Rwanda Health Information system Ecosystem (RHIE). Achievements over last 3 years

September 2024

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Executive Summary

The Health Information Exchange (HIE) platform represents an innovative leap in healthcare technology. Its overarching goal is to establish a secure and centralized repository for the meticulous exchange and management of patient health records, thereby revolutionizing the way healthcare data is accessed, shared, and coordinated. This pioneering system stands as a testament to the relentless pursuit of excellence in healthcare, championing the principles of efficiency, security, and scalability.
Rwanda has adopted the use of open-source software with open standards known as "Open Health Information Exchange" (OpenHIE) to connect the siloed systems. This project was undertaken from the national digital health transformation among key project priorities in phase one. For the effective and successful implementation of the unified HIE, the Ministry of Health has set the minimum viable product with few use cases to be expanded after showcasing the successful implementation. By 2023, the first pool of sites in Kigali was connected to this national interoperability bus with minimum features limited to HIV case-based surveillance and indicator reporting.

To move towards an AIDS-free generation, data is needed to identify new HIV cases, know which cases are linked to treatment, and which cases are virally suppressed. This can be achieved through Case Based Surveillance (CBS). Having achieved the first 90 in Rwanda (proportion of HIV-positive persons who know their status), the target is to reach 95%. The Ministry of Health Through Rwanda Biomedical Center plans to exceed the first 90 of UNAIDS target to reach 95%. In addition, the Ministry of Health wants to move from aggregated data to individual-level data for case-based reporting. The OpenMRS is a principal platform for creating customized Electronic Medical Records (EMR) systems based on the actual needs on the ground. Since 2008, around 450 health centers in Rwanda have already rolled out the OpenMRS system for storing and managing electronic medical records for HIV. The hospital package implemented in 42 public hospitals includes additional modules such as registration, clinical consultations (both Inpatient and outpatient), billing, lab, and pharmacy.

The openMRS instance was enhanced to cater for useful features of the HIV case-based surveillance such as multi-month dispensing, spaced appointments, clinical monitoring, as well as pharmacovigilance and monitoring, evaluation, and reporting (MER) indicators features/indicators. For a seamless integration of all HIV-related systems with a smooth data exchange within health facilities, the Ministry of Health has implemented additional HIE components known as national registries. The first and the most essential component was the client registry introduced to support a nationwide unique identifier for every patient. In the context of the Client Registry, it has been integrated with NIDA (the National Identification Agency), which is involved in generating a unique health ID, combining different identifiers from various existing ID schemes where necessary, such as National ID, NIN (National Identification Number), Application number, Foreign ID number, community-based insurance, and

passport numbers. The second useful component aims at consolidating medical records of the patients stored securely in a central shared health record system (SHR). The third component was developed to standardize health facilities naming and hierarchy through a national master facility repository where each facility is given a unique code known as FOSA ID. The fourth component was introduced to store the information of health workers in Rwanda (health workforce registry) through a seamless integration with different professional councils. Lastly, the terminology registry also developed to harmonize the medical terms across the health sector. The terminology registry (TR) maintains a set of mapped open standards for clinical procedures, diseases, lab tests, and Drugs and consumables using the International Classification of Diseases Version (CD11), International Classification for Health Interventions (ICHI), Logical Observation Identifiers Names and Codes (LOINC) and National Product Catalog (NPC).

In pursuit of the Case-Based Surveillance objectives, some modifications to existing OpenMRS have been made and these adaptations have also been applied to the CBS Forms. To establish connectivity with the HIE system, it was necessary to upgrade core and non-core modules from the 1.9.11 version to the 2.5.6 version. Additionally, customizations have been performed on the Primary Care Module, Pharmacy Management, Metadata Management, HIV Flowsheet, Legacy UI, Data Flow Module, and the Provider Update Module. To attain the generation and exchange of MER indicators reports, there have been diligently established datasets that enable seamless integration with the reporting module, thereby facilitating the generation of the essential aggregate reports.

Currently, the deployment efforts have reached 197 healthcare facilities spanning 30 districts, however, some gaps have been noted throughout the implementation. The full HIE was expected to help clinicians share patient medical records between themselves and between health facilities in case of patient transfers, but due to the complexity of the HIE, the first emphasis was put on assigning the unique patient ID to both old and new cases. The rest of the components have now been deployed but the users haven't been trained on them. When you monitor the data exchange, the SHR receives a lot of data, but the clinicians were not yet trained to navigate it through and view patient data taken from another facility, which doesn't give a holistic view of the continuum of care. Despite the above-mentioned challenges, the HIE has brought a significant change in the patient journey, especially inpatient registration processes and seamless data exchange within HIV programs.

Table1: List of Acronyms

Acronyms	Expansion
AWS	Amazon Web services
CBS	Case based surveillance
CDC	Centers for Disease Control and Prevention
CII-CHIN	Center for Impact Innovation and Capacity Building for Health Information. And Nutrition
CSAMS	Clinical Staff Application Management System
DA	Digital Ambassadors
DHIS2	District Health Information System2
ELMIS	Electronic Logistic Management Information System
EMR	Electronic Medical Records
ETL	Extract, Transform and Load
FHIR	Fast Health Interoperability Resources
HIE	Health Information Exchange
HIV	Human Immunodeficiency Virus
HTC	HIV Testing and Counseling
ICD11	International Classification of Diseases version 11
ICHI	International Classification of Health Interventions
ID	Identification
InSTEDD	Innovative Support to Emergencies Diseases and Disasters
IT	Information Technology
JICA	Japan International Cooperation Agency
JSON	JavaScript Object Notation

LOINC	Logical Observation Identifiers Names and Codes
LTS	Long term support
MEMMS	Medical Equipment management and maintenance System
MER	Monitoring, Evaluation and Reporting
MINICT	Ministry of Innovation and ICT
MS-Azure	Microsoft Azure
MTID	Medical Technology and Infrastructure Division
MySQL	My Structured Query Language
NCSA	National Cyber Security Authority
NDTP	National Digital Talent Policy
NIDA	National Identification Agency
NPC	National Product Catalog
NRL	National Reference Laboratory
OI	Opportunistic Infections
OpenMRS	Open Medical records System
PEPFAR	The U.S. President's Emergency Plan for AIDS Relief
PIT	Provider-initiated HIV testing
QT	QT Global software LTD
SAVICS	SAVICS
SHR	Shared Health Records
SQL	Structured Query Language
UI	User Interface
UNAIDS	Joint United Nations Programme on HIV/AIDS
UPID	Unique Patient Identification
VLSM	Viral-Load System Management
VPN	Virtual Private Network
WHO	World Health Organization

1. Objectives

- This report provides a highlight of Rwanda's Digital Health Ecosystem by focusing on Case-based surveillance platforms and the accomplishment of RHIE over the last 3 years
- Generate actionable recommendations for future investments.

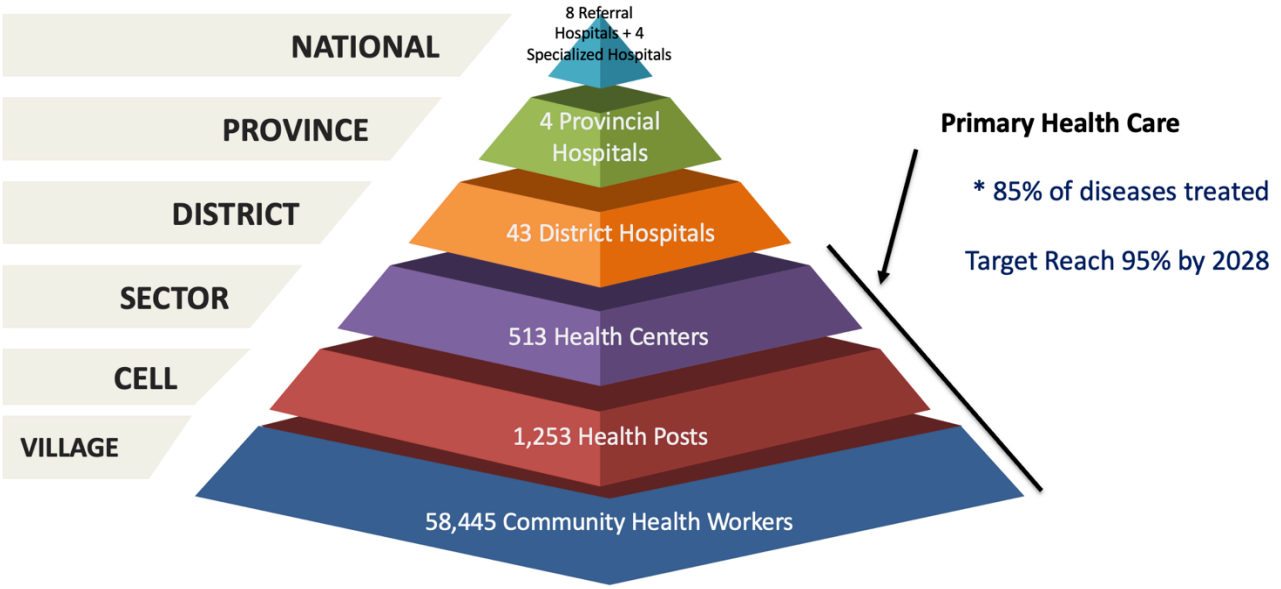
2. Approach and Methodology

The Center for Impact Innovation and Capacity Building for Health Information and Nutrition (CII-CHIN) used a holistic and structured approach to consider the wider RHIE digital platform's implementation, along with specific CBS digital interventions at the point of care, to assess if they have contributed to the overall digital health goals.

The consultants conducted field interviews and observations to assess the impact of the Rwanda Health Information Exchange (RHIE) on the continuum of care, particularly within HIV programs at selected sites, including Kibagabaga Hospital in Gasabo district, CorUnum Health Center in Nyarugenege district, We-Act Clinic, Rubona Health Center in Rwamagana, Rubengera Health Center in Karongi, Musambira Health Center in Kamonyi, and Nyamata Hospital in Bugesera. These sites were chosen based on the significant data they have submitted to the Shared Health Record and Client Registry over the past seven months, indicating higher utilization compared to others. Additionally, the consultants evaluated the core tenets of HIE service levels, focusing on its role in reducing the complexity and fragmentation of digital systems.

The analysis examined the point-of-care systems to understand the user's experience. It also reviewed Rwanda's information communications technology (ICT) and enabling environment to understand the overarching context in which patient and provider-facing digital tools operate. Together, those findings informed areas for further growth within the ICT-enabling environment and how these improve the point of care. Recommendations build on these findings to suggest where the Ministry of Health's prioritization can have a bigger impact and return on investment.

3. Health System Overview



Public healthcare structure (Source of data: Rwanda HMIS)

Rwanda's healthcare system is serving approximately 13 million people. There are eight national referral hospitals and four provincial hospitals. Supporting the referral and provincial hospitals are 43 district hospitals that facilitate the flow of patients between community health centers and higher-level facilities.

The next level of the public healthcare system is composed of a network of 518 health centers and 1,253 health posts with approximately 58,445 community health workers (CHWs). In addition to the public healthcare infrastructure, Rwanda also benefits from private healthcare providers. Population growth and the burden of chronic conditions have posed serious threats to improvement in health outcomes. While innovation in healthcare delivery and financing have brought advances in the healthcare industry, Rwanda's Healthcare systems face significant challenges such as growing populations, longer lifespans, multiple chronic conditions, insufficient doctors and nurses, and strained budgets. However, the same challenges present numerous opportunities to advance patient care and increase the impact that health professionals can provide.

To monitor and manage diseases, allocate resources efficiently, increase access to healthcare services, improve healthcare delivery, and drive positive health outcomes, the government must continue to mature its existing health information systems and digital health capabilities.

4. Policy and Related Laws

Policy and legislation refer to developing, implementing, and regularly reviewing national policies and legislation governing digital health. In Rwanda, several strategic plans have been established to guide the country's development across various sectors.

4.1. National Digital health-related Strategic plans

At the core of Rwanda's development efforts there is Rwanda Vision 2050 [1] and the National Strategy for Transformation (NST1), 2017–2024[2]. These strategic plans serve as blueprints for the country's socio-economic transformation and long-term aspiration to become a high-income country with a better quality of life for the population.

4.1.1. ICT sector Strategic plan

The ICT Sector shall continue to be a catalyst for rapid and sustained economic growth, equitable social development, and employment creation. The ICT SSP has defined the following seven pillars: Smart Cities, Fintech, Smart agriculture, Trade& Industry, Health, Education, Government, Women and Youth Empowerment in ICT. Along with three redefined enablers: ICT Capability and Capacity Development, Smart Governance and intelligence, and secured & shared infrastructures.[3]

4.1.2. Rwanda Health Sector Strategic Plan, 2018–2024

In alignment with Rwanda Health Sector Strategic Plan, 2018–2024. This strategic plan focuses on harnessing ICT to drive socio-economic transformation and on improving the quality and accessibility of healthcare services.

In the context of Rwanda's Health Sector Strategic Plan, 2018–2024[4], emphasizes the importance of health information systems in strengthening the health sector and achieving universal health coverage. By 2024, the plan aims to ensure the availability of interoperable, responsive, and functional information systems to streamline the timely collection, analysis, and dissemination of high-quality data to inform planning and decision-making. Specifically, SSP4 aims to extend the deployment of the electronic medical record (EMR) system to all public hospitals and to integrate all health information systems (HIS). It is also committed to promoting new digital health solutions to enhance patient management, improve the quality of health services, and increase data utilization for decision-making.

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[1] https://www.minecofin.gov.rw/fileadmin/user_upload/Minecofin/Publications/REPORTS/National_Development_Planning_and_Research/Vision_2050/English-Vision_2050_Abridged_version_WEB_Final.pdf

[2] https://vision2050.minecofin.gov.rw/fileadmin/user_upload/Publications/NST1/NST1.pdf

[3] https://www.minict.gov.rw/index.php?eID=dumpFile&t=f&f=1110&token=3c72357ef5a933870448878fe42162871262fcc6

[4] https://www.moh.gov.rw/index.php?eID=dumpFile&t=f&f=25999&token=ed64a48ec308901591d77d78816faf67ce888b64

4.1.3. National Digital Health Strategic Plan, 2018–2023 and Digital Transformation Strategy

The Ministry of Health (MoH) developed the National Digital Health Strategic Plan, 2018–2023[5], and Digital Transformation Strategy. These strategic plans set the long-term vision for digital health in Rwanda. The Digital Transformation Strategy, developed in partnership with the Rwanda Information Society Authority (RISA), sets the tone for the MoH's priorities and activities in the context of digital transformation and aims to accelerate the achievements outlined in the digital health strategic plan. It outlines the main phases of the roadmap and guides principal digital interventions to achieve the desired outcomes. Since the launch of this strategy, all digital initiatives have been aligned with it, but the entire strategy and roadmap require additional updates to reflect the current implementation and some identified gaps.

The first phase of the roadmap was eighteen months after the kickoff of the first activity in April 2021. The above phase comprised a set of projects to lay the groundwork including the robust Health Information Exchange where different digital interventions operate together, rather than as duplicative and isolated systems, to meet the needs of the country as stated in the digital transformation strategy.
In line with the first phase, both the government and development partners made efforts to establish foundational initiatives, including a health cloud, an enhanced electronic medical record (EMR) system, and a community health worker (CHW) and health post-management information system. Additionally, the Health Information Exchange (HIE) was one of the key priority projects, with its development driven entirely by open standards promoting data interoperability and security.

The second phase - Enabling Intelligent Health & Healthcare (not yet tackled) is 24 months in duration and will build on the foundations established in Phase 1. It will focus on the full rollout of the HIE to all public and private health facilities as well as enabling other services that provide the most value to patients and providers. These include a patient portal and mobile app, clinical and operational analytics, expanded telemedicine, clinical decision support, and a health bot.

Third Phase - Transforming Health & Healthcare (not yet tackled) is 24 months and will build on the capabilities established in the previous 2 phases. It focuses on achieving maximum value and establishing the target state, with a move towards prevention-based health. The specific areas of focus include genomics/precision medicine, patient relationship management, remote patient monitoring, EMR standardization, population health management, care coordination, and establishing a center of excellence for artificial intelligence (AI).

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[5] https://extranet.who.int/countryplanningcycles/sites/default/files/public_file_rep/RWA_Rwanda_Digital-Health-Strategy_2018-2023.Pdf

4.2. Legislation in place

A Law relating to the protection of personal data and privacy[6] passed in 2021 creates robust protections and protocols for the management and use of personal data, including digitized data. It provides rights for data subjects and the creation of data controllers and processors to take on specific roles in data management. It also includes requirements regarding sharing data outside the country. The law requires that the data controller or data processor store personal data in Rwanda unless the data controller or data processor has a valid registration certificate issued by the National Cyber Security Authority (NCSA) authorizing them to store personal data outside Rwanda.

5. Digital Health Governance and Capacity Building

5.1. National Digital Leadership and Governance

In the context of health, several leadership authorities and structures exist to govern ICT and digital health in Rwanda including:

- **The Ministry of ICT & Innovation (MINICT):** The Ministry of ICT and Innovation is mandated to monitor and evaluate the implementation of national policies, strategies, and programs to promote technology and communication, developing and disseminating policies, strategies, and programs for ICT and Innovation.

- **The Rwanda Information Society Authority (RISA):** RISA has the mandate of planning and coordinating the implementation of the national ICT Agenda.

- **The Ministry of Health (MoH):** The mission of the MoH is to provide and continually improve affordable promotive, preventive, curative, and rehabilitative health care services of the highest quality, thereby contributing to the reduction of poverty and enhancing the general well-being of the population.

- **The Rwanda Biomedical Centre (RBC):** The RBC is Rwanda's national health implementation agency acting on behalf of the MoH. RBC promotes high-quality, affordable, and sustainable health care services to the population through evidence-based interventions and practices guided by ethics and professionalism.

[6] https://www.risa.gov.rw/index.php?eID=dumpFile&t=f&f=65369&token=15e7fad700949646dd7c1faae89f9663048f4f92

- **The National Cyber Security Authority (NCSA):** The NCSA coordinates national cybersecurity functions in Rwanda to protect citizens and all organizations from cyber threats. The NCSA provides guidelines for securing ICT infrastructure and information. It is also responsible for compliance with the Protection of Personal Data and Privacy law and the Prevention and Punishment of Cyber Crimes law.

5.2. Chief Digital Office

- **Digitization Directorate General and Chief Digital Officer (CDO):** A CDO is assigned to each sector's ministry. In the health sector, the role of the CDO is to coordinate and streamline digital health initiatives and ensure the alignment of the overall national ICT strategic plan. On MOH structure, this directorate is composed of 15 staff mandated to support the entire sector in collaboration with IT staff deployed in all public hospitals.

- **Digital Health Committee:** biweekly platform within the MoH under CDO's office, which is an internal digital health committee, that brings together information technology (IT) representatives from various programs within the ministry and affiliate institutions, serves as a technical working group that assesses the progress made towards achieving targets and reviews proposals for new projects. They evaluate whether the tool fills a need expressed in the current digital health ecosystem and aligns with government priorities. They then examine the architecture and technology stack to determine if it is compatible with existing HIS infrastructure. Cost and sustainability are also evaluated at this stage.

- **Digital Health Technical Working Group (TWG):** The Digital Health TWG includes all stakeholders involved in the digital health space and, therefore, evolves as new partners join. The Digital Health TWG is chaired by a permanent secretary, co-chaired by RISA, and convenes every quarter. During this meeting, clinical and programmatic end users evaluate the tool's usefulness. It is also the forum to share the progress in implementation of digital health initiatives with TWG members so that they can be aware of what is going on.

5.3. Strengthening Digital Workforce

5.3.1. Skills development

Rwanda is increasingly strengthening its digital workforce. Every year, RISA conducts a digital skills gap analysis and generates a list of ICT certifications required to enhance the ICT skills of government employees. In addition, the government has initiated several initiatives to promote digital skills,

including the National Digital Talent Policy (NDTP) [7] with Digital Ambassadors (DAs) who are recruited from among young social innovators and are deployed in communities throughout the country in order to directly train citizens in accessing e-Government and other digital and mobile services, Secondary research found that the not-for-profit, non-governmental organization, Society for Family Health, hired 40 Digital Health Officers to be based at a portion of the 200 health posts they support, to manage and provide staff and patient training on the point-of-care digital tool being piloted in their intervention sites. There was an additional digital resource deployed in PEPFAR sites to strengthen the use of EMR and HIE through which the MOH and ICAP have deployed 20 digital officers dispatched to 197 CDC/PEPFAR sites. The above temporary workforces came to strengthen both central and decentralized IT teams. The MOH digitalization as the coordinating entity, oversees the implementation in collaboration with 2 IT officers deployed at each hospital who provide technical support within the hospital and the catchment area (health center and health posts)

As the retention of technical teams who work on such big projects is becoming very problematic globally, the Rwanda Information Society Authority has decided to engage local private companies to outsource their skills and this was the basis of engaging QT Global software to work on the Rwanda Health Information Exchange project.

5.3.2. Capacity building through Hackathons

Through the existing technical assistance platform (TAP), CDC and the Ministry of Health have established hackathons as an effective forum for brainstorming and resolving identified technical issues. Hackathons are a hands-on approach for the software development team to develop solutions to real world problems within defined contexts and use cases. Between November 2022 and August 2024, Rwanda hosted a series of hackathons in Kigali, which led to significant advancements in the country's health information systems. Each hackathon focused on distinct areas but shared a common goal: to strengthen Rwanda's Health Information Exchange (HIE) infrastructure, build local capacity, and foster a more integrated and efficient healthcare system. These events brought together a diverse group of global and local experts including representatives from the Ministry of Health (MoH), RBC, UCSF, CIICHIN, CDC, ICAP, QT Global Software, PIH, and Jembi who collaborated to address key challenges and drive innovation within the healthcare infrastructure.

First Hackathon (November 7–11, 2022)

Hosted at the Kigali Convention Center and centered around enhancing the OpenHIM and HIS systems. During this event, the technical teams embarked on a comprehensive assessment of the existing Rwanda HIE infrastructure. This assessment led to a critical evaluation of the system's performance, revealing

[7] *https://rwandatrade.rw/media/2016%20MINICT%20Digital%20Talent%20Policy.pdf*

key areas that required immediate attention. To address these challenges, the teams deployed a transaction monitoring system based on Prometheus and Grafana, which were specifically tailored to the Rwanda use case. This tool provided crucial insights into the operational status of the HIE, allowing for more informed decision-making.
In parallel, significant efforts were directed toward security.

Key achievements from the first hackathon

- A thorough security assessment was conducted, and the most pressing vulnerabilities were addressed. The teams also laid out options for scalability, with a particular focus on optimizing MongoDB, which was identified as the most stressed component of the infrastructure. The outcome of these discussions was a robust architecture plan for future infrastructure upgrades, designed to ensure that the HIE could scale effectively as the demands on the system increased.
- Rwanda's OpenHIM instance was upgraded from version 5.12 to version 8.2 for enhanced traffic monitoring and data visualization.
- The team developed a monitoring tool based on Grafana and Prometheus, which provides key performance and transactional information HIE
- Furthermore, the hackathon placed a strong emphasis on capacity building. Technical staff from the Ministry of Health and QT Systems received in-depth training on the deployment and optimization of OpenHIM, equipping them with the skills needed to manage and enhance the system independently. This knowledge transfer was crucial in empowering local teams to maintain and improve the HIE infrastructure beyond the scope of the hackathon.

Second Hackathon (June 5- 9, 2023)

The Second hackathon was held at Park inn Hotel Kigali. The hackathon looked at strengthening the existing Health Information Exchange (HIE), with a focus on improving HIE security and addressing performance enhancements identified in pre-hackathon activities. Additionally, the hackathon aimed at investigating the performance issues in OpenMRS.

Key achievements from the second hackathon

During the hackathon, several key achievements were highlighted regarding the Health Information Exchange (HIE) system.

- A comprehensive performance testing assessment was presented, which included modeling the current National HIE load to evaluate its performance. To enhance system oversight, a monitoring tool was successfully deployed to the production HIE infrastructure.
- The discussion continued to focus on the future HIE infrastructure architecture. The team reviewed the current HIE architecture, addressing the performance concerns identified during the testing phase. Options for HIE scalability were also presented and discussed, with a particular

focus on MongoDB, the database under the most stress. While the system is stable under the current load, plans for future scalability were outlined to ensure smooth operation as demands grow.

- Lastly, the team worked on a new configuration of OpenMRS global property to include encounters and observations in the patient dashboard, resolving an issue where the dashboard would hang for patients with more than 500 encounters. Moreover, an ETL (Extract, Transform, Load) process was set up to improve overall performance and prevent the system from hanging when pulling large financial reports from the EMR/OpenMRS.

Third Hackathon (September 11-15, 2023)

The third hackathon, also held at Park inn Hotel Kigali with the following objectives:

- Validate the OpenHIM Operational Dashboard with a view of its use to monitor the EMR-VLSM exchange amongst others
- Ensure the dashboard supports tracking of the EMR-VLSM data exchanged.
- Implement the JSON-based (non-FHIR) EMR-VLSM integration in the Production environment
- Implement the FHIR-based EMR-VLSM integration in the Testing environment via FHIR server

Key achievements from the third hackathon

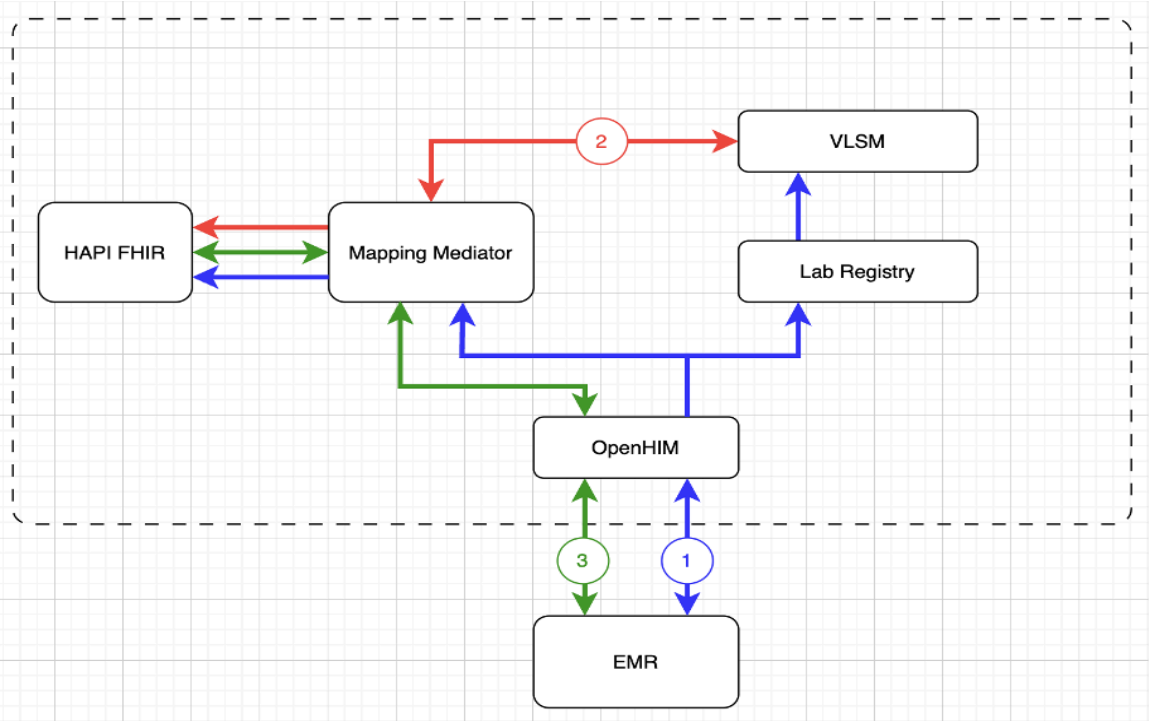
- The event was marked by the successful validation of the OpenHIM Operational Dashboard. This dashboard became a critical component in ensuring the transparency and reliability of data exchanges across the health system.
- Another standout accomplishment of this hackathon was the implementation of both JSON-based and FHIR-based EMR-VLSM integrations. While the JSON-based integration was tested on a demo server, the FHIR-based integration underwent rigorous testing, setting the stage for future deployment. These integrations were essential in ensuring that the EMR could communicate effectively with the VLSM system, thus improving the overall efficiency of healthcare data exchange processes.

Fourth Hackathon (August 12-16, 2024)

The 4th Hackathon marked significant progress in integrating the EMR with VLSM, refining the operational dashboard, and upgrading the Rwanda EMR/OpenMRS system to the OpenMRS 3.x (O3) version while addressing identified performance issues. By focusing on immediate, impactful tasks and planning for future upgrades, the team ensured that the project continued to advance effectively and efficiently. This hackathon not only built on previous achievements but also set the stage for continued success in enhancing Rwanda's healthcare system through digital innovation.

Key achievements from the Fourth hackathon

- The team concentrated on refining the operational dashboard using Grafana and Prometheus. After a thorough review, necessary updates were made and successfully deployed to the production environment, ensuring that the system operates with the latest enhancements. Detailed documentation of all relevant metrics was also completed using Grafana and Prometheus, which are crucial for ongoing system monitoring and troubleshooting. These tools effectively capture vital EMR-lab transactional data exchange, including both lab requests and results, across the HIE system.
- Substantial progress was made toward transitioning to the OpenMRS 3.x platform. Although the Minimum Viable Product (MVP) is still a work in progress and not yet ready for deployment, significant milestones were reached. However, the Ministry of Health (MoH) will need to expand the work to cover all forms and conduct full testing with the relevant end users. While billing is not the sole cause of reported performance issues, it contributes significantly due to its data-fetching approach in reports. To address this, the team-initiated enhancements by moving to a pagination method to avoid memory overload.
- For the broader performance issue, the team recommended migrating to the O3 interface, which offers a modern user experience and improved performance through better resource management practices. Recognizing that such a migration will take time, the team also explored the possibility of implementing a patch fix for the Legacy UI module to enhance system performance immediately. Although this patch is not a long-term solution, it is necessary under the current circumstances.
- The MambaETL process was successfully upgraded, enhancing scalability across healthcare facilities. Lab request exchanges from EMR to VLSM systems were also implemented using the FHIR standard, although further work is needed to validate the orders and results by comparing the values at the source and receiving systems.



FHIR based integration architecture (data flow architecture between EMR, OpenHIM, VLSM and HAPI FHIR server)

Overview of Flow 1: submit lab order

- *The EMR submits the lab order as a json payload*
- *The OpenHIM routes this payload to both the Mapping Mediator and Lab Registry*
- *The mapping mediator transforms the json payload into FHIR and stores it into HAPI FHIR*
- *OpenHIM returns a confirmation message back to the EMR*

Overview of Flow 2: submit lab result

- *VLSM submit the lab result as a json payload*
- *The mapping mediator transforms the json lab result into FHIR and stores it into HAPI FHIR*
- *The mapping mediators returns a confirmation message to VLSM*

Overview of Flow 3: retrieve lab results

- *The EMR initiates a query to get lab results*
- *The mapping mediator queries HAPI FHIR to retrieve the results, and transforms the lab results into json format*
- *OpenHIM returns the lab results json back to the EMR*

6. Government's investment in Digital Health

Country ICT infrastructure refers to the physical infrastructure that forms the foundation for digital health systems. This includes the availability of electricity, Internet connectivity (in the form of fixed or mobile broadband), and digital devices, such as mobile phones, tablets etc.

6.1. Power and Electrification

The Government of Rwanda has initiated several power generation projects to improve access to electricity. As of June 2024, the cumulative connectivity rate in Rwanda is 78.9% of Rwandan households whereby 55.9% of all households in Rwanda are connected to the national grid. With the recent desk review, the electricity supply at hospitals was at 100%, and health centers connected to either national grid or off-grid systems were at 100% as of end 2023.

6.2. Digital Infrastructure

Data from the Rwanda Utilities Regulatory Authority (RURA) indicates that by the end of June 2024, the active mobile subscriptions in Rwanda experienced a 15.5% increase, reaching 13.5 million from the 11.7 million SIM cards recorded at the end of June 2023. This growth led to a rise in active mobile-cellular telephone subscriptions per 100 individuals, escalating from 87.4% in June 2023 to 98.7% in June 2024.[8]

Over 80 percent of Rwanda's population access public services through the online platform, irembo including health services. The 4G internet covers 95.2 percent of the Rwandan geography and reaches 97.2 percent of the population. Internet penetration is at 58.3 percent with only 16 percent using 3G and 4G. Furthermore, more than 90 percent of healthcare facilities are connected to the Internet. [9]

Despite the investment and significant increase of internet connectivity, there are still some areas with limited or no connectivity. In addition, the average cost of the Internet in a health center is approximately 100$ monthly, which is slightly expensive. However, given that the internet market is growing so fast through enabling many internet providers to invest in that space, the cost is expected to be reduced due to competition. On the other hand, the cost of smart mobile devices is still high despite many campaigns for acquiring affordable devices like the "Macyemacye" campaign. The above

[8]https://rura.rw/fileadmin/Documents/ICT/statistics/Statistics_Report_for_Telecom__Media_and_Broadcasting_Sector_as_of_the_Second_Quarter_of_the_Year_2024.pdf

[9] *MINICT website: https://www.minict.gov.rw/news-detail/what-you-should-know-about-connect-rwanda campaign#:~:text=Currently%2C%20on%20average%202G%20and,cent%20using%203G%20and%204G.*

challenges reflect the financial barrier for extending the usage of digital systems and applications across Rwanda's healthcare sector.

6.2.1. Interoperability and Standards

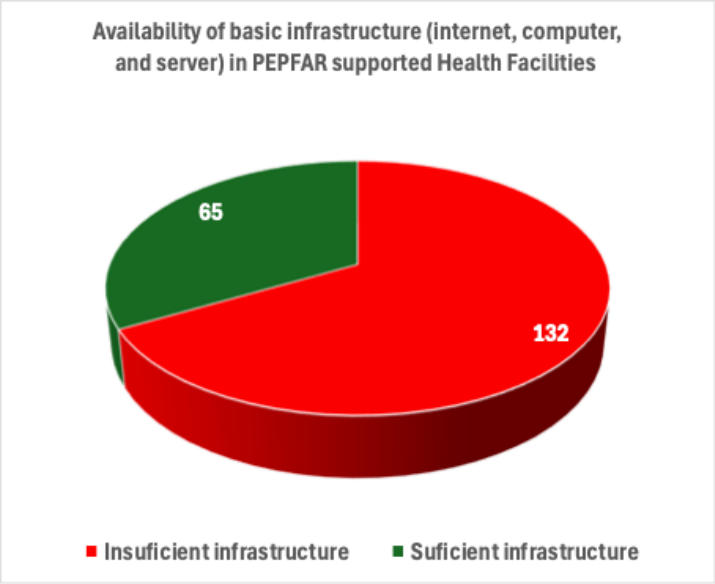
Interoperability serves as a critical national infrastructure aimed at connecting all current and future systems within the ecosystem. It adheres to standards that enable seamless integration between diverse ICT systems and components, ensuring solutions that are scalable, flexible, and vendor-neutral. By promoting interoperability, these standards foster innovation, reduce integration costs, and improve efficiency in healthcare. The Ministry of Health has taken a step further by defining the Data Management and Interoperability Standards, which govern the integration of various systems within the health ecosystem. While the implementation of RHIE is ongoing, the standards document is currently being updated to meet evolving requirements.

6.2.2. IT infrastructure in PEPFAR sites

The Ministry of Health, in collaboration with CDC-PEPFAR under its Technical and Science Support Services (TSSS) mechanism, has actively funded the foundational phase of the digital transformation strategy. Since 2018, TSSS, through its Strategic Information component, has placed significant emphasis on strengthening the National Health Information Exchange (HIE), aligning it with HIV case-based surveillance (CBS) from development through to the piloting of the minimum viable product.

Additionally, the CDC has played a crucial role in establishing the backbone infrastructure that supports the smooth and efficient operation of digital health initiatives. Over the last three years, the Ministry of Health and CDC have invested in IT infrastructure to lay the foundation for deploying, operating, and managing the digital health ecosystem. This infrastructure includes mainly a collection of servers, computers, and the internet.

Summary report on infrastructure in PEPFAR supported sites:



65 out of 197 sites are fully equipped.
Basic Infrastructure Requirements:

- A functional Internet connection
- At least one server capable of accommodating the OpenMRS latest version
- A minimum of four computers dedicated to HIV management

6.3. Overview of Rwanda Digital Health

Building on the above digital foundation, Rwanda has implemented numerous information systems over the past decade. These include the integrated routine reporting Health Management Information System, Electronic Medical Records, Electronic Logistics Management Information Systems, Mobile Community-Based Information Systems, Human Resources Information System, Laboratory Information System, Integrated Disease Surveillance Information Systems, Health Resource Tracking Tool, Blood Bank Information System, and others. To ensure interoperability across these systems, the health sector has adopted a standards-based health information exchange (HIE) platform.

Key Milestone in the last decade: Major Digital Solutions Successfully Implemented on a Large Scale

- **DHIS2 (adopted in 2012):** This platform consolidates national clinical, logistical, and health resource data from the local health facility level up to the national level, providing critical support for leadership in planning, resource allocation, and informed decision-making. Furthermore, DHIS2 has been tailored to monitor a range of events and individual data, including electronic tuberculosis records, integrated disease surveillance, cancer registries, non-communicable disease tracking, hepatitis monitoring, and the management of fortified blended foods for vulnerable groups, such as pregnant women, lactating mothers, and children under two.

- **OpenMRS**
  In 2012, The Ministry of Health decided to use OpenMRS as the principal EMR for HIV patient management. The package for the hospital is extended to the Registration, consultations, lab orders management and payment. The EMR/OpenMRS system is operational in 36 out of 39 district hospitals, 3 out of 4 provincial hospitals, 3 out of 8 referral hospitals, and over 450 health centers, albeit with limited functionality due to infrastructure constraints. Some hospitals have opted for alternative platforms like OpenClinic.

- **RapidSMS:** Launched in Musanze District in 2009 and expanded nationwide by 2012, RapidSMS is an SMS and mobile technology system that improves the monitoring of pregnant women and newborns. It manages the pregnancy cycle and maternal and newborn care in the community, while also enabling emergency reporting through Red Alert messages. The tool is now used nationwide.

- **Electronic Logistic Management Information System (eLMIS):** This system enhances the procurement, storage, and distribution of medical commodities for Rwanda Medical Supply. It allows all public health facilities and district pharmacies to efficiently process orders and receive supplies.
- **Clinical Staff Application Management System (CSAM):** Launched in 2023, CSAM is a web-based application that facilitates the recruitment and transfers of health professionals by ensuring transparency from job vacancy announcements to appointments.
- **eLearning:** Since January 2018, the health sector e-Learning System has provided continuous learning for the workforce through a blended approach, combining online distance learning, virtual face-to-face sessions, and local in-person facilitation.
- **Health Facilities Licensing Platform:** This newly launched web-based solution digitizes the entire health facility licensing process, from account creation to electronic license issuance. It streamlines operations, reducing the burden on the Clinical Service Department and improving report generation.

- **Medical Equipment Management and Maintenance System:** A newly enhanced web-based portal that supports the maintenance of medical equipment. It helps with the registration of medical equipment, planning routine maintenance, and performing emergency maintenance. The tool facilitates communication between providers and maintenance teams, allowing for quick response to equipment malfunctions. It has recently been revised to be more user-friendly and dynamic, including a mobile app. Additionally, it provides oversight for the Ministry of Health and Rwanda Biomedical Center.
- **Health Resource Tracking Tool (HRTT):** Initially developed in 2013 to monitor financial flows within the healthcare sector, this platform is currently being updated to meet new business requirements.
- **Community and Health Post Information System (CHIS):** A recent project aimed at digitizing patient healthcare services in communities and health posts, starting with pilot programs in Kigali and select districts. The tool is being rolled out countrywide.
- **Blood Bank System:** The Ministry of Health has initiated a project to revamp the existing Blood Bank System to ensure adequate, safe, and effective blood management, with plans to enhance the system's engagement with blood donors. The tool has been enhanced to cater to all needs and it is now in use.

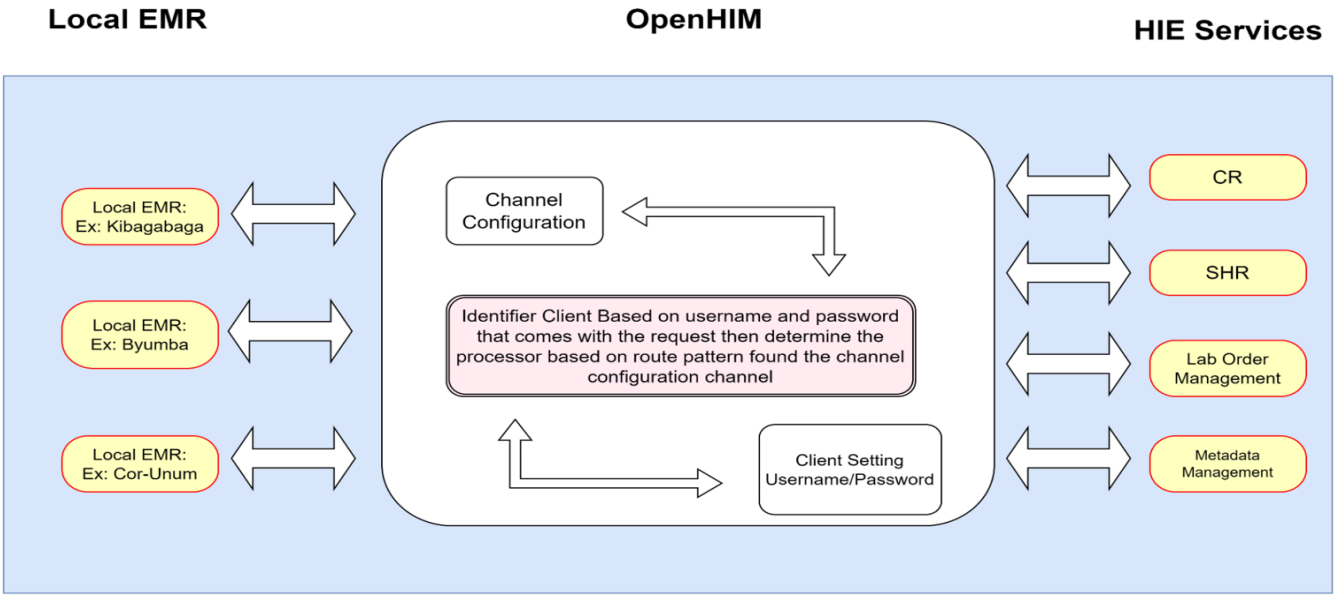
6.3.1. Progress on the Rwanda Health Information Exchange ecosystem

6.3.1.1. OpenHIM

The Open Health Information Mediator (OpenHIM) is a middleware component designed to ease interoperability between disparate information systems. It provides secure communications and data governance as well as support for routing, orchestrating and translating requests as they flow between systems.[10]

Specifically, it helped in monitoring transactions between OpenMRS and shared health records (SHR) where data from various component systems are transferred for uploading to the SHR registry and downloading saved records for clinician review at the health facility.

[10] *https://openhim.org/*



This picture shows how OpenHIM interacts with local EMR/ OpenMRS and other national resources

The above figure describes how information is flowing out in HIE ecosystem. In OpenHIM, a channel captures requests that align with its configuration and directs these requests to one or more routes specified within the channel's configuration. Once OpenHIM receives the response from the primary route, it promptly returns it to the sender of the initial request.

6.3.1.2. Client registry

In the context of the Client Registry, it has been integrated with the National Identification Agency (NIDA) database, which is used in verifying patient identity and retrieving demographics for registration and complies with FHIR format to enhance interoperability. This significantly simplifies the registration because 90% of the information required during registration is retrieved and auto-filled in the registration form. The system generates a unique health ID known as unique patient identification (UPID) based on various identifiers, such as national ID, national identification number, application number, community-based insurance, and passport numbers. The unique health ID is ubiquitous and is not localized to an individual health facility but can be used to identify a patient across all facilities nationally. UPID number is formed with 3 digits represented by the patient's date of Birth, Facility code where the service was provided and a random number.

UPID format: YYMMDD-Facility Code-Random number. Eg (240308- 1140 – 9963)

The Client registry was initially launched at both Kibagabaga Hospital and CorUnum Health Center and later deployed in the rest of CDC PEPFAR-funded sites and longitudinal patient data can be linked for patient visits within implemented sites. Kibagabaga and CorUnum use one document ID (the national

ID, NIN, foreign ID, passport, primary care ID, or Application number) to search the existing patients or generate UPID for a new patient. At this level, the existing patient who holds a UPID can be found through searching so that the system cannot allow duplicates.
The Communication with Client Registry happens when the Health Facility would like to identify the patient during registration. This happens for two original purposes:

- Searching Patient demographic/identification information from NIDA
- Saving retrieved information in the Registry for later easy access whenever required.

This communication is initiated from the Rwanda Primary Care module in OpenMRS where all functionality of Patient Identification is located.

Findings

Feedback recorded:
"The patient registration using this new model is so quick since it doesn't require filling in demographic details. The registration time moved from four minutes to two minutes or less with the new registration process using CR. However, searching the patient using his foreign ID (Rwanda ID that is given to special foreign groups like refugees.) doesn't retrieve demographic information

The end-users attested that the patient registration is performed in different ways described in below scenarios:
UPID at the Facility is generated when one of the below cases happens:
Scenario 1 (the site is online, and the patient has one official document)

- The client presents one of the official identification documents
- The system checks if the client/patient exists or not in the client registry of the local EMR/OpenMRS
- UPID generator retrieves client demographic data (Names, DoB, Gender, Location where the ID was issued, Marital status) and UPID Generator issues the Patient UPID
- The patient details including demographic information are sent back to OpenMRS
- Patient data are saved in local OpenMRS instance

***Some noted exceptions*:**

- If the client doesn't have any official document ID: Searching combines different attributes like names and age or gender to find the patient
- When the client document is Passport: Because NIDA doesn't have Passport ID as one of the national population attributes, the UPID generator issues the UPID without further

authentications to NIDA. However, if the patient is registered, he/her demographic information is captured once and will never be captured again at any point of registration in health facilities.

- The registration process can be improved in the future by having scanners that easily scan the ID card number details instead of typing the number manually, hence cutting down the registration time

Scenario 2 (when the population registry is offline or not accessible)

This scenario represents different cases where the facility is not able to authenticate the client.
The system checks if the patient is already registered in the local EMR/OpenMRS instance. However, when the NIDA goes up, the CR never synchronizes with it to update patient identification. This scenario was not implemented at this stage. The patient continues using a temporary ID

- The system creates a TempID (system ID, for example: Primary care ID). This tempID is passed to the UPID Generator and the patient is assigned a UPID which enables it to fill the required demographic information.
- Save patient details and send them to CR
- UPID is generated and patient details are saved in CR.
- EMR/OpenMRS then updates patient records

Scenario 3 (the site is offline, or CR is not accessible)

The third scenario represents the very rare situations where the facility experiences an internet issue or downtime of the UPID generator.
In such a scenario, the local EMR/OpenMRS generates a temporally UPID, and all required demographic information is filled at the point of registration. The patient demographic and medical data are kept in local EMR/OpenMRS until the connectivity is restored to be able to synchronize with CR. In this case, the patient data both demographic and medical data remain at the premise until CR recognizes and saves the UPID.

6.3.1.3. Facility and Provider registries

The facility and provider registries were fully developed and approved to be sources of users for the local medical records (EMR) system. Since their implementation requires a lot of enforcement at the policy level, both registries are deployed in testing environments. Basically, they will be managed by MoH admin users to reconcile health provider Identification into a single controllable repository.

Whereby every healthcare provider, registered and licensed to practice in Rwanda, should have access to the local EMR only if he/she has records in the central Provider Registry (PR) and his/her license to practice is configured as an identifier in provider management from EMR. The health provider information (names, national ID, council registration number, license validity) is shared with EMR from the Provider Registry using a provider update module designed to request on-time basis information regarding the status of registered providers and updates the local EMR accordingly.

The provider registry and facility registry use a MongoDB storage to store required information for later access they can upload, and create a new provider, facility or any other task related to provider information.

6.3.1.4. Shared Health Records

Shared Health Records maintains the patient health record in a centralized repository and complies with FHIR format to enhance interoperability. Currently, the SHR holds various health information grouped under four categories, but the summary report will come in future enhancements:

- Encounters are the type of records where patient enrollment and visit-related information are captured.
- Observations are the type of records where the patient's vitals and clinical observation are captured. The patient summary records will come later in upcoming enhancements
- Service requests are the type of records where various kinds of health service requests are tracked for a given patient such as lab diagnostic requests.
- Medication requests are the type of records where information about the supply and administration of medication to a patient is tracked.

Findings

The SHR is deployed in a production environment where the clinicians can use it. However, at this early stage of the HIE implementation, the SHR as the essential registry of RHIE is not fully operational. It requires training to the clinicians to be able to utilize and benefit from it. Also there is a concern regarding data privacy and patient consent to be considered to ensure that the aspect of information security and data privacy is achieved.

6.3.1.5. Terminology Registry

The harmonized coding scheme of all clinical terms is an important requirement in HIE implementation. The Terminology Registry enables the local EMR to look up clinical codes needed for various workflows such as medical prescriptions or drug orders, service requests, disease information etc. The following semantic coding standards were emphasized:

- International classification of diseases version 11 (ICD11)
- International Classification of Health Intervention (ICHI)
- Logical Observation Identifiers Names and Codes (LOINC)
- National Product catalog for medical products (NPC)

All those services are required by clinicians, and they are integrated with EMR/OpenMRS within two identifiable stages:

- Local EMR register required concept which matches with those terms as required by OpenMRS
- Remote service holds the endpoints required to serve searching and naming required terms.

Findings

This registry has passed through the development stages and was successfully tested. It is now in a testing environment waiting to be operationalized.

6.3.1.6. Laboratory Registry

Lab Order registry is another essential resource created under the RHIE framework to integrate with external lab systems namely VLSM and Labware for samples and results which are required to be monitored or transferred to the upper layer for testing. This service uses a MySQL database to store all its information. Local EMR are connected to this service when trying to send sample requests to be tested and the same communication is required when a clinician would like to check for lab results.

The service itself makes a periodic request to check if a given sample has a result available once found. It records the result in the MYSQL database waits for clinicians to try to check the result and automatically returns the result without consulting the external service provider because the result is cached in the database. This lab service was developed for HIV tests which are not performed at the premises of some health facilities. Most of these lab cases are viral load, CD4 count, and recency tests. Lab request exchanges from EMR to VLSM system were also improved using the FHIR standards, although further work is needed to deploy the solution in production.

Findings

We observed that the registry has been tested in a testing environment but has not yet been deployed to the production environments. The integration using JSON and FHIR standards is currently being tested, focusing on the business flow of the lab process.

6.3.1.7. DHIS2 Tracker for HIV Case Surveillance

DHIS2 Tracker is an application within the DHIS2 platform that is designed for data collection, management, and analysis of individual-level (or case-based) transactional data over time. In addition, DHIS2 Tracker supports the event data model for individual-level data that is anonymous or not tracked over time. It also includes tools to support enhanced workflows at the facility or community level, such as SMS reminders and appointment schedules. In 2018, the CBS tracker was introduced and deployed in all 197 PEPFAR sites. More recently, the OpenMRS has been enhanced to cater for CBS forms and taken as the principal/source system for CBS data at PoC. OpenMRS covers all processes from HIV testing up to care and treatment when CBS came in as a new strategy for tracking new infections and transmission of HIV but its utilization differs from site to site. OpenMRS is newly upgraded to cater CBS enrollments, and the data are pushed to DHIS2 CBS tracker through the OpenHIM mediators.

Findings

During our site visit, we observed that the link between OpenMRS and the DHIS2/CBS tracker had been established. However, due to issues identified by users, both systems were still being used concurrently. For the sites visited more recently, these issues have been resolved, and users have begun updating OpenMRS/CBS as the primary platform. All records are now automatically pushed to DHIS2/CBS through the HIE.

6.3.1.8. OpenMRS

OpenMRS is a modular and open-source EMR platform designed to be used in healthcare settings. It provides a flexible and scalable solution for capturing, managing, and analyzing patient-level health information. At Kibagabaga and CorUnum health facilities, OpenMRS has been extended for use in nearly all points of care for patient management. However, at other sites visited, its use remains focused primarily on HIV management.

The tool has been used in Rwanda in different iterations since 2012. Despite this, it is not used in all facilities, and it doesn't cover all services. Being a modular system, it provides the flexibility to onboard other or new services.

The EMR/OpenMRS is implemented nationally across all 30 districts in Rwanda, including 42 hospitals and more than 450 health centers, however, the adoption and utilization are different. Normally, the clinicians are the primary users of the EMR/OpenMRS, at both health centers and hospital facilities. Beyond clinical protocols, automatic reports allow nurses to pull reports on patients and their bills over time. Aggregate reports generated by the EMR/OpenMRS are used by administrators and managers to assess performance, follow up with patients, and identify areas needing improvement. Accountants use the EMR/OpenMRS to pull reports for insurance reimbursement, and cashiers utilize it for patient billing. Data managers extract reports from the EMR to enter data into DHIS2. Ultimately, the clinician can submit lab requests, order medication, and get back the results for further decision.

A. Upgrade/backend level

The core modules of OpenMRS were upgraded and implemented to reflect the most recent interoperability features such as FHIR, and security fixes as well as bring it up to the most compatible level:

- Core OpenMRS modules upgraded from 1.9.11 to 2.5.6
- Adding support for Tomcat 8.5+ and 9
- Extending administration through REST endpoints for OpenMRS 3.0
- Fixing security threats
- On the server side, the server has also been upgraded from Ubuntu 16.04 LTS which was no longer supported up to Ubuntu 20.04 LTS. The Apache Tomcat has been upgraded from 5 to 8.5 version which is the closest compatible version to the ubuntu 20.04 LTS
- Introduction of MambaETL for optimizing the generation of heavy reports (i.e. monthly insurance reports)

B. Upgrade/ Front end level

- Review of HIV Forms adaptations to fit CBS was made on the following forms:
  - ✔ CBS Confidential HIV section1 for enrolment & section II for Follow-up Information,
  - ✔ Surveillance Form for Index testing, partner notification, and recency testing information,
  - ✔ CBS contact information,
  - ✔ Adult HIV Flowsheet for New Lab, HTC RESULTS, PIT RESULTS, HIV Patient transfer in & Out Form,

- ✔ Adult HIV Flowsheet for New OI,
- ✔ Adult HIV Flowsheet for New Visit

- There was a new development of Monitoring, Evaluation, and Reporting (MER) indicators consolidated at OpenMRS level
- Billing enhancement by Introducing auto-billing rather than ticking every billable service

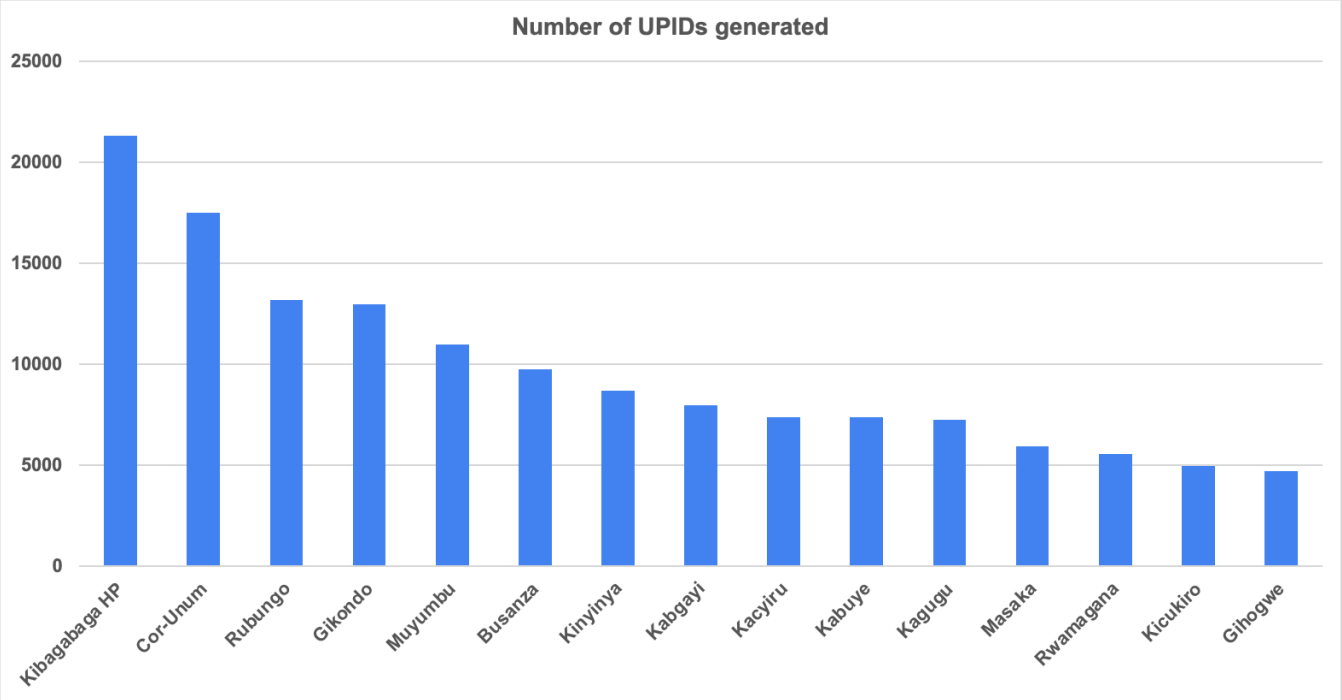
With subsequent testing sessions of the above-upgraded package in connection with HIE, MOH has begun to implement the upgraded package starting with Kibagaba and CorUnum. A few months later the entire package was rolled out to all PEPFAR sites.

6.3.2. Overall HIE data findings

The full Rwanda Health Information Exchange (RHIE), as documented, was developed and tested at the Ministry level. While RHIE offers numerous resources, only a few have been prioritized within the Minimum Viable Product (MVP) packages alongside the existing platforms (openMRS and DHIS2). OpenMRS has been updated to support integration and all PEPFAR sites are now running the upgraded versions.
During interviews with end users, it was noted that the updated version did not retain certain features from the previous version, such as a reporting module that was useful for patient tracking. Additionally, OpenMRS was upgraded to serve as the primary platform for patient management, including Case-Based Surveillance (CBS). However, CBS is not currently in use due to inconsistencies between OpenMRS and DHIS2. Fortunately, at the time of the field visit, the Digital Health Officers were in the process of linking the two systems to avoid duplicative work and ensure that all HIV-related patient management is handled within OpenMRS

After thoroughly analyzing the implemented HIE and gathering user experiences, we pulled data from national registries to assess whether local EMR interacts with national resources through OpenHIM. Over the last seven months, two key resources were analyzed: client registries and shared health records. The data shows a higher volume of patient data for some sites where the HIE was initially piloted. The attached data highlights the number of newly generated UPUIDs and recorded encounters/visits in the shared health records.

Utilization of Client registry: Unique patient identification issued over the last 7 months



Source: HIE data for the top fifteen facilities with a large number of UPIDs generated: *Over the past seven months, the first fifteen facilities with the highest number of Unique Patient Identifications (UPIDs) generated reflect the influx of new patients at each location. Each patient receives a unique identifier, consolidating his data from different health facilities to support the continuum of care whenever he seeks healthcare services at any point of service. Kibagabaga and CorUnum top the list, as they were the initial sites where this initiative was piloted.*

Utilization of Shared Health Records*:* Number of medical visits registered in the Shared Health Record over the last 7 months

Facilities	***Total Encounters***
Kibagabaga HP	*462,865*
Cor-Unum	*42,814*
Kimironko	*7,894*
Rubengera	*7,618*
Biryogo	*5,290*
DISP WE-ACTx	*4,735*
Nyamata L2T Hospital	*4,659*
Musambira	*3,752*
Rushaki	*3,600*
Kabusunzu	*3,029*
Kibogora	*2,768*
Kamonyi (NYAMASHEKE)	*2,243*
Rubona (RWAMAGANA)	*2,001*
Muyanza	*1,886*
Kibeho	*1,845*

Source: HIE data for all patient encounters submitted directly to the Shared Health Record. *The table shows the total number of patient encounters submitted to the shared health records across fifteen health facilities over the last seven months. Kibagabaga HP stands out with a significantly higher number of encounters (462,865) compared to other facilities, indicating a much larger influx of patients. Cor-Unum follows with 42,814 encounters, while the remaining facilities have significantly fewer encounters, ranging from 7,894 at Kimironko to 1,845 at Kibeho. This disparity highlights the underutilization of Health Information Exchange (HIE) resources in many facilities.*

7. Identified main challenges

7.1. HIE and infrastructure:

7.1.1. The overall aim of the Rwanda Health Information Exchange (RHIE) is to facilitate data sharing between health systems, enhancing patient care coordination across the continuum of services. However, due to the complexity of RHIE, its full framework is not yet fully utilized. While some of its components are being implemented, others depend on the successful rollout of the Client Registry and Shared Health Record systems.

7.1.2. The current HIE standards documentation lacks onboarding guidelines to enforce adoption and compliance. Additionally, the documents are three years old and may require updates to reflect recent technological advancements.

7.1.3. Funding Limitation: The HIE is a complex, long-term project that requires substantial funding to achieve full operational capacity. The next phase of implementation should involve additional partners from the digital sector to ensure adequate support and resources

7.2. Some health facilities face challenges due to insufficient or outdated ICT infrastructure, limiting their ability to connect to the broader digital ecosystem. Key issues include inadequate network connections that link users within and outside the facility, outdated servers, and a lack of sufficient computers

7.3. OpenMRS platform:

7.3.1. The current openMRS UIs version lacks the simplicity and friendliness to navigate through different forms. Patient data are scattered in many forms therefore the clinician doesn't get a full view of patient records.

7.3.2. OpenMRS, as a locally based application, requires significant resources and time to scale effectively.

7.3.3. Some essential services (surgery, maternity, anesthesia, Family planning, pediatric, and ophthalmology) are not included in the deployed hospital package, thus they still use paper which further creates duplication and lost time for an already strapped workforce.

7.3.4. Several useful features, such as MambaETL, automated billing, and integration with lab instruments for automated lab results, were deployed during long-term pilot projects and had a positive impact on a few sites. However, these innovations have not been scaled nationwide

7.3.5. The OpenMRS system has been updated to support the Case-Based Surveillance (CBS) system, as HIV management is also conducted within OpenMRS. However, all visited sites reported that CBS in OpenMRS is not yet fully operational due to several implementation challenges, such as inconsistencies in drug information, visit records, and patient IDs between OpenMRS and DHIS2. Additionally, while the previous version of OpenMRS

included customized reporting, the new version requires users to utilize the Cohort Builder for generating reports, which is concept-based and necessitates familiarity with each concept

7.3.6. Lack of integration between OpenMRS and insurance systems for insurance validity and subsequent medical services approvals

7.4. There is insufficient staff to support the overall implementation, hindering the project's progress and effectiveness

8. Recommendations

8.1. HIE and infrastructure:

8.1.1. There is a need to expedite central infrastructure and country-specific standards to ensure integration and interoperability, while also prioritizing user-centric design principles to ensure that end-user needs are met at the point of care. This recommendation requires the full implementation of RHIE's components where each integration should be guided by the HIE standards and principles/policies. Subsequently, for a larger scale, Rwanda HIE which is now hosted at the national Data center, will need to be more optimized and made easily scalable as more sites are being onboarded. We recommend that the future enrollment of facilities should think of expanding to no CDC as well as private facilities.

8.1.2. Speed up the review process of the HIE standards framework to drive future enhancements and onboarding.

8.1.3. The achievements and impact of the current HIE implementation should be documented and shared with key development partners to encourage their investments in the extension of HIE to address the HIE components that are yet to be fully deployed such as the FR, PR, and TR.

8.2. To address the challenges related to insufficient or outdated ICT infrastructure at some health facilities, it is crucial to prioritize infrastructure upgrades. This includes improving network connectivity both within the facility and externally, replacing outdated servers, and increasing the availability of computers. Additionally, partnerships with government bodies, donors, and private sector stakeholders should be explored to secure funding and resources for these upgrades.

8.3. OpenMRS platform:

8.3.1. The Ministry of Health should leverage the work done during the hackathon to upgrade OpenMRS from the basic UI to the O3 version, expanding the upgrade to the rest of the forms to get more friend UIs

8.3.2. Review the deployment model and architecture of OpenMRS to fit the current needs. The current OpenMRS model requires a lot of infrastructure on-premises including servers and other network equipment. The current pace of the internet in the Health Facility provides

the opportunity to change the model where most of the effort should be injected into building the national infrastructure and remain with fewer devices at a premise like computers and simple wireless networks that link the facility with the national system through VPN or any other secured mode.

8.3.3. The existing OpenMRS package for the hospital needs to be revamped to cater to other essential clinical forms in surgery, maternity, family planning, anesthesia, pediatric, and ophthalmology. Additionally, the clinicians complained about including some other useful features such as having access to the list of treated patients for specific clinicians or patients received within specific services.

8.3.4. Scale up the automated billing along with Memba ETL to all hospitals. The package should also consider end-to-end integration with lab instruments as a temporary solution to automate lab results while the Ministry of Health is looking for a long-term strategy to use a lab analyzer system that interconnects all lab instruments through a laboratory information system

8.3.5. Operationalize CBS in OpenMRS and make it the principal tool along with MER indicators to help facilities monitor and report

8.3.6. Integration with insurance to streamline the registration process. Insurance systems are not linked to EMR/OpenMRS, so inputting data from the insurance system into OpenMRS at reception involves taking a paper from the insurance intake person to the overall registration person.

8.4. Workforce: The Ministry of Health through the support of the Ministry of ICT and Innovation have achieved an impact by investing in a digital health office. The Digital health office has been successful in operationalizing timely, efficient, large-scale digital projects in the Ministry. The technical support team is quite understaffed and should be increased to optimum levels to ensure full operationalization of digital initiatives. As an interim solution, the Ministry of Health can explore an approach of having a permanent team or retaining the digital Officers newly deployed to support CBS implementation. This will address an issue of oversight of the implementation and timely providing technical support.

25/10/2024

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