs and assess the effectiveness of the previous training. From all the assessment, a response rate of 99% for SDPs and 80% at site level was achieved. Some of the identified skill gap areas that required capacity reinforcement include mHealth, eHealth, Data protection and Security, Ethics using human subjects in research, GIS & QGIS. The modules of the training were based on the 6 identified thematic areas. Additionally, 15 eLearning modules were developed and utilized. The mode of delivery for the trainings included In- person, online (NASCOP and JKUAT Platforms), Webinars and the projects YouTube channel. Participants of the training were drawn from SDPs and County Team (Site level). In the first year, 17 training sessions were completed with a cumulative attendance of 2,401. In year 2, additional training was completed based on identified needs. In quarter one, there were a total of 2,495 training attendance, 2,222 in] quarter 2, 125 in quarter 3, and 206 in quarter 4. High participation rates in training sessions indicated effective capacity-building efforts.

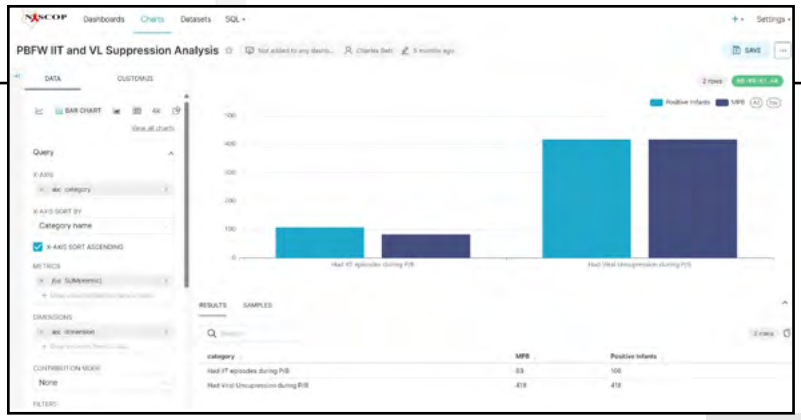
c) Extent to which the project strengthened data analysis and use to inform programmatic direction to achieve and sustain HIV epidemic control

The project has significantly enhanced data analysis and use to inform programmatic direction for achieving and sustaining HIV epidemic control. Key information products and services include:

i. Creation of self-service portals to enhance data accessibility and utilization for ad hoc needs. This has enhanced the use of NDW data for decision making and has played a role in ensuring partners identify their gaps in the different program areas and address them accordingly with minimal delay. Through the addition of new filters, the project has improved the NDW site and allowed the United States Government (USG) agencies to access and filter data by agencies. This improvement allows each agency involved in HIV control initiatives to focus on more relevant data analysis. Additionally, the project updated all HIV testing services with gender and age group filters.

ii. Formation of the Data Use COP team that develops information products for data use and programmatic decision making. The team has developed a number of information products through the self-service platform around HTS and Prevention, NCDs, Appointment management, PMTCT, HEI Outcomes among others.





Top: Select dashboard and chart within the self-service portals designed to improve data accessibility and utilization. **Right:** Published bulletings on Viral Load Monitoring and Machine Learning (ML) features.

iii. Webinars: These were aimed at informing stakeholders on progress on critical areas that include but not limited to viral load suppression, PrEP services uptake, and machine learning applications for HIV case finding.

iv. Bulletins, presentations, and line lists on various programmatic focus areas, including Viral load management, HTS Machine learning utilization, Non-Communicable Diseases (NCDs), Advanced HIV Disease (AHD), and PMTCT uptake and treatment continuity.

v. Scientific writing: These aimed at improving skills and provide mentorship in data analysis and scientific communication. A total of 16 participants from palladium were trained and six papers were developed from the activity.

vi. Information products to support COP planning, NASCOP annual report writing and TDYs with different countries such as Ethiopia, Zimbabwe, and Mozambique

d) Sustainability structures that have been implemented by the project to support MOH for maintaining HIS interventions, and how effective are these structures

Several sustainability structures have been developed to support maintenance of HIS intervention's. These include development of application catalogues, public repositories, technical assistance, Community of practice and TWGs.

i. Applications Catalogue: Developed to detail all eHealth and mHealth systems, facilitating maintenance and access.

ii. Public Repositories: Migration of source codes to a centralized repository for ease of access and sustainability.

iii. Technical Assistance: Ongoing technical support to MOH, including training and participation in design meetings to establish national terminology services.

iv. Strategic Engagements: Involvement in technical working groups (TWGs) and communities of practice to ensure continued focus on HIS agenda.

v. Communities of practice: The project began the formulation of its concept on community of practice with the aim being to 'develop and use digital health solutions through practitioners working together to leverage individual knowledge and skills for sustainable community solutions.' This involved the first HIS community EMR hackathon, the development of a website for the management of community activities, and a bootcamp with JKUAT students. The year 2 hackathon led to the development of several useful modules. The student community of practice was built to build interest in HIS while also upskilling students on implementation and management of key HIS products. This provides a pool of resources that can be easily harnessed to support where there are human resource gaps. Additionally, a data use community of practice was operationalized.

Effectiveness: The project has successfully created redundancy and failover mechanisms through MPLS connections, regularly reviewed and updated licensing requirements and software for the data center, and effectively promoted HIS sustainability through routine engagements and collaborations with stakeholders and partners.

For example, in year one, we established MPLS connections that reduced failover time by 70%, and 100% of source codes have been migrated to centralized repositories. The project has participated in 25 TWGs and communities of practice sessions.

3.2 Objective 2

The evaluation aimed to assess the contribution of four specific HIS solutions to quality of care and use of data to inform decision making in efforts to achieve and sustain HIV epidemic control. These enhancements include HTS machine learning-powered prediction scores in the EMR, WHO clinical staging documentation as a mandatory field in the EMR, differential loading in DWAPI for improved data quality, and self-service functionality in the NDW for data access.

a) The effect of integration of machine learning-powered prediction scores into the EMR on HIV case finding.

Data integration strategy involved combining Individual level data from Kenya's HIV Electronic Medical Records (EMR) with open-source geospatial data to comprehensively characterize patient testing and locational context. The EMR dataset included 167,509 tests conducted between June and November 2022, encompassing diverse demographic, clinical, and behavioural features. Geospatial data from sources such as the Institute of Health Metrics and Evaluation (IHME), World Pop, and Meta enriched our dataset with regional HIV prevalence, risk factors, and demographic information. Four distinct model types – Logistic Regression, Random Forest, AdaBoost, and XGBoost – underwent rigorous training and evaluation. A hyperparameter

grid search was conducted for each tree-based model, and the training process was repeated across the various imputed datasets. We utilised Area Under the Precision-Recall Curve (AUCPR) and gain metrics to assess model performance. The evaluation considered efficiency and effectiveness metrics, focusing on fixed sensitivity and proportion target scenarios.

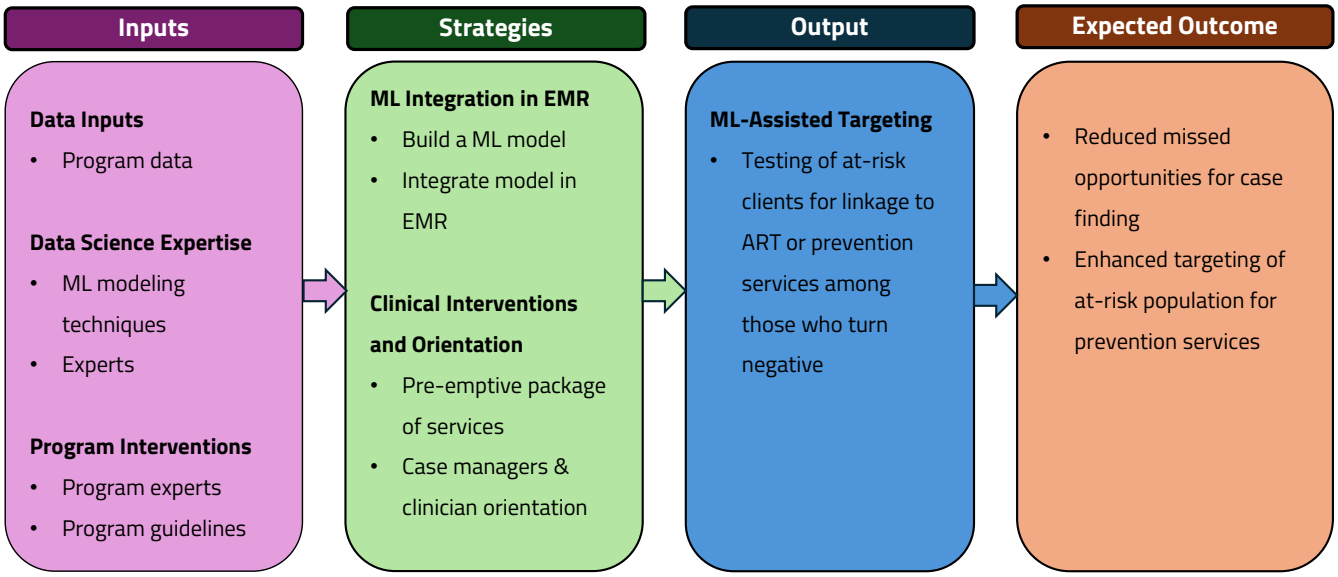


Figure 2: A theory of change framework to introduction of HTS ML model in the EMR

Data used for the evaluation includes individual level data collected from January 2024 to July 2024. Data on clients who were screened and categorized by the model was extracted then we compared the risk categories with the actual HIV testing outcomes to determine the model's accuracy and effectiveness. The data contains patient demographics, screening responses and testing outcomes. The ML model categorizes clients into four risk levels (highest, high, medium and low) based on their predicted likelihood of testing positive for HIV. The primary outcome of interest is whether a client tested positive or negative for HIV. The analysis also includes data on whether clients were linked to prevention services based on their risk category. This helps in assessing the model's impact on health interventions. Descriptive analysis was applied to examine the distribution of clients across different risk categories and gauge how the model stratifies the risk of turning positive.

i. ML Uptake

Between January 2024 and July 2024, 1,642,696 individuals were screened, with 95% receiving machine learning (ML) risk predictions. Additionally, 99.68% of the 1,893 eHTS facilities utilized the ML model, demonstrating widespread implementation of the model in testing.

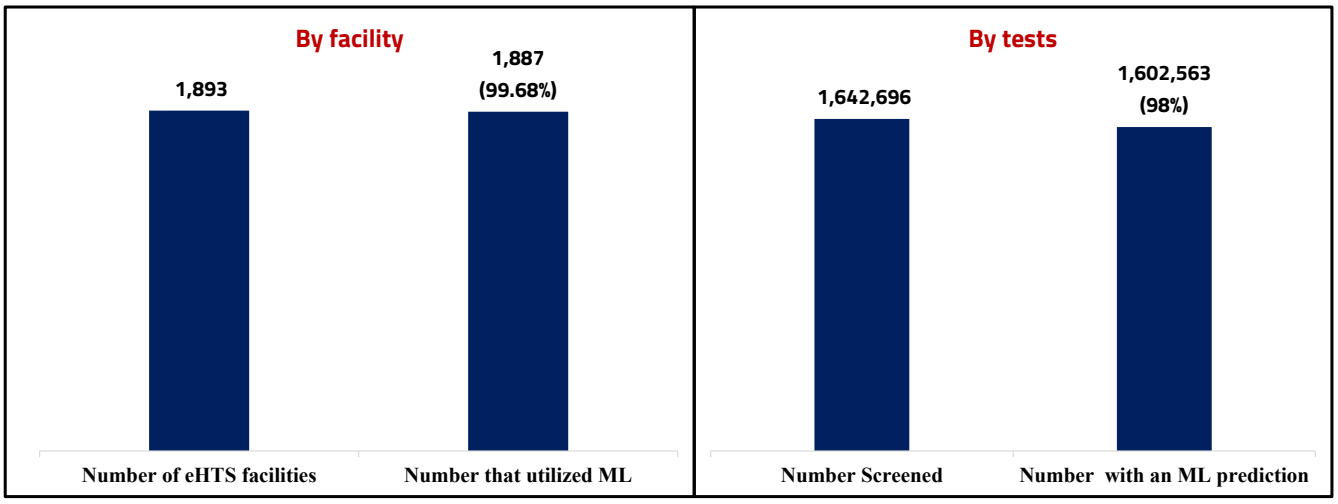


Figure 3: HTS ML by facility and tests

ii. Outcomes/performance of the ML model

	Highest Risk	High Risk	Medium Risk	Low Risk
Number of tests	61,296	176,159	533,162	707,613
Number positive	5765	6695	9375	4835
Positivity	**9.41%**	**3.80%**	**1.76%**	**0.68%**
Number of negatives	55,531	169,464	523,787	702,778
Number enrolled in prevention services	4,258	10,011	24,192	20,275
% Enrolled	**7.67%**	**5.91%**	**4.62%**	**2.88%**

Table 5: HTS ML model performance

The ML model recommends HIV testing for clients categorized as Highest, High, and Medium risk. The ML model effectively distinguished clients into different risk categories. Clients in the highest-risk category were 9 times more likely to test positive compared to those in the low-risk category ($p<0.001$). The ML model achieved a sensitivity of 82%, covering 52% of all tests conducted, showcasing its ability for optimized testing. Additionally, a majority of clients in the Highest, High, and medium risk categories who tested negative for HIV were also referred for prevention services. The results indicate that the model is effective in stratifying clients based on their likelihood of testing positive and helps in also identifying high risk clients who turn negative for linkage to prevention services. The model's performance in differentiating risk levels and facilitating appropriate follow-up demonstrates its value as a tool in the fight against HIV.

Reasons for Testing	Negatives	Positives	Total	Positivity
Routine Testing	Positivity	6305	209,171	3.01%
Discretionary	626,795	4,223	631,018	0.67%
Machine Learning Based	621,899	16,142	638,041	2.53%

Table 6: HIV positivity yield from HTS ML model

This table outlines the reasons for recommending testing: Routine tests are tests done as per guidelines, discretionary tests are tests done at clinician discretion, and ML-based tests are tests that are aided by machine learning. The model successfully screened in approximately 16,142 clients, identifying positives that would otherwise have been missed opportunities. The yield from ML-assisted referrals for HIV testing services (HTS) was 3.7 times higher compared to referrals based solely on provider discretion.

b) Extent to which the enhancement of EMR to include WHO staging as a compulsory field has improved compliance with HIV treatment guidelines

Before enhancement of the KenyaEMR to include WHO Stage as a compulsory field, some patients had incomplete documentation of their WHO clinical Stage. This made it difficult to promptly identify recipients of care with AHD which may lead in delayed treatments interventions and monitor disease progression over time. The incorporation of WHO staging as a compulsory field was done and rolled out with the KenyaEMR version 18.6.0 on June 12th, 2023. The purpose of the enhancement was to ensure that all clients had a documented who stage at every visit to facilitate timely and accurate AHD diagnosis and provide data to inform decision making and programmatic interventions. During the pre-enhancement period, 20.2% (185,528) of the total recipients of care (919,652) did not have their WHO stage documented. In contrast, during the post-enhancement period, only 0.07% (690) of the total recipients of care (984,019) were missing WHO stage documentation. Before the enhancement we were only able to determine AHD cases among 79.83% of the TxCurr population. However, after the enhancement we could determine AHD cases for 99.93% of our TxCurr population, where AHD prevalence is observed to be lower (3.52%) than before the enhancement which was (4.33%). CD4 count data was not used to determine AHD cases as it is not routinely collected and might not give a clear picture of AHD cases as of the assessment dates.

Figure 4 shows WHO stage documentation and AHD diagnosis pre and post enhancement.

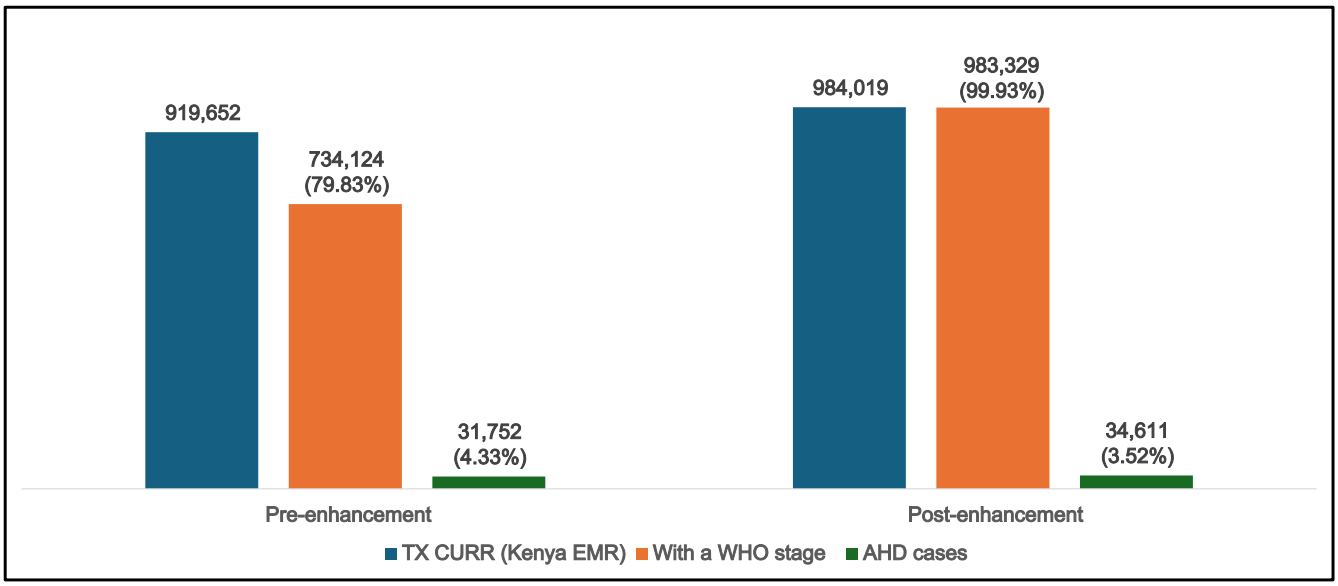


Figure 4: WHO stage documentation and AHD diagnosis pre and post EMR enhancement

c) The influence of NDW enhancement through improvements in the Extract, Transform, Load (ETL) process and the Data Warehouse API (DWAPI) on data quality and utilization to inform programming.

The NDW is a key element in Kenya's health management information framework, serving as a central repository for health data, particularly in the context of the HIV/AIDS epidemic. By aggregating data from EMRs, it provides a comprehensive view of the HIV landscape making it crucial for trend monitoring, informing public health interventions, resource-allocation, and policy making. Given these critical roles, any enhancements made to the data management processes could potentially impact data quality and consequently the effectiveness of the HIV program.

The previous flush and load NDW architecture was designed to completely replace all existing data with each monthly update. This involved systematically removing existing records (flushing) and then replacing them with the latest data retrieved from the source systems – facility EMRs. This often led to:

Frequent loss of data, more so of records that were inadvertently left out during the refresh cycles, leading to data gaps, and reduced reliability and completeness.

System inefficiencies where overwriting existing databases was not only time consuming but also resource-intensive, causing system downtimes and even delays in data availability.

Acknowledging these shortcomings, the NDW architecture underwent the significant enhancement of transitioning to an incremental ETL process, complemented by enhancements to the DWAPI, in December 2022. This promised several potential benefits by preserving existing data while updating only the modified or new records. Additionally, an Operational Data Store (ODS) layer was established to persist incomplete uploads and resolve data inconsistencies with overall checkpoints and automated error handling mechanisms were introduced to notify refresh status, start, end, and failure, ensuring timely response and resolution of issues.

A descriptive comparative analysis was conducted to assess accuracy and alignment between the pre-(January 2022 to December 2022) and post-enhancement (January 2023 to July 2024) periods.

TX_CURR concordance between NDW and KHIS was performed using a one-to-one correspondence, based on data availability, between sites that reported in both databases.

Tracking Treatment Cohort Growth: Pre-Enhancement

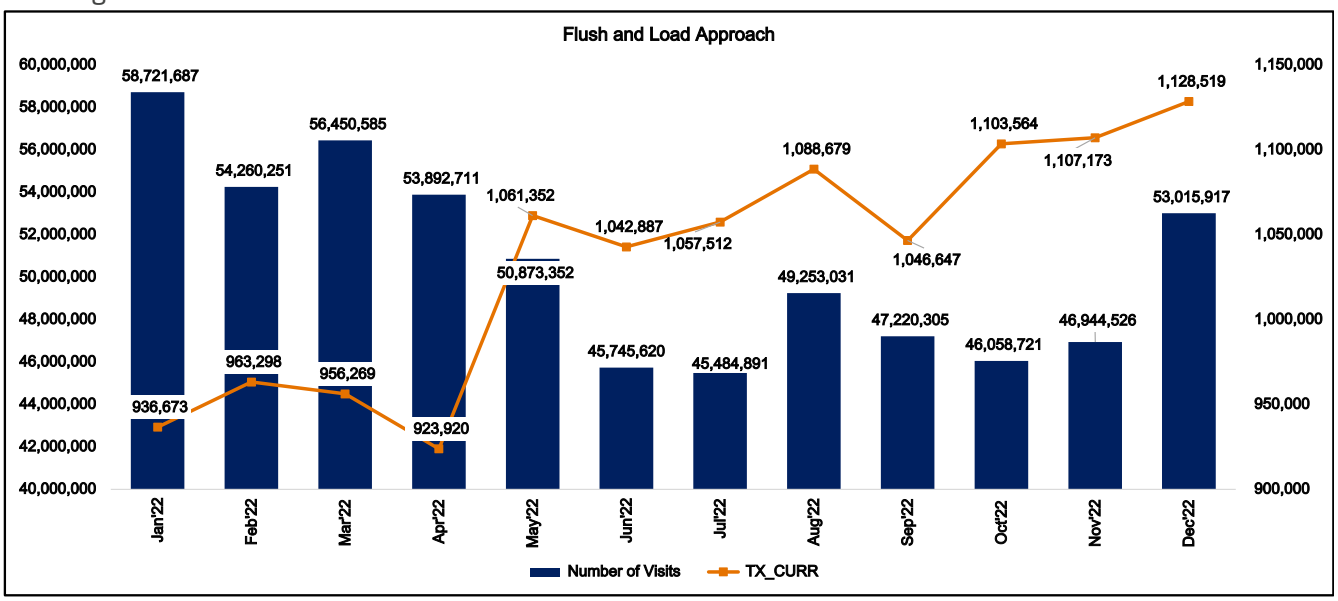


Figure 5: Treatment Cohort Growth: Pre-Enhancement

With this approach, fluctuations were experienced in the cumulative number of visits over the months highlighting the evidence that there were records being omitted during the ETL process.

Also, the treatment cohort experienced several spikes and drops as its computation largely depends on (but not limited to) the number of recorded visits.

Tracking Treatment Cohort Growth: Post-Enhancement

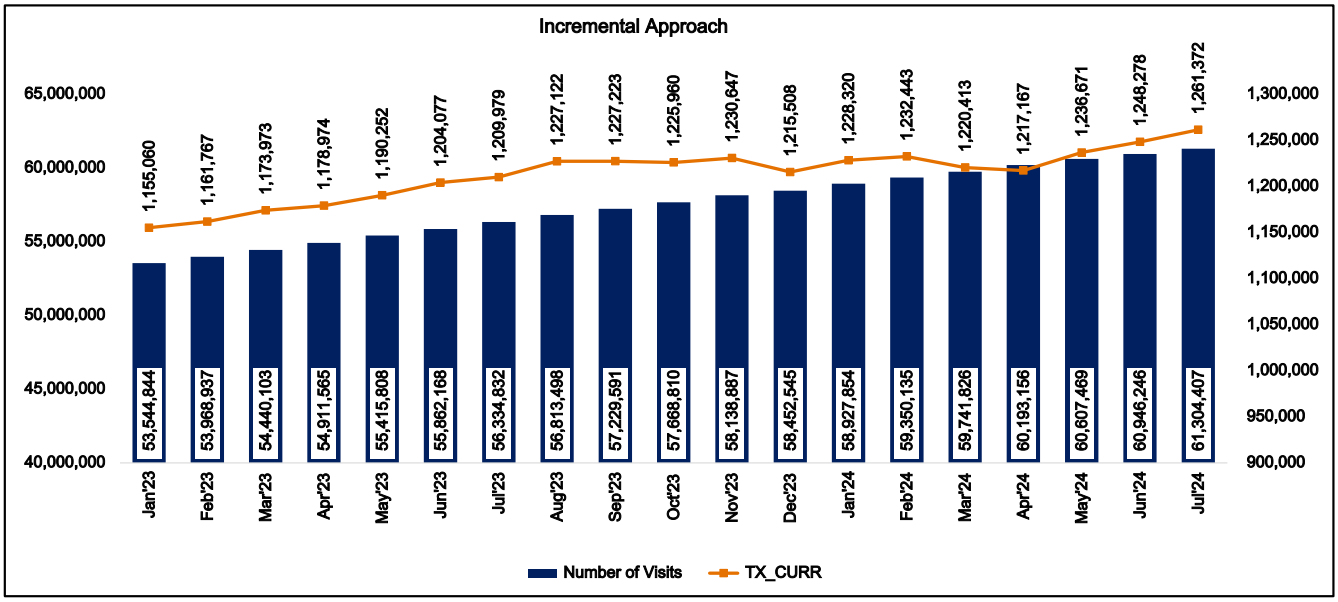


Figure 6: Treatment Cohort Growth: Post-Enhancement

A steady increase in the cumulative number of visits was observed over the months. Records that were previously being lost during the flush and load approach were now retained consistently. With this, the NDW offered a more accurate reflection of the HIV landscape.

The treatment cohort also increases, with a few fluctuations between December 2023 to April 2024 attributed to a drop in reporting rates within NDW.

TX_CURR Indicator Concordance: KHIS vs. NDW

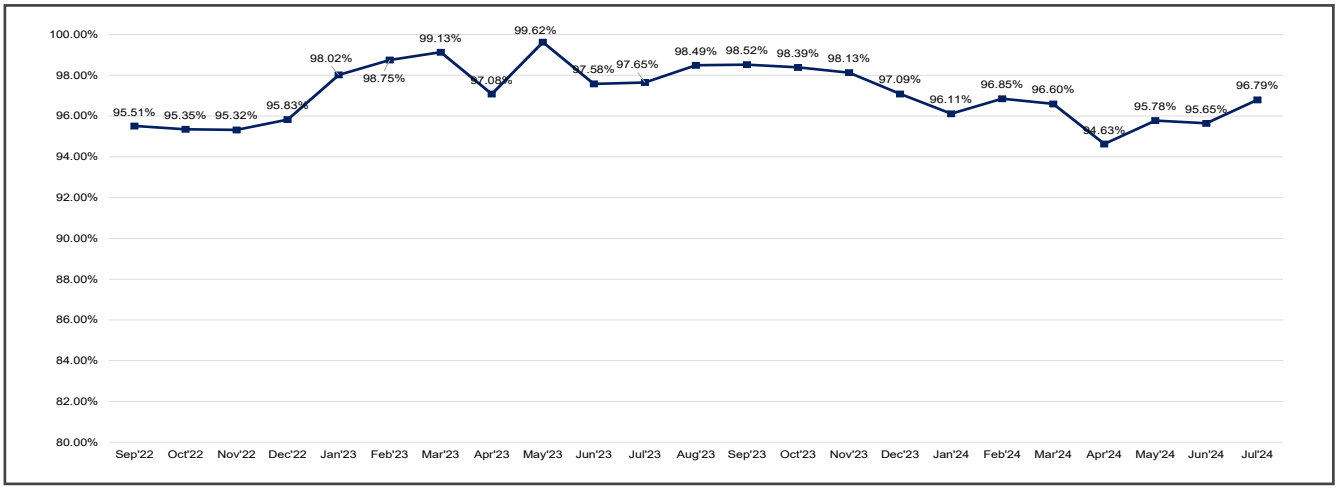


Figure 7: TX_CURR Indicator Concordance: KHIS vs. NDW

TX_CURR concordance was stagnant at approximately 95% pre-enhancement (September 2022 to December 2022) but rose over the months to as high as 99.62% in May 2023.

The decline observed from November 2023 to April 2024 was attributed to the drop in reporting rates within NDW.

d) The extent to which the NDW enhancement with self-service functionality has increased stakeholders' access to and utilization of NDW data for decision-making.

The analysis design was based on the theory of change, where key indicators under the output component were measured. The National Data Warehouse (NDW) was enhanced with a self-service functionality in 2023 where NDW data can be accessed via the Superset platform. The primary goal was to improve stakeholders' access to and utilization of data for decision-making purposes in regard to initiatives and efforts to achieve and sustain HIV epidemic control in Kenya. This involves anonymized individual level data that was initially not readily available.

The self-service feature was developed and a workshop involving representatives from Palladium KeHMIS and several service delivery partners was held in the last week of May 2024, spanning through the first week of June 2024, after which the developers worked on improving the feature based on the feedback from the workshop participants. Upon completion, training of stakeholders began in the last week of August, with the last group being trained in the first week of September 2024. From this, the expectation was that all stakeholders can access the NDW data, create visualizations and dashboards and also interact with dashboards created by others for data utilization in decision-making. Figure 8 below demonstrates the theory of change applied and used for measurement of progress towards a successful data access democratization.

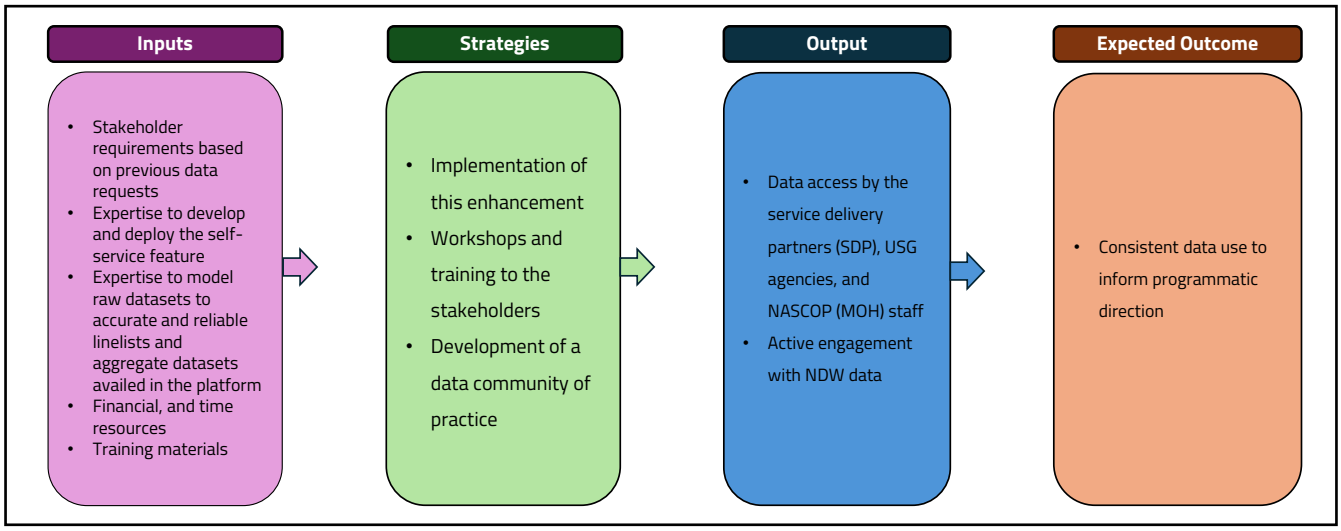


Figure 8: A theory of change framework for enhancing NDW with self-service feature

Data analysis for the evaluation included all individual users of the self-service feature apart from the KeHMIS project staff. A descriptive analysis of data access was done, covering the period of during and post the training, (24th July 2023 – 31st August 2024).

i) Progress in stakeholders' access to NDW data through superset self service

The enhancement of the NDW with self-service functionality enabled 34 out of 43 stakeholder organizations to access NDW data as of 31st August 2024, following the platform upgrade. Prior to this enhancement, the NDW platform lacked the capability to timely provide data to all stakeholder and track usage due to resource limitation.

Every month had users from the 34 stakeholder organizations accessing the NDW datasets. There was a total of 253 distinct users interacting with the NDW data at different frequencies per month. July 2024 had the highest number of users (85) interacting with the data while December 2023 had the lowest (41) as shown in Figure 9 below. The average number of stakeholder organizations with users interacting with the data every month was 60 (SD = 16).

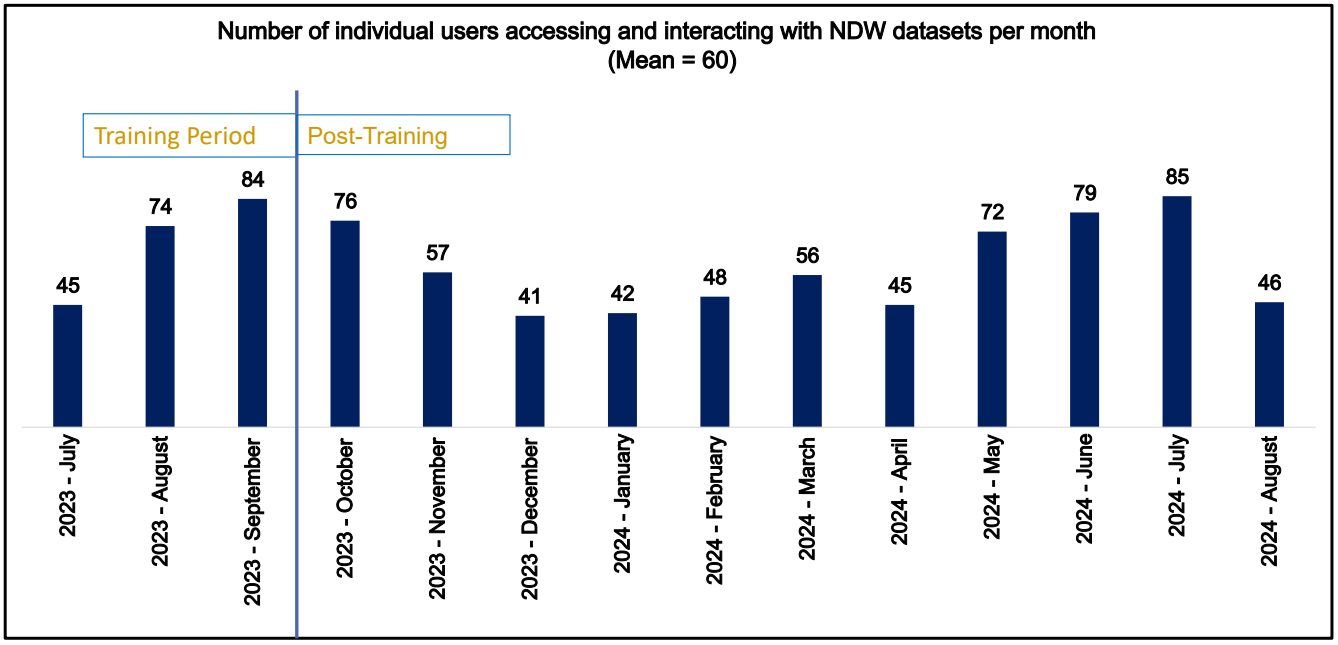


Figure 9: Users interacting with NDW data per month

There were 651,670 logs to the platform by users from the different stakeholder organizations interacting with the NDW data within the study period. Figure 10 below shows the number of logs per month, with most logs occurring in the months of February 2024 and May 2024 post-training period.

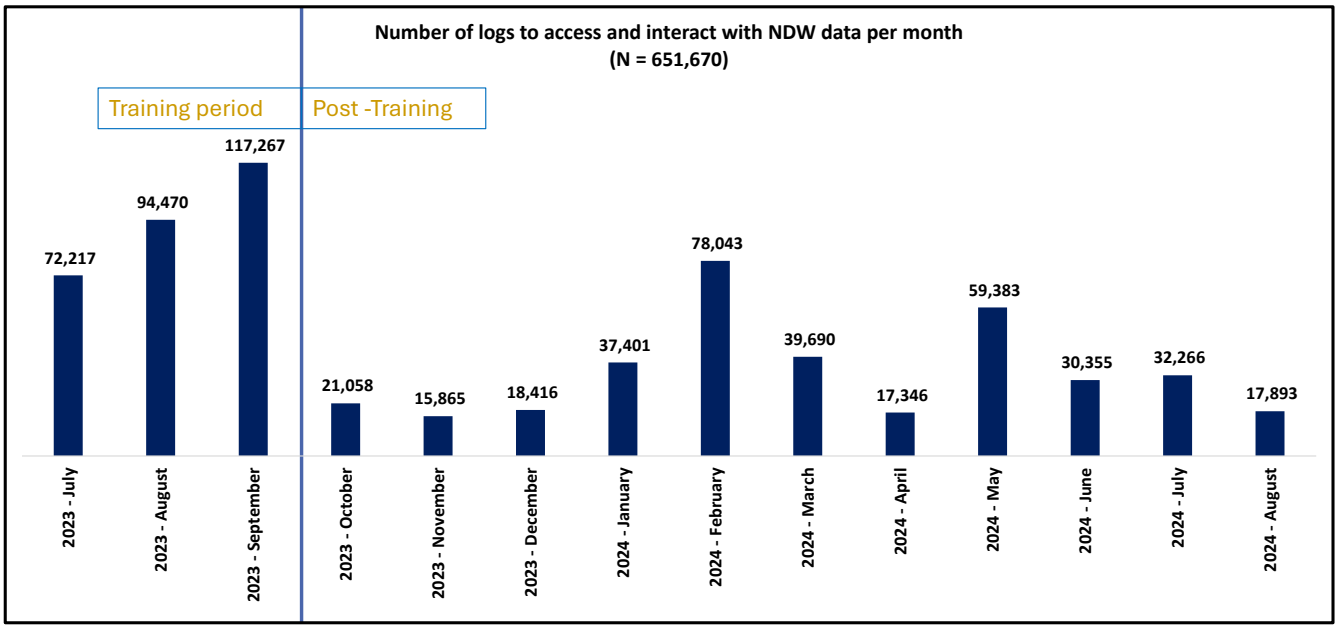


Figure 10: System logs for accessing and interaction with NDW data per month

31 of the 34 stakeholders who accessed and interacted with NDW data using self-service created visualizations, while 3 did not, but interacted with visualizations and dashboards generated by other stakeholders. Annex IV shows the distribution of the users accessing and interacting with NDW data and logs by stakeholder organization.

ii) Progress in access and interaction with NDW datasets for different program areas

As at 31st August 2024, stakeholders successfully utilized 60 (82.19%) out of the 73 HIV program datasets available on the NDW self-service platform to create visualizations, up from 21 (28.77%) when training began, as shown in Figure 11.

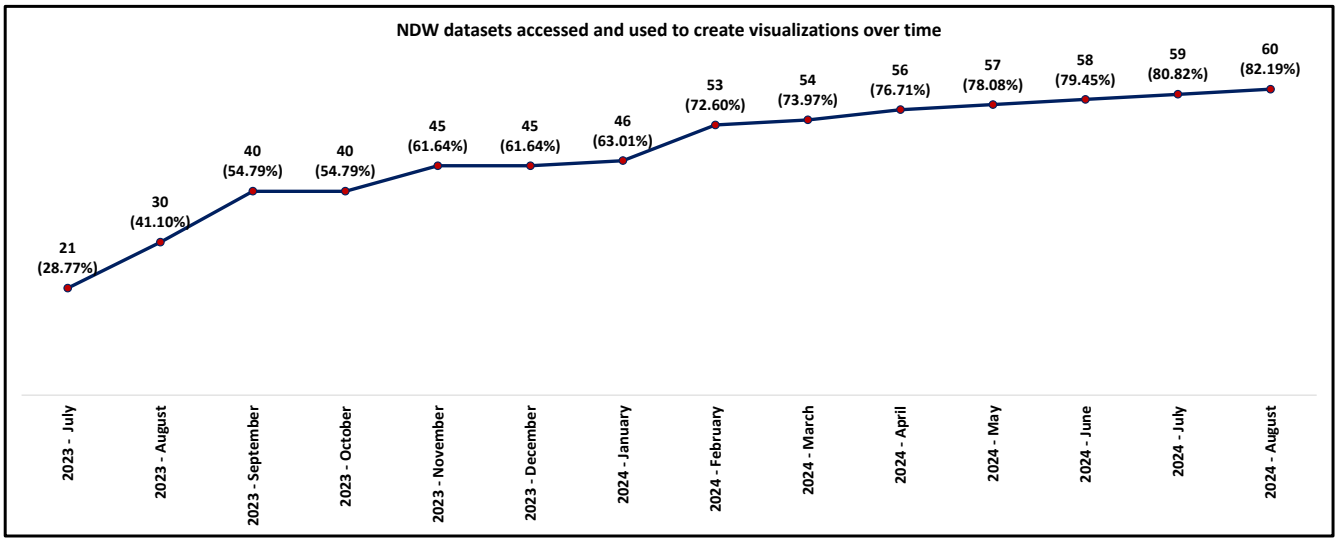


Figure 11: Progress in access of NDW datasets availed in self-service

All datasets related to HTS, PrEP and PMTCT were fully utilized, while 69.77% of the Care & Treatment datasets were accessed. From these 60 datasets, stakeholders generated a total of 1,522 visualizations. Of these, 921 were based on HIV Care and Treatment data, 361 on HTS data, 137 on PrEP data, 98 on PMTCT data, and 5 on facility details datasets, as illustrated in Figure 12.

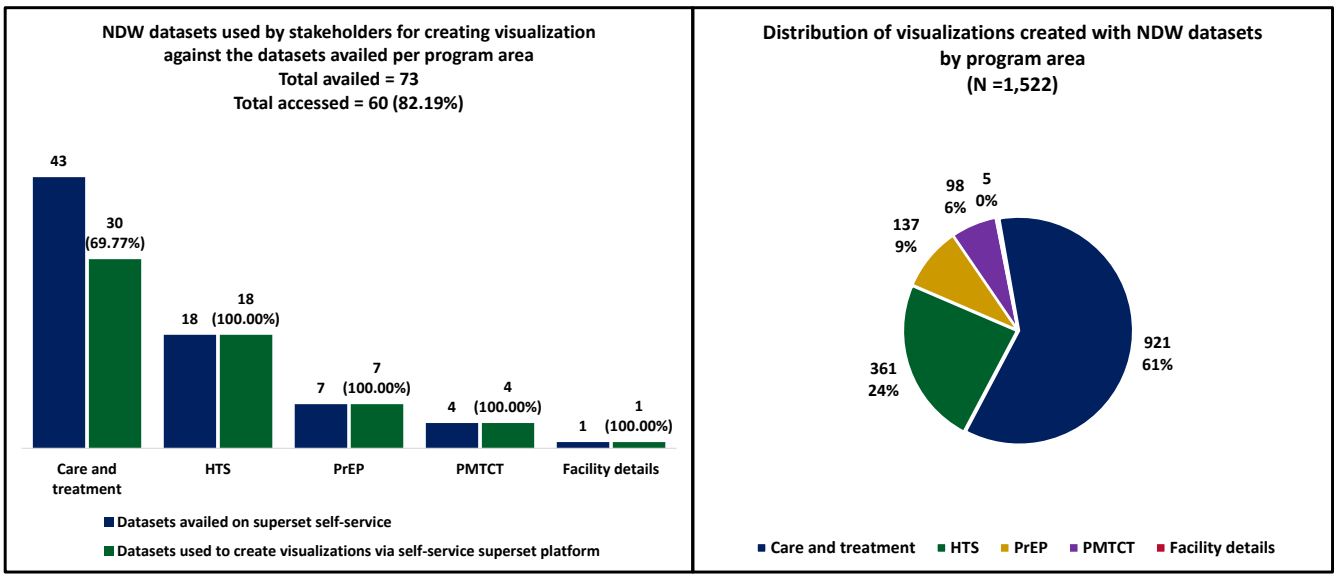


Figure 12: NDW data access and utilization by program area

Participants of the Ladies in Coding program collaborate on projects ahead of the student bootcamp grand finale.

Railways Health Center staff receive a briefing from Capacity Building Lead, Benard Otieno, during the filming of a documentary highlighting the intergrated ML features in Kenya EMR.

The Palladium team celebrates a milestone with the OpenMRS Transformative Leader badge award at OMRS24.

Our eHealth Developer, Laurent Ouma, leading a demo at the grand finale of the Kenya HMIS Ladies in Coding and Student Bootcamp.

Coptic Hospital team showcases a demo to Mozambique and CDC delegates during a TDY visit.

4. CONCLUSION AND RECOMMENDATIONS

4.1. Summary

During the project period, new technological enhancements were developed and integrated into existing HIS systems that support patient management. These enhancements have resulted in improved data transmission and security, support in patient management and Improved stakeholder engagement for example, the facility directory and referral have enabled linkage of patients transferring out ensuring treatment continuity. This has addressed the issue of fragmentation and increasing reliability, availability, and accessibility of services through Superset.

Capacity building activities of county teams and SDPs have facilitated the utilization of HIS solutions and resulted in better programmatic decision making. This has helped improve service delivery at all levels.

Through routine data analysis, the monitoring of progress over time of HIV/AIDS control programs has been enhanced. Moreover, the project receives ad hoc data requests from SDPs and MOH available for program interventions. Development of and use of the self-service portal has helped create data demand and data use culture at the levels of service delivery.

In addition, the use of Artificial intelligence and machine models have been used to predict new HIV cases and risk of interruption in treatment hence ensuring early case detection and management.

The community of practice has been used to build skills to support, innovate and improve existing HIS interventions. For example, it is through a student hackathon that Dawa drop was conceptualized and integrated into mainstream software. Engagement of MOH, county teams and SDPs in capacity building activities has been a priority seeking to employ ownership of the HIS solutions and interventions.

Technical assistance to SDPs through the service desk has seen over 2,000 issues raised and slightly above 90% of those resolved. This has shown the need that was previously a gap, addressed.

The integration of machine learning-powered prediction scores in the EMR supported the categorization of HTS service recipients into four risk levels which provided valuable geospatial insights for outputs on risk profiles informing stakeholders on where to allocate more resources. Based on risk classification, service recipients are linked to HIV preventive services. Additionally, it supported in identifying positives that would otherwise have been missed opportunities.

Enhancement of EMR to include WHO staging as a compulsory field has ensured that almost all recipients of care have a documented WHO stage which is in line with Kenya HIV prevention and treatment guidelines. This also eases in identification of recipients of care categorized as having AHD optimizing their care by ensuring they receive the appropriate package of care.

Enhancement of NDW transitioning to incremental ETL process complemented by enhancements to the DWAPI has addressed issues of data loss by retaining all previously existing records and updating of modified or new records. The ODS layer has addressed issues of incompleteness and inconsistencies in data ensuring timely response and resolutions to errors. This has led to improvements in data concordance between NDW and KHIS.

The self-service feature on NDW using superset has empowered stakeholders at the national, county and service delivery levels to access de-identified individual level data which was previously not instantly available and enabled the program in tracking data use.

4.2. Conclusion

The project has demonstrated that embracing use of new technology and integration in existing systems is important in strengthening service delivery. This has been achieved through collaboration with the MOH, county teams and SDPs to ensure sustainability of the HIS solutions.

The project's technological evolutions have contributed significantly to improved quality of care among PLHIV, especially enhancements that are aimed at improving adherence to HIV treatment guidelines. The evolutions have also responded to the program's increasing demand for high quality and reliable data to inform programmatic direction by covering data quality and data access needs.

4.3. Recommendations and lessons learnt

1. The unified technology approach employed to the existing Nishauri for Dawa drop and AI chatbot using is a robust solution to the ever-growing service delivery needs. The benefits include improved efficiency and user experience. Future technological evolutions should embrace the approach

2. Through the SMS appointment reminder system (Ushauri), patients who consent are constantly reminded of their upcoming appointments. To complement this finding and determine the effectiveness of the SMS system, a survey need to be carried out to correct user perspectives and insights

3. Capacity gaps assessments are an important tool in identifying training gaps. However, there is a need to assess the effectiveness or impact of these courses on service delivery and quality of care. A standardized tool can be developed for this.

4. Democratizing data access empowered stakeholders at all levels, including service delivery partners, county and national government and USG agencies, to access and use data for informed decision-making without requiring technical expertise. Given the high demand of NDW data on all HIV program areas by different stakeholder, availing all relevant datasets in the self-service platform could improve the data use for informed decision making in the country. Thus, the KeHMIS project needs to gather more data users' needs on a regular basis – a strong feedback mechanism on the feature would be helpful

5. Use of Community of practice for sustainability has been impactful in advancing innovation. This can be extended to involve more tasks undertaken by the project.

6. The distinct difference in positivity and linkage to prevention services across the risk categories within the HTS model shows the model effectively stratifies clients by risk which suggests good performance of the model however the HTS providers should continue documenting the reason for test for continued evaluation of the model. HTS providers to capture accurate data on eHTS especially behavioral variables for accurate risk predictions.

7. Data quality improvement. - The enforcement of WHO documentation ensured that almost all recipients of care had a documented WHO stage. Data quality of other metrics in the NDW can be improved through the enforcement of documentation to ensure that patients receive appropriate care.

8. The NDW architectural transition from the flush and load to the incremental approach demonstrated clear benefits in reducing refresh time, preserving data integrity, and addressing data inconsistencies. This not only enhanced operational efficiency but also minimized data loss and improved the accuracy of key metrics such as the TX_CURR indicator. This approach can be applied to other health data systems to similarly improve reporting and data management across different health domains.

5. DISSEMINATION PLAN

Audience	Goal	Tool/Medium	Forum	Responsible Party	Timing
KeHMIS Team Leads	To ensure team leads are aware of the findings and can implement necessary changes	Internal report and presentation	Email updates and Team Leads meeting	DDIU Team Lead	Before FY24 completion
KeHMIS staff	To inform staff about the evaluation results and their implications.	Internal report and presentation	Internal Staff meetings	Evaluation Lead	Before FY24 completion
CDC	To share findings and contribute to the knowledge base	Report and presentation	Email updates and/or meeting	DDIU Team Lead	Before FY24 completion
NASCOP	To share findings aimed at informing policy and program decisions	Report and presentation	Email updates and/or meeting	DDIU Team Lead	Before FY24 completion

Table 7: Summary of evaluation report dissemination plan

6. REFERENCES

1. KeHMIS III Final Approved Protocol
2. KeHMIS III EPMP
3. The National DataWarehouse repository
4. KeHMIS annual and quarterly progress reports
5. PEPFAR evaluation standards of practice v3.1.2_Jan25 https://help.datim.org/hc/en-us/article_attachments/13797449520148

7. ANNEXES

ANNEXE I: Approved Evaluation SOW and/or protocol

Routine and Non-Routine Evaluation of Health Information Systems Evolution, Data Use and Associated Sustainability Structures Under KenyaHMIS III

ANNEXE II: Project Results Framework

KenyaHMIS III Results Framework

ANNEXE III: Conflict of interest statement

The primary purpose of the project was quality improvement which inherently reduced bias because it admitted that there was room for improvement. The investigators from CDC, Palladium, JKUAT and HETARK involved in guiding the evaluations also helped to mitigate bias, since each party could hold the others accountable for the results of the program. The JKUAT team provided technical assistance on evaluation and data analysis for several aspects of the program. The team endeavored to ensure that the results were credible, and biases were mitigated. There was no declaration of conflict of interest from all teams.

ANNEXE IV: A table showing the distribution NDW data access by stakeholder organizations

Stakeholder organization name	Number of users accessing and interacting with NDW data	Number of visualizations created using NDW data	Number of logs to interact with the NDW datasets
NASCOP	38	306	48,766
USAID NURU YA MTOTO	31	125	55,292
CDC	25	41	47,079
USAID Fahari ya Jamii	17	30	29,458
CIHEB PACT IMARA	12	43	15,700
LVCT Prisons	10	45	51,887
MOH	10	77	19,069
USAID Jamii Tekelezi	9	79	36,961
LIVERPOOL VCT CARE & TREATMENT - (LVCT HEALTH)	8	20	8,787
CHS Shinda Tena	7	41	17,992
LVCT Vukisha 95	7	67	13,696

USAID Dumisha Afya	7	48	21,304
USAID Tujenge Jamii	7	16	18,225
USAID Ampath Uzima	6	35	10,441
CIHEB CONNECT	5	39	26,286
County Representative	5	2	646
KCCB – ACTS	5	74	33,532
Siaya CHMT	5	48	14,399
CHAK CHAP STAWISHA	4	115	38,710
CIHEB ENTRENCH	4	31	13,645
Coptic Orthodox Church	4	22	16,766
HJF-South Rift Valley	4	34	7,992
DREAMS Kenya Trust	3	1	2,902
HJF-Kisumu West	3	32	10,286
LVCT Dhibiti	3	12	10,088
AHF Kenya	2	0	534
MIGORI CHMT	2	17	5,696
NYERI CDHS	2	20	8,899
USAID	2	0	144
USAID Imarisha Jamii	2	7	5,736
HJF-Nairobi	1	0	130
HOMA BAY CHMT	1	8	2,176
HOPE worldwide Kenya	1	14	3,585
Mkomani Clinic society	1	73	54,861
Total	**253**	**1,522**	**651,670**

Contact Us

www.kenyahmis.org

www.thepalladiumgroup.com

Tel: +254 717 969471

Email: kenyahmis@thepalladiumgroup.com

This project is funded by the U.S. President's Emergency Plan for AIDS Relief (PEPFAR) through the U.S. Centers for Disease Control and Prevention. The content, materials and opinions expressed by authors contributing to this report do not necessarily reflect the official position of the U.S. Department of Health and Human Services, the Public Health Service, the Centers for Disease Control and Prevention.