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THE NATIONAL DIGITAL

HEALTH STRATEGIC PLAN

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Document History

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LIST OF ABBREVIATIONS:

4G:	Fourth generation
ATC:	Anatomical Therapeutically Chemical Classification
CDC:	Center for Disease Control
CHAI:	Clinton Health Access Initiative
CHUK:	Centre Hospitalier Universitaire de Kigali
CHW:	Community Health Workers
DHIS-2:	District Health Information System version 2
DHMT:	District Health Management Team
DHS:	Demographic Health Survey
DHU:	District Health Management Units
DICOM:	Digital Imaging and Communications in Medicine
DQA:	Data Quality Audit
DSL:	Digital Subscriber Line
EDPRS:	Economic Development and Poverty Reduction Strategy
EICV:	Enquête Intégrale sur les Conditions de Vie
eIDSR:	Electronic Integrated Disease Surveillance and Response
eLMIS:	Electronic Logistics Management Information System
EMR:	Electronic Medical Records
HIE:	Health Information Exchange
HISP:	Health Information System Program
HMIS:	Health Management Information System
HRTT:	Health Resource Tracking Tool
iCCM:	Integrated Community Case Management
ICD:	International Statistical Classification of Diseases and Related Health Problems
ICT:	Information and Communication Technology
IFMIS:	Integrated Finance Management Information System
IMCI:	Integrated Management of Childhood Illness
IPPIS:	Integrated Payroll and Personal Information
KPI:	Key Performance Indicators
LAN:	Local Area Network
LIS:	Laboratory Information System
LMO:	Logistics Management Office
LTE:	Long-Term Evolution
MEMS:	Medical Equipment maintenance System
mHealth:	Mobile Health
MIFOTRA:	Ministry of Public Service and Labor
MINICOFIN:	Ministry of Finance and Economic Planning
MNHBC:	Maternal and Newborn Home-based Care
MOH:	Ministry of Health
MPPD:	Medical Procurement and Production Division
MTI:	Medical Technology and Infrastructure
MyICT:	Ministry of Youth and ICT
NBTC/CNTS:	National Blood Transfusion Center/ Centre National de Transfusion Sanguine
NHA:	National Health Accounts
NICI:	National Information and Communication Integration
NID:	National Identification
NISR:	National Institute of Statistics Rwanda
NRL:	National Reference Laboratory
OpenMRS:	Open Medical Record System
PHCPI:	Primary Health Care Performance Initiative (PHCPI)

PMTCT: Prevention of Mother-to-Child Transmission
POC: Point of Care
PPP: Public Private Partnership
PRISM: Performance of Routine Information System Management
RapidSMS: Rapid Short Message Service
RBC: Rwanda Biomedical Center
RHEA: Rwanda Health Enterprise Architecture
RHMIS: Rwanda Health Management Information System
SISCom: Système d'information de santé communautaire
SRMP: Smart Rwanda Master Plan
SWOT: Strengths Weaknesses Opportunities and Threats
TWG: Technical Working Group
VCT: Voluntary Counseling and Testing
VSAT: Very Small Aperture Terminal
WHO: World Health Organization
WiMAX: Worldwide Interoperability for Microwave Access

GLOSSARY:

- **Digital Health:** The delivery of Healthcare services through the use of ICT. It includes mobile health (mHealth), health information technology, electronic medical records (EMR), and Telemedicine.

- **mHealth:** Delivery of Health care services through the use of mobile networks and devices

- **eHealth**: The use of ICT to support health care delivery

- **Telehealth:** The provision of clinical service from a distance, or the use of electronic information and communication technologies to provide and support of healthcare services, health education when distance separates the participants

- **Telemedicine:** The remote diagnosis and treatment of patients using electronic information and communication technologies

- **Interoperability**: The ability of different information technology systems and software applications to communicate, exchange data, and use the information that have been exchanged. Integration allows two applications to exchange information. Interoperability allows many.

- **Information and Communications Technology:** An extended term for Information Technology (IT)

- **eLearning:** The provision of learning, training or education program using electronic means. It involves the use of computer or any other electronic devices (mobile, tablet, etc)

- **Web Portal**: a specially designed website that brings information from diverse sources, like emails, forums and search engines, together in a uniform way

- **Electronic Medical Records:** Digital version of paper charts in health facility. EMR contains notes and information collected by and for clinicians in a health facility and are mostly used by health providers for diagnosis and treatment.

- **Blockchain:** Blockchain is a log of transactions that is replicated and distributed across multiple decentralized locations: As such, it offers a secure, high integrity, "neutral" 3rd party mechanism for knowing what data is where and precisely how it is changing over time (Forbes). It offers great opportunities for securely sharing personal medical records or tracking individual doses of medicines through the supply chain, for example.

- **Big data analytics:** Big data in healthcare refers to electronic health data sets so large and complex that they are difficult (or impossible) to manage with traditional software and/or hardware; nor can they be easily managed with traditional or common data management tools and methods. By applying advanced analytics and artificial intelligence tools, big data can be mined or harvested to improve public health and individual patient care.

FORWARD

The Government of Rwanda seeks to provide quality health care to all Rwandans. The e-Health Strategic Plan is a guiding document that describes Rwanda's long-term vision for e-Health, with a strong focus on activities, tangible benefits and deliverables for the next five years. The strategic plan builds on the existing 2009 five-year strategic plan and the various Digital Health initiatives that the Ministry has embarked on over the past few years. The strategic plan is also complementary to the Smart Rwanda Master plan.

Section 4.1 of the Smart Rwanda master plan commits the government of Rwanda to "Expanding remote medical/healthcare services and enhance accessibility" with a list of clear objectives, outcome indicators and related projects. This strategic plan takes this commitment into consideration in addition to other health sector goals as defined in the Health Sector Strategic Plan (HSSP III).

Over the past decade a number of information systems have been put in place including; integrated routine reporting Health Management Information System, Electronic Medical Records, Electronic Logistics Management Information Systems, Mobile community based information systems, Human Resources Information system, Resource tracking information system, Laboratory Information System, Integrated Disease Surveillance Information Systems, Health Resource Tracking Tool, Blood bank information system and telemedicine equipment. The Health Sector has also adopted some standards to ensure that the various information systems are interoperable.

This strategic plan builds on earlier successes by proposing strategies to scale up certain interventions at a national level and enhancing their performance to ensure that the systems meet users' needs. The strategic plan also proposes new information system interventions in order to automate the remaining services in the health sector.

The strategic plan emphasizes engagement of the private sector in form of public private partnerships especially in activities related to software development and support as well as ICT infrastructure maintenance.

This Strategic plan was developed by the Ministry of Health with inputs from RBC, MYICT, RDB, eHealth TWG members, and with financial and technical support from USAID's Rwanda Health Systems Strengthening Project/MSH, UNICEF/Rwanda and Health Systems Innovations Ltd.

Minister of Health

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EXECUTIVE SUMMARY

The Government of Rwanda has a vision to use Information Communication Technologies in transforming the health sector. The Digital Health strategic plan underlines this vision as stipulated in the Health Sector Strategic Plan (HSSP IV) and the Smart Rwanda Master plan.

Over the past decade, the Ministry of Health has implemented a wide rage information systems in a bid to automate health services and improve health outcomes. The systems are at various stages of implementation, some being at initial stages while others are operational at national scale.

Key challenges

A number of system evaluations have been carried out to assess the progress of the implementation and to document the successes and challenges. In addition to this a SWOT analysis of the Health Information ecosystem was carried out and the following health system challenges have been documented and will be addressed by the new Digital Health policy and strategic plan:

- Medical records in hospitals and health centers are paper-based and this renders sharing of medical records and patient follow up very difficult.
- Due to Rwanda's hilly terrain and inefficient transport infrastructure especially in rural areas, patients find it difficult to access health facilities. Patients also have to make long distance travels to urban areas to access specialized medical services.
- Health services are primarily health facility based, citizens are not sufficiently engaged or informed in matters concerning their health.
- Multiple reporting systems impose a burden on health workers and make it difficult to access data for evidence-based decision-making. Some systems are stove-piped, so it is difficult to compare key performance indicators from different systems.
- An increasing share of services delivered by the private sector that does not report systematically means that a growing piece of the epidemiological situation is missing.
- Appropriate distribution of Health Sector human resources (doctors, nurses and even community health workers) are key to effective service delivery, better systems are needed to ensure staff are equitably distributed, to manage their career development, and for future workforce planning.
- Assuring continuous availability of drugs at all levels of the health system remains a problem. The supply chain system needs to be extended and better technologies implemented for more efficient distribution, stock management and quantification.
- Sustainability of interventions is always a concern in the Health Sector, which is heavily dependent on donor funding. With decentralization, health facilities need robust financial management systems to improve efficiency, accountability and enhance revenue collection.
- Impressive initiatives have been undertaken to implement a wide range of health information sub-systems in Rwanda, but frequently they have been developed on different platforms and data stored in legacy systems. This has resulted in considerable duplication of effort and difficulty to access and consolidate data for evidence-based decision-making. Terminology and technology standards need to be implemented to ensure system interoperability.
- With an increasing dependence on information technology at every level of the health system to support many different operational needs, the current MOH led mechanisms to support a vast community of users is unable to keep up with the demand that is needed to keep the systems running constantly. There is a need to leverage investments made by the Government in

connectivity and hosting services and to engage the private sector that can provide many of these services more efficiently and in line with Rwanda's e-Governance strategies.
- Electronic information is easier to share and is vulnerable to fraudulent use if adequate measures are not put in place to ensure its security.

Strategic framework

Figure SEQ Figure * ARABIC 1: Rwanda Digital Health Framework

The figure to the left depicts some of the key elements of the future citizen- or patient-centered digital health services to be implemented though this policy (in the green ring) are built upon the foundational components in the outer circle in order to focus on the health of all Rwandan citizens.

Policy Directions

The overarching goal of the Digital Health Strategic plan is to improve health service delivery and accessibility through Digital Health. Specific policy directions objectives of the plan are to:

1.   Strengthen integration and interoperability of health information systems
2.   Improve health service delivery and accessibility through Digital Health
3.   Improve access to health information and digital services for citizens
4.   Improve collection, management and use of data at all levels of care
5.   Strengthen the management of critical resources in the health sector, by enhancing the following systems:
6.   Improve ICT infrastructure and software support in the Health Sector
7.   Improve the legal and regulatory framework for security, confidentiality and controlled access to information.
8.   Leverage technology to build the capacity of the health workforce, offer decision-support and prepare health workers at all levels to manage and use the full range of Digital Health technologies
9.   Promote research and development to adapt innovations and the use of emerging technologies in the health sector

Purpose of this document

The Digital Health Strategic plan is a guiding document that presents a high-level plan to develop and implement Digital Health in Rwanda. It describes Rwanda's long-term vision for Digital Health with a strong focus on the tangible benefits and deliverables that will be achieved over the next five years. The strategic plan also describes the leadership and governance structure that has been put in place to guide the implementation, and help ensure the timely completion of Digital Health deliverables and realization of the associated benefits for Rwandans.

The strategic plan was initially updated following a 3-day Digital Health Strategic Planning workshop attended by over 80 stakeholders in Gisenyi from November 3-6, 2015. This was followed by a series of meetings with sub-groups of stakeholders to develop the detailed sub-projects. In Rwanda, the Ministry of health defines Digital Health as – *The delivery of Healthcare services through the use of ICT. It includes mobile health (mHealth), health information technology, electronic medical records (EMR), and Telemedicine.*

Rwanda's Digital Health policy translates the Government's overall vision of using Information Communication Technologies to transform the health sector as set out in the Health Sector strategic plan and the SmartRwanda master plan developed by the Ministry of Youth and ICT (MyICT).

The National Information and Communication Integration (NICI) document (2010) committed the Government of Rwanda to an integrated socio-economic policy and plan leveraging ICT. In line with this plan, the Ministry of Health is committed to the deployment of ICT in order to improve healthcare service delivery.

In 2015 the SmartRwanda plan was developed by the Ministry of Youth and ICT. This plan brings a new focus on services and less on technology alone. The SmartRwanda plan promotes private sector engagement such as the RwandaOnline initiative and proposed new governance structures with sector managers taking the lead and ICT supporting their priorities. An important component of the SmartRwanda master plan is SmartHealth, which proposes a series of Digital Health interventions.

In 2017, the MoH developed a new Health Sector Strategic Plan (HSSP IV). This reflects Rwanda's commitments to achieving the Sustainable Development Goals (SDGs) and includes key strategies related to Health Information Systems (HIS) and use of ICT to improve global health security. Key interventions have been added to the Digital Health policy and plan to reflect these priorities.

The Ministry of Health has been implementing various Digital Health solutions over the past years, guided by the first five-year national eHealth Strategic Plan, that started in 2009. A

number of systems are functional at a national level such as RHMIS, RapidSMS, eLMIS, etc. The Ministry will build on some of these successes to improve the existing systems and put in place new ones.

Digital Health will be key to transforming and enabling the sustainability of Rwanda's healthcare system. It supports an environment with integrated services to efficiently deliver high-quality and coordinated healthcare services to the citizens of Rwanda.

The document presents the Digital Health Strategic Plan in seven parts:

1) Situation Analysis (context, progress and challenges)
2) Policy Directions and Overarching goals
3) Vision, Mission, Values and Key Strategic objectives
4) Comprehensive strategic framework
5) Implementation plan
6) Budget
7) Governance,
8) Monitoring & evaluation
9) Logical framework (in Annex)
10) Summaries of selected digital health related evaluations

SITUATION ANALYSIS

COUNTRY CONTEXT

DEMOGRAPHIC AND GEOGRAPHIC SITUATION

Rwanda is a small, mountainous and land locked country of 26,338 square kilometers lying just south of the equator with an average elevation of 1,700 meters. Approximately 35 percent of the land is fit for cultivation.

Rwanda's population is growing rapidly with implications on socio-economic conditions and coverage of health services. The most recent population census, conducted in 2012, estimated the population to be around 10.5 million people. Population density is the highest in Sub-Saharan Africa (416 inhabitants per square kilometer). The population is essentially young, with 52 percent of all Rwandans under the age of 20. In terms of gender, the 2012 census shows females to be in the majority (52 percent) while males make up 48 percent of the population (NISR, 2012) (1).

The illiteracy rate declined from 34 percent to 15.5 percent among women and from 24 percent to 10.3 percent among men between 2005 and 2010 (DHS 2005 and 2010) (2, 3).

SOCIO-ECONOMIC SITUATION

Significant efforts have been made to develop the service sector and stimulate investment in the industrial sector; however, the Rwandan economy remains dominated by agriculture. In 2012, the service sector accounts for the largest share of Rwanda's Gross Domestic Product (GDP), 46 percent, followed by agriculture with 32 percent and industry with 22 percent (NISR, 2012) (4).

According to EDPRS II, average GDP Growth during the 2008-2012 period was 8.2% and the GDP per capita in 2012 was $644. Data from integrated household living conditions surveys (EICV) show that the percentage of people living below the poverty line was 44.9% in 2010-11, down from 56.7% in 2005-06. In 2010-11, net primary school and secondary school attendance were respectively at 91.7% and 20.9%. The percentage of people having access to safe drinking water was 74.2% while it was 10.8% for people having access to electricity for lighting (EDPRS 2, 2012) (5).

The health sector has a crucial role to play in the achievement of the national mid-term (EDPRS 2) goal of 11.5% economic growth rate. Continuous progress in the coverage and quality of preventive, curative and rehabilitative health interventions and in the health seeking behavior of the population ensure improvements in the health status and productivity of the Rwandan population. The health sector also has an influence on the enabling environment for economic and social transformation as envisioned by the EDPRS II, aiming to contribute to a reduction in the fertility rate, which will help ease the demographic pressure in the country. Availability of

high quality health services, as an important element of the service sector, contributes to the generation of collective wealth and is crucial to attracting investors and tourists.

Table 1: Key Health Indicators

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Key indicators

Population density: 414 inhabitants per km²
Total population 11,262,564 (2015) projected to rise to 12,663,116 by 2020
84% of inhabitants live in rural areas
Annual population growth rate is 2.6%
Life expectancy at birth: 64.5 years for the entire population (NISR 2012)
Real GDP per capita: 718 US dollars (MINECOFIN 2014)
Infant mortality: 48.6/1000 (Census, 2012)
Maternal mortality: 476/ 100,000 (DHS 2010)
HIV average prevalence rate: 3% (DHS 2010)
Malaria prevalence: 2.4% children under five (DHS 2010)
TB: 5979 All cases notification in the country (MOH 2013)

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DIGITAL HEALTH CONTEXT

Globally, Digital Health is seen as a key pillar in health system strengthening as evidenced by the global Health Sustainable Development Goals. A recent survey that was carried out by Health Enabled (9) showed that African countries have embraced the use of Information Communication Technology for transforming Health Sectors by putting governance frameworks in place that provide an enabling environment as well as implementing a variety of Digital Health solutions.

Due to the attention that is being given to Digital Health, strong international software development communities have been formed and have developed a number of open source platforms such as DHIS-2, OpenMRS, OpenHIE, etc. A perfect example has been the use of DHIS-2, which is currently deployed in 47 countries worldwide mainly for collecting and analyzing of routine health data and case-based tracking of patients. (10)

In Africa, mHealth applications such as RapidSMS, mHero and others have been widely used for follow up of pregnant mothers, tracking of epidemics such as Ebola, etc. Electronic medical records have also been widely used for patient monitoring.

A number of countries have also adopted the use of Digital Health terminology standards such as ICD-10, LOINC as well as messaging standards such as HL7 to facilitate system integration and interoperability.

In Rwanda, there has been significant progress in implementing Digital Health solutions over the past decade. A five-year Digital Health strategic plan was endorsed in 2009 and the country has

been exemplary in Africa in implementing Digital Health solutions at a national scale. Below are the different initiatives that have been implemented;

● An open source Electronic Medical Record System (EMR) called OpenMRS was implemented in various health facilities.

● RBC implemented a Logistics Management Information System (eLMIS) at the central level (MPDD warehouse), 30 district pharmacies and in all public health facilities

● Following an introductory period of pilot testing in Musanze District, the RapidSMS software was rolled out to all community health workers (CHW) across the country. It enables CHWs to report on vital events and selected health indicators concerning pregnant women and children up to 2 years of age.

● Transition of most routine reporting systems to the Rwanda HMIS (RHMIS) on the web-enabled DHIS-2 platform: These systems include the RHMIS, TracNet, SISCom, eIDSR, Health Financing, eTB). In addition, this platform hosts a data warehouse that pulls together key performance indicators across the entire sector. These systems are supported by Data Managers and M&E officers across all hospitals and health centers, as well as teams from RBC and the MOH at the central level.

● Creation of a web-based Mutuelle Membership Management System (3MS) that has been transitioned to RSSB: This system facilitates processing of CBHI contributions in the over 400 mutuelle sections across the country and helps to track progress towards universal health coverage.

● Development of a medical equipment maintenance system (MEMS): Developed with support from CHAI, this system enables all hospitals to better manage medical equipment, including inventory control, service and repair.

● The Laboratory Information System (LIS) was introduced into Rwanda's National Laboratory in 2012. The system streamlines receiving and processing of lab samples. RBC has plans to roll it out to selected referral and district hospitals.

● Rwanda's Nation Blood Bank implemented a web-based system at the national level and in each of the provincial blood banks. The system manages data regarding blood donations, testing and distribution across the country.

● The Ministry of Health designed and implemented the Rwanda Health Information Exchange. The initiative created a blueprint architecture (see **Error! Reference source not found.**) illustrating how all health sector information systems can talk to each other and demonstrated the feasibility and challenges of implementing an interoperable electronic medical records system in rural health facilities.

- The former Kigali Health Institute, in partnership with the Ministry of Health, designed and introduced a Masters degree program in eHealth (health informatics) in 2010. After the creation of the University of Rwanda the course was transitioned to the UR/CMPH as a Center of Excellence for eHealth and Biomedical technology in 2014. So far, more than 40 candidates have completed this 2-year course. This competency-based course should help to provide the local human resources needed to support Digital Health initiatives into the future.

Global Digital Health trends and Best Practices

The incredible potential to improve global health delivery through appropriate use of digital health drives discussion in global digital community. Every pillar of the "health" umbrella is now acknowledging the importance of innovation, and more than ever we are seeing the prioritization of streamlined processes through digital platforms. Medicine, in particular, is a very old industry with massive companies that struggle to innovate from the inside—hence why so much money is being invested externally.

The digital community has shown the high interest in digital health. Members connect to learn about feasibility, planning, and implementation of a broad spectrum of digital health projects, including electronic medical record systems, mHealth, Telemedicine and Interoperability of systems. These technologies aim to increase the quality of care, with greater safety in patient follow-up.

Digital Health becomes an insider in the clinical processes: Health is data. Digital health makes it possible to circulate this data safely, monitoring patients in and out of hospital, improving everything from sleep patterns to patient treatment. Both chronic or acute patients can be empowered and improve their health outcomes. At the same time health care services can be safer, save time and avoid routine doctor visits or hospital stays.

Insurance companies have realized the value since they can save money by reducing the number of patient re-admissions, improve success rates for adherence and investing in services that promote better health life styles. A cultural change is necessary, in order to understand that digital technologies are not a replacement for health professionals, on the contrary,

Blockchain in healthcare: Blockchain technology is one of the leading trends in the digital community. In healthcare, the blockchain is expected to benefit patients interacting with healthcare systems by reducing their waiting times and avoiding repetitive registration processes. It will reduce manual paperwork and overheads and underlying costs by providing transparent and immutable personalised healthcare records that can be accessed from anywhere in the world: a "Universal EMR". It's expected that blockchain will become the most

innovative healthcare technology ever by creating a trusted peer-to-peer network for sharing information and value.

mHealth: Mobile health is one of the fastest growing phenomena in the last decade. Despite many definitions and sometimes antagonistic concepts and opinions it is, nonetheless, developing into a set of strong tools focused on patient engagement, compliance, data monitoring, clinical trials and other areas. This initiative could be a big step forward to leverage the digital health services by healthcare workforce. No longer dependent upon having an expensive computer, mHealth can contribute to knowledge transfer among countries and regions, health professionals' capacity building, clinical guidelines and job aids to assist health worker implement complex protocols and guidelines.

Several mHealth: initiatives, such as RapidSMS, mobile payments for CBHI payments and tablet-based data collection are already commonly used in the sector, but there are opportunities to do much more:

- expanded use of smartphone video for telemedicine consultations
- health worker decision support though phone-based protocols
- social media and mobile phone health information messaging for health behavior change communication
- health status monitoring – when connected with wearable or other devices for monitoring blood sugar, blood pressure, temperature, etc…

Big Data & Analytics are delivering practical solutions: By definition, big data in healthcare refers to electronic health data sets so large and complex that they are difficult (or impossible) to manage with traditional software and/or hardware; nor can they be easily managed with traditional or common data management tools and methods. Health data volume is expected to grow dramatically in the years ahead. In addition, healthcare reimbursement models are changing: meaningful use and pay for performance are emerging as critical new factors in today's healthcare environment. Although profit is not and should not be a primary motivator, it is vitally important for healthcare organizations to acquire the available tools, infrastructure, and techniques to leverage big data effectively or else risk losing millions in revenue and cost savings. In addition, the advent of big data provides new opportunities for data mining and de-identified medical records can be sold to create a new revenue stream for the health sector.

Artificial intelligence: Advances in the field of artificial intelligence offer great potential for decision support to front-line health workers and to help predict adverse health events and health risks, so that they can be managed at an early stage.

Digital finance: Digital finance has the potential to make the health sector's financial transactions more efficient and secure with cashless transactions. This will reduce fraud, make cost recovery more effective and open the way for the large majority of unbanked citizens to

contribute easily to their CBHI payments or set up health savings accounts using mobile money, so that they are better protected from financial risk if they fall ill.

Learning from best practices: Rwanda has opportunities to learn from best practices across the globe. One example that the GOR has followed closely is that of Estonia. Through their eEstonia intitiative 95% of health data is digitized; 99% of prescriptions are digital; and 100% healthcare billing is now electronic.

Estonia's healthcare system has been revolutionized by innovative eSolutions. Patients and doctors, not to mention hospitals and the government, benefit from convenient access and savings that eServices have delivered. Each person in Estonia that has visited a doctor has an online eHealth record that can be tracked longitudinally. Identified by the electronic ID-card, the health information is kept completely secure and at the same time accessible to authorized individuals. The system uses blockchain technology to ensure data integrity and mitigate internal threats to the data.

Similarly, there are opportunities to learn from successful intitiatives across Africa, such as the rapid expansion of mobile money adoption in Kenya and Tanzania, and mHealth technologies such as MomConnect in South Africa. The East African Community is helping to promote some of these initiatives through specialized secretariats and scientific commissions.

SWOT ANALYSIS:

A Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis was conducted during the initial strategic planning workshop on key themes: Electronic Medical Records (EMR), ICT infrastructure and support, Data Use for Evidence-Based Decision-Making, and mHealth (Mobile Health) Systems. The key areas represent many aspects of eHealth as they address issues at all levels of the healthcare system.

The crosscutting results from those analyses are summarized below:

Strengths: Across nearly all themes, there was praise for the level of Government commitment and leadership for eHealth initiatives and evidence-based decision-making. Investments in capacity building are also recognized as contributing to the widespread adoption of eHealth technologies – especially at district and facility levels. There are staff designated to support eHealth in most institutions, starting from Data Managers at the Health Center and Hospital levels and ICT officers in most Provincial & District hospitals. All health facilities now have access to one or more computers and nearly all district hospitals have wired or wireless local area networks and local servers for hosting the EMR.

The Health Sector now has a wide range of good quality data sources available online to users at every level of the health system – a major improvement since 2009 when most data were captured in off-line and largely paper-based systems. The adoptions of open source web-based platforms, such as RapidSMS, DHIS-2 and OpenMRS, have helped to harmonize disparate information systems and will improve sustainability. The Government has put in place policies that have promoted the rapid expansion of the telecommunications network to the extent that nearly all district hospitals now are connected to the national fiber optic internet connections.

CHWs in nearly all villages benefit from being able to use their mobile phones thanks to 98% network coverage and donations of 45,000 mobile phones. The National Data Center opened its doors to the Ministry of Health in 2013 – and most web-enabled systems are now hosted on the world-class infrastructure. The national program for rural electrification is on course to have full coverage of all health centers and district hospitals by 2017.

Weaknesses: Key weaknesses that were identified included the low numbers of staff trained in some of the more specialized areas of systems analysis and software development (both in public and private sectors), insufficient back-up electric power, and limited numbers of staff and resources at central level to support nationally deployed systems. Other weakness are related to change management as clinicians with relatively low computer literacy have been slow to adopt and use some of the systems on a routine basis and in some facilities managers have not been adequately engaged in promoting the benefits of the systems. The current eHealth governance structure has been sharply affected by funding cuts resulting in fewer staff to support key initiatives. In addition, changes to the MOH, RBC and decentralized health services have resulted in eHealth and ICT expertise being scattered across these institutions in a manner that is difficult to coordinate.

While there have been considerable investments in integrated supervision and data quality assessments, maintaining high levels of quality across all reporting systems remains a challenge. Some data are not used effectively at the local level where they are collected and feedback from higher levels remains relatively ad hoc. Staff attrition and turnover, especially at the national level, have resulted in the loss of specialized staff supporting EMR programming and system administration. Some of the platforms, such as EMR and Health solutions, have been put in place without a clear understanding of the total cost of ownership and funding for recurrent expenditures such as user support and equipment maintenance & replacement remain challenges for long-term sustainability.

Opportunities: Strong international software development communities exist for key open source platforms and there is also increasing expertise to support them in-country. If Rwanda continues to build on these platforms there is a better likelihood of sustainability and a continuous upgrade path. Rwanda's investments in the National ID system (NID) and efforts to strengthen civil registration will form a sound basis for patient unique identifiers – crucial for electronic medical records. The overall coverage of the cell phone network at well over 90% of the country has enabled the MOH to implement national level systems for reporting data – even to the village level. Similarly, MYICT and RDB have been working together to extend the fiber-optic and 4G networks to provide last mile connectivity to health facilities, to establish the world-class National Data Center for securely hosting data and applications, to promote local private firms to manufacture and maintain computers and to train technicians at the decentralized level to maintain ICT infrastructure. The Health Information Exchange project completed in 2014 developed a forward-looking enterprise architecture framework and a functional platform upon which to implement interoperability between key systems. Rwanda's recent passing of the public-private partnership (PPP) law signals an opportunity to develop long term partnerships with the private sector that could play a crucial role in providing the underlying support for ICT and software development functions that the MOH has found difficult to staff and maintain. Even though development assistance funding is decreasing sharply, donors still appear interested in funding innovative projects to improve information systems and

evidence-based decision-making. Finally, Rwanda is seen as a leader in ICT in East Africa and the government has invested in setting a Center of Excellence for eHealth and Biomedical Engineering – this center can become a regional hub for promoting innovation and developing local capacity that can create economic opportunities that extend beyond Rwanda's borders.

Threats: The key crosscutting threats identified across the themes included: Investments in systems without adequate information about the total cost of ownership once the system is implemented. This has become more critical as external sources of funding are declining rapidly and Rwanda seeks to identify domestic sources of financing. With the increasing shift to electronic medical records, data security and patient privacy could become issues without the development and implementation of formal data security policies and electronic data exchange protocols for individual data. Similarly, such systems can't tolerate downtime and need to function on a 24 hour/7 day a week basis. At the peripheral level, there remain big challenges with continuity of electric power and periodic cuts in Internet connectivity that are dependent on other sectors. Although there have been considerable investments in capacity building of Ministry of Health staff to support basic ICT functions, decreasing budgets at the national level have resulted in low retention rates for these specialized staff and threaten the sustainability of some of the systems. Though a PPP law has been passed by Parliament, much work needs to be done on changing internal financial management procedures before the private sector can be effectively engaged to take on a strong supporting role in digital health. Most groups also noted a threat intrinsic to ICT: constant change. Innovations are constantly being developed and it is becoming more difficult to manage the change process – both for system upgrades and for users, especially with the shift of users from data managers with specific ICT training to clinicians, many of whom start with low levels of computer literacy and are resistant to new technologies.

KEY CHALLENGES/PROBLEM STATEMENTS:

Below are some high level challenges from the policy that this strategic plan will address:

- Medical records in hospitals and health centers are paper-based and this renders sharing of medical records and patient follow up very difficult.
- Due to Rwanda's hilly terrain and inefficient transport infrastructure especially in rural areas, patients find it difficult to access health facilities. Patients also have to make long distance travels to urban areas to access specialized medical services.
- Health services are primarily health facility based, citizens are not sufficiently engaged or informed in matters concerning their health that can be managed at the household level.
- Multiple reporting systems impose a burden on health workers and make it difficult to access data for evidence-based decision-making. Some systems are stove-piped, so it is difficult to compare key performance indicators from different systems.
- An increasing share of services delivered by the private sector, which does not report systematically, means that a growing piece of the epidemiological situation is missing.
- Appropriate distribution of Health Sector human resources (doctors, nurses and even community health workers) are key to effective service delivery, better systems are needed to ensure staff are equitably distributed, to manage their career development, and for future workforce planning.

- Assuring continuous availability of drugs at all levels of the health system remains a problem. The supply chain system needs to be extended and better technologies implemented for more efficient distribution, stock management and quantification.
- Sustainability of interventions is always a concern in the health sector, which has been heavily dependent on donor funding historically. With decentralization, health facilities need robust financial management systems to improve efficiency, accountability and enhance revenue collection.
- With an increasing dependence on information technology at every level of the health system to support many different operational needs, the current MOH led mechanisms to support a vast community of users is unable to keep up with the demand to keep the systems running constantly. There is a need to leverage investments made by the Government in connectivity and hosting services and to engage the private sector that can provide many of these services more efficiently and in line with Rwanda's e-Governance strategies.
- Electronic information is easier to share but is vulnerable to fraudulent use if adequate measures are not put in place to ensure its security.
- Most medical records in hospitals and health centers are paper-based and this renders sharing of medical records and patient follow up very difficult.
- Multiple reporting systems impose a burden on health workers and make it difficult to access data for evidence-based decision-making. Some systems are stove-piped, so it is difficult to compare different types of data for evidence-based decision-making, for example, linking utilization of medicines with disease morbidity. Terminology and technology standards need to be implemented to ensure system interoperability.
- An increasing share of services delivered by the private sector, which does not report systematically, means that a growing piece of the epidemiological situation is missing.
- Appropriate distribution of health sector human resources (doctors, nurses and even community health workers) are key to effective service delivery. Better systems are needed to ensure staff are equitably distributed, to manage their career development, to support digital literacy and capacity building, and for future workforce planning.
- Assuring continuous availability of drugs at all levels of the health system remains a problem. The supply chain system needs to be extended and better technologies implemented for more efficient distribution, stock management and quantification.
- Sustainability of interventions is always a concern in the health sector, which has been heavily dependent on donor funding historically. With decentralization, health facilities need robust financial management systems to improve efficiency, accountability and enhance revenue collection.

VISION, MISSION AND VALUES

VISION

The vision for Digital Health is to leverage ICT investments to support an efficient health workforce offering cost effective patient-centered services with secure access to data for continuity of care and evidence-based decision-making, resulting in improved health and economic status for all Rwandan citizens.

MISSION FOR EHEALTH

The mission of Digital Health in Rwanda is to contribute to the transformation of the health sector by providing access to infrastructure; digital health services; and information that is accurate, valid, reliable, timely, relevant, and complete in a bid to improve the quality of and universal access to healthcare services.

VALUES

Service to the citizen: Strategies and priorities will be based upon a client-centered service delivery model where health workers are accountable to the population.

Promote health: Implement digital health services using a public health approach that emphasizes prevention, health promotion in addition to treatment.

Public protection: Digital health services will be guided by effective policies and regulation to protect their data and timely information that protects the public from health risks.

Efficiency and cost-effectiveness: The eHealth Unit is committed to achieving highest efficiency at all levels of healthcare with minimal investment.

Sustainability: Decisions about adopting new systems and technology will be based upon a sound analysis of total cost of ownership, engagement of private sector, and the development of local capacity to manage the technology to ensure sustainability.

COMPREHENSIVE STRATEGIC FRAMEWORK

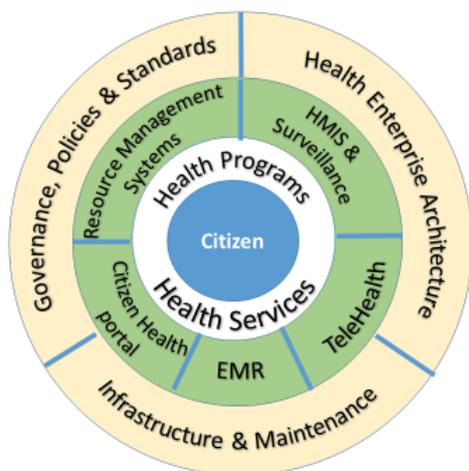

Figure SEQ Figure * ARABIC 2: Digital Health Framework

Figure 2, to the left, depicts some of the key elements of the future citizen- or patient-centered digital health services to be implemented though this policy.

The five digital health system components (in green) and the foundational components in the outer circle are examined in detail in the following sections. A

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brief summary describing the basic nature of each component is provided.

The sections below summarize the logical framework that has been developed for the implementation of the main policy directions determined by the Digital Health Policy and the sub-projects prioritized in this Digital Health Strategic Plan. Below is the summary of these policy directions and their associated sub projects:

1. Strengthen integration and interoperability of health information systems
    1.1. Update the Rwanda Health Enterprise Architecture framework
    1.2. Enhance the Health Information Exchange
    1.3. Implement a unique patient identifier linked to national civil registration and vital statistics
2. Improve health service delivery and accessibility through Digital Health
    2.1. Configure and implement an EMR in all health facilities
    2.2. Laboratory information system
    2.3. Promote telemedicine for remote diagnostics and care
3. Improve access to health information and digital services for citizens
    3.1. Implement a Citizen's Health Portal (including National Health Observatory)
4. Improve collection, management and use of data at all levels of care
    4.1. Continue to expand RHMIS platform
    4.2. Continue to build capacity for data quality assurance and data demand and use
    4.3. Enhance epidemic disease surveillance and response
5. Strengthen the management of critical resources in the health sector, by enhancing the following systems:
    5.1. Supply chain system
    5.2. Medical equipment maintenance & management
    5.3. Blood bank system
    5.4. Financial Management
    5.5. Quality Improvement and Performance-Based Financing information systems
    5.6. Health Sector Mutual Assistance Group (MAG) microfinance system
    5.7. Human resource management
6. Improve ICT infrastructure and software support in the Health Sector
    6.1. Improving electricity and internet connectivity
    6.2. Putting in place LAN and WAN equipment to support EMR
    6.3. Safe disposal and recycling
    6.4. Improving user support through PPPs
7. Improve the legal and regulatory framework for security, confidentiality and controlled access to information.
    7.1. Develop and implement a personal data sharing/confidentiality policy and enforcement strategy
    7.2. Develop other policies and regulatory frameworks guiding digital health systems and devices (e.g. use of SocialMedia, telemedicine)

8. Leverage technology to build the capacity of the health workforce, offer decision-support and prepare health workers at all levels to manage and use the full range of Digital Health technologies
   8.1. Workforce development strategy
   8.2. Expand use of eLearning
9. Promote research and development to adapt innovations and the use of emerging technologies in the health sector
   9.1. Support operational research on innovative digital health technologies

Figure SEQ Figure * ARABIC 3: Flagship Projects

FLAGSHIP PROJECTS

While this strategic plan includes a wide range of digital health interventions across most of the health program and service areas, four initiatives were selected as the flagship projects for the sector. These are the most cross-cutting and are likely to have the highest impact on the well-being of citizens.
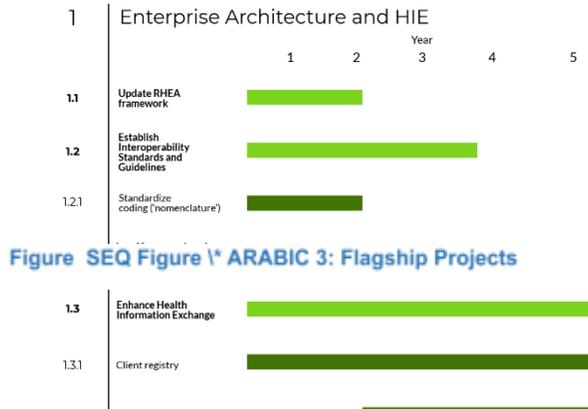
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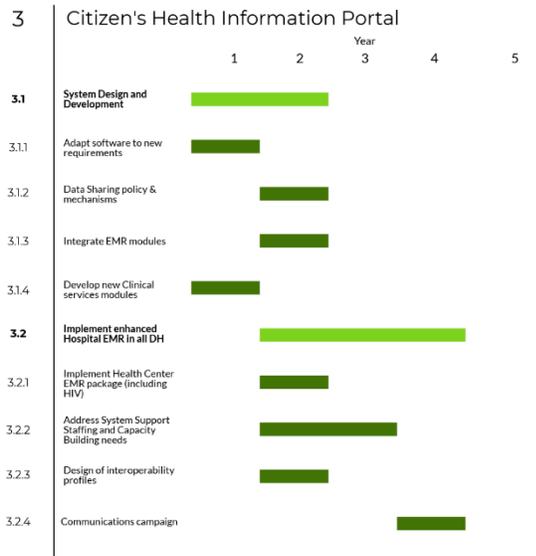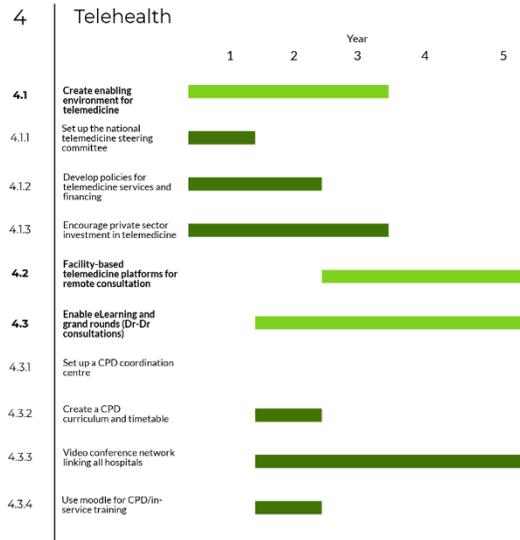
HEALTH ENTERPRISE ARCHITECTURE

Rwanda was a pioneer among African countries in developing and enterprise architecture for health and implementing the first proof of concept for a health information exchange through the Rwanda Health Enterprise Architecture Project (2010-2014). With the GOR's multi-sectoral Enterprise Architecture initiative now well underway, these concepts need to be updated. In particular, the HIE aligns very closely the "Government Service Bus" that will simplify exchange of data across systems that manage transactions for a wide range of services provided to the Rwandan population.

This initiative envisions the following developments:

- Updating the Rwanda Health Enterprise Architecture framework
- Standards for interoperability
- Policies for data privacy and exchange
- Infrastructure at the National Data Warehouse to scale up the Health Information Exchange
- Links to multi-sectoral initiatives including the "Citizen Service Bus" and/or direct links with Ubudehe and NID.

ELECTRONIC MEDICAL RECORDS (INCLUDING FACILITY MANAGEMENT SYSTEM)

Health facilities in Rwanda have been using electronic medical records systems of one type or another for many years. Nearly 400 health centers have OpenMRS-based HIV case management modules, while about 10 hospitals have a more comprehensive 'full package' also developed in OpenMRS. At least 20 facilities are using OpenClinic at the hospital level with features similar to the full package. Following the assessment that indicated that many of the OpenMRS modules were not being fully utilized, the MOH conducted a detailed business process analysis with health facility staff and developed functional requirements for a comprehensive hospital management system.

While the costs for implementing a unified solution for EMR will be high, the benefits are many and the expected return on investment can be used to justify that the health facilities fund much of the investment themselves. Other benefits include:

- Increased efficiency – sharing results for diagnostic tests, billing and insurance claims processing
- Patient management and referral – historical records of patient visits can be quickly accessed in the facility and, if the shared health record is implemented, the records can be shared with other facilities when the patients are referred.
- Improved work flows and scheduling/appointments to reduce patient waiting times

CITIZEN'S HEALTH PORTAL

 With the view towards increasing citizen- or patient-centered care, the rapidly increasing penetration of mobile phones and internet connectivity can be leveraged to deliver new typese of services and engage citizens more in their own health care. The development of a citizen's information portal is being led by the Ministry of Local Government (MINALOC) and health information and services are likely to be a major component. The Health Information Portal that would provide citizens with:

- Access to their own personal history of health records
- Information about health risks and real time data about disease trends
- Tips for self-care – especially related to growing burden of NCDs
- Information to help them find and select health care providers/services

TELEHEALTH

 Two related initiatives that build on Rwanda's investments in connectivity and show great promise are telemedicine and eLearning. These will extend the reach of specialized health services to patients and capacity building to health care providers in remote areas in cost-effective ways. Telemedicine is an ideal domain to engage private sector investment and some innovative initiatives have already begun by offering phone and pharmacy kiosk-base remote consultations. However, more work needs to be done on the policy front to create an enabling environment for these services. eLearning can leverage some of the same technologies to provide a cost effective platform for continuing professional development (CPD), reduce the need for costly workshops and help to deal with the needed for continuous refresher training due to staff turnover. Key interventions include:

- Establishing an enabling environment for telemedicine
- Operationalizing videoconferencing
- Establishing a central command center for sector monitoring
- Leveraging eLearning for workforce capacity building

QUICK WINS

The eHealth team has identified a number of quick wins that will help gain momentum towards the implementation of this strategic plan. Several of these are foundational interventions that are pre-requisites for many of the other sub-projects.

The following are some of the main quick wins:
- Elaboration of a **data security policy for individually identifiable data**: Having such a policy is essential before the implementation of the EMR and health information exchange. In addition, it will determine the citizen's role in providing consent to data sharing and the extent to which the will be able to access their own records.

- **Client/Patient registry with unique IDs.** With the transition from reliance on aggregated data from the HMIS to individual data stored in and EMR, it has become critical to have a unique patient identifier to link records longitudinally across the systems. Many stakeholders will benefit from this system including chronic disease programs (HIV, TB, NCDs) and health providers needing access to data stored in shared health records. It will also benefit the individual citizen who can have a single ID number to link their data across many services in and beyond the health sector. It builds on work done by MINALOC to enhance the CRVS as well as the NID and is an important component of MITEC's enterprise architecture framework: the government service bus.
- **eLearning:** Substantial progress has already been made to set up a health sector eLearning platform and develop the capacity of key staff to design and facilitate course. Similarly, nearly all district hospitals now have videoconferencing equipment and broadband internet. Transitioning more of the sector's capacity build initiatives to blended-learning or eLearning approaches can save substantial resources for the health sector and is especially appropriate for digital literacy and refresher training for users of health information systems platforms.

KEY INTERVENTIONS AND STRATEGIES

STRENGTHEN INTEGRATION AND INTEROPERABILITY OF HEALTH INFORMATION SYSTEMS

This component focuses on updating the Rwanda Health Enterprise Architecture framework to link it with the Government's multi-sectoral initiative to develop an enterprise service bus. In addition, it will build on the health information exchange including a client registry for uniquely identifying citizens across the health system and the development of policies to protect and securely share individual data.

HEALTH ENTERPRISE ARCHITECTURE (INCLUDING HEALTH INFORMATION EXCHANGE) – FLAGSHIP PROJECT

As indicated in the situational analysis, Rwanda has made substantial progress in developing and adopting health information standards, as part of the Rwanda Health Enterprise Architecture (RHEA) initiative, and creating a Health Information Exchange. Key infrastructure is already in place including: a client registry that is based on available data from the Ubudehe database, a health facility registry, a health providers' registry, terminology service, health information mediator (HIM/Interoperability layer), a database of shared health records, a health data warehouse and several interoperability profiles connecting different information systems together (including OpenMRS, RHMIS, RapidSMS, etc…). Rwamagana district served as a pilot district to demonstrate a proof of concept in the implementation and use of Rwanda Health Information Exchange (RHIE) using a maternal health use case. The proof of concept was successful but the system is no longer functional largely because there is no more data entry at

the health facility level although the central infrastructure is still in place and is located in the National Data Center.

The figure below shows how the health information exchange relates to other key components of the RHEA framework.

Figure 4: Rwanda Health Enterprise Architecture Framework
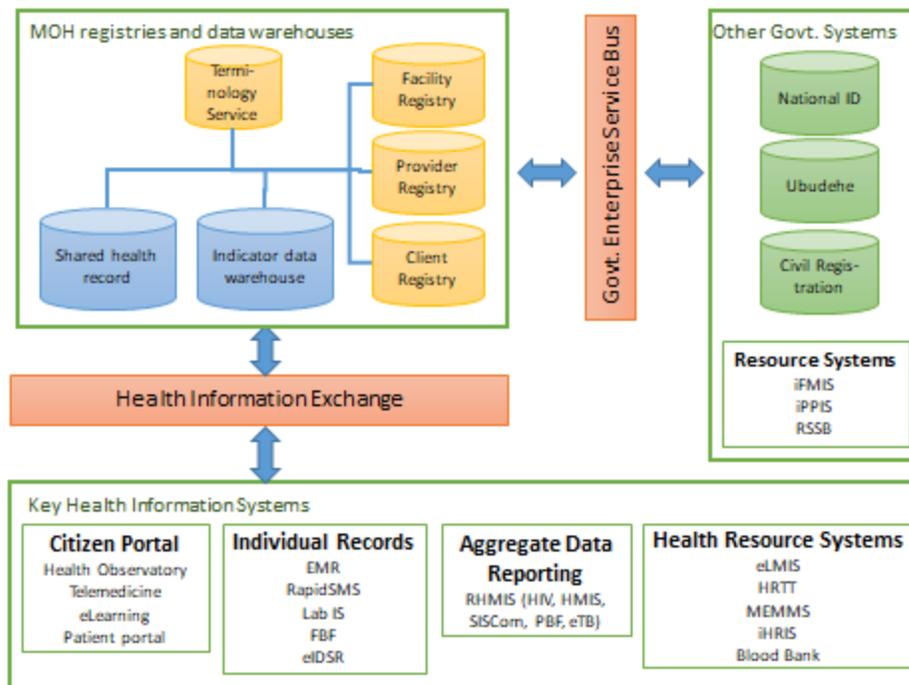
The different infrastructure components perform the following functions:

- *A national Shared Health Record (SHR)* that maintains a person-centric longitudinal record. It is a back-end service for the RHIE and only be accessed at the point-of-care (POC) or through a web interface. The SHR is built on OpenMRS and used primarily for storage and retrieval of clinical information.

- *A Terminology Service (TS)* that promotes semantic interoperability between systems by storing common data sets such as LOINC, ICD10 and enables validation.

- *A Client Registry (CR)* that uses algorithms to perform matching using client identifiers in new messages coming from the POC systems with existing clients recorded in the CR to ascertain if the new records are for an existing client or a new client is being added to the CR and SHR.

- *A Provider Registry (PR)* that is a register of healthcare providers from multiple sources/levels of health service. The PR validates healthcare providers submitting data from POC applications against the central PR before they enter the SHR.

- *A Facility Registry (FR)* that is a database that keeps track of different healthcare facilities within Rwanda, e.g. clinics, hospitals.

- *A Health Information Exchange (Interoperability Layer)* that facilitates the transfer of information between the registries and POC systems OpenMRS and RapidSMS. The RHIE IL is a software system called Open Health Information Mediator (OpenHIM) that was developed by the Jembi South African team specifically for the RHIE use case.

This infrastructure will be very key in supporting future interoperability needs but more investments are still required to update and enhance the existing technologies.

When this intervention is complete, the following should be in place:

- The Rwanda Health Enterprise Architecture framework guides interoperability across the entire health system
- Data flows securely and efficiently between systems that are linked through the HIE and personal information is protected.
- Person registration systems are fully integrated with the NID (including infants and young children)
- Health facilities use computerized financial management system to comply with public sector accounting standards and efficiently manage their financial resources.
- The RHIE framework is leveraged to implement interoperability between key health sector systems for more efficient and timely data flows.

Some of the key benefits of this strategy are to:

- Improve identification and tracking of patients across the entire health system including management and referral of patients within and between health facilities
- Seamless data exchange among systems with minimal duplication of data entries.
- Link between EMR Billing system and future RSSB Claims management system to improve efficiency of billing and claims processing with paperless transactions
- Integration between EMR and IFMIS to improve Health Facility accounting and reporting
- Efficiency of processing laboratory samples and communication of results
- Facilitate access to data from multiple systems with single password (e.g. Data Warehouse for Aggregate Data)
- Reduce errors and eliminate registers by facilitating aggregation of individual data to RHMIS
- Improving accuracy of drug and supply quantification by linking data from multiple systems (e.g. eLMIS, HMIS and IFMIS)
- Improving efficiency of drug supply chain including procurement, dispensing

Strategic objectives:

The main strategic objective of this foundational component of the eHealth strategic plan is to update the Rwanda health enterprise architecture framework. In addition it aims to leverage the

existing Health Information Exchange implementation and develop it further, create a shared health record for all citizens, expand the interoperability profiles and adopt standards to improve the overall interoperability across all systems in the health environment.

Key interventions:

A detailed logical framework for this component is included in the annex of this report. Key interventions proposed include:

- Update all the RHEA components and upgrade them where necessary
- Improve data access, operational efficiencies and unique patient tracking across the entire health system by creating a shared health record for all citizens.
- Link the RHIE with the National ID to facilitate civil registration and vital statistics
- Establish Interoperability Standards and Guidelines
- Select and adapt standard procedure coding ('nomenclature') for use in EMR and billing.
- Complete linkage between Civil Registration and NID for seamless Unique Patient Identification
- Design, test and implement interoperability profiles between key health sector systems
- Complete configuration and roll-out of the Rwanda health data warehouse
- Develop capacity of Provincial/District authorities and Central level staff to access, analyze and use data from key Health Sector data sources for evidence-based decision-making
- Develop in-country capacity to maintain the RHIE
- Ensure that the RHIE is securely hosted and backed up regularly

IMPROVE HEALTH SERVICE DELIVERY AND ACCESSIBILITY THROUGH DIGITAL HEALTH

EMR/FACILITY MANAGEMENT SYSTEM IN ALL HEALTH FACILITIES

The Government of Rwanda proposed the use of Electronic Medical Records systems (EMR) to transform patient and resource management in all health facilities. To achieve this goal, the Ministry of Health embarked on developing an open source software, that was expected to provide the solution of evolving health care data needs. This development was based on an existing EMR software that is called OpenMRS. To date the MOH has implemented various modules of the EMR system, including but not limited to HIV, primary care and billing packages. Although the HIV package has been implemented in 362 health facilities across the country, the billing package has only been implementation in 8 district hospitals. The use of this system in the health facilities where it has been implemented remains somewhat limited and the system is not being exploited to its full potential.

Given the importance of the EMR – and the challenges encountered during the implementation of the current system, the MOH and RBC see this as one of the most important components of this 5 year Strategic Plan.

In the coming five years, the Ministry of Health would like to achieve the following:

● An Integrated EMR/Facility Management System implemented in all public district hospitals and health centers
● Sustainable mechanisms in place for ICT infrastructure and end user software support
● An EMR which is interoperable with other key systems such as insurance, financial management, supply chain, RHMIS, etc.
● Availability of shared health records (for all people that have medical files in the EMR) at national level and accessible at all points of care that use the EMR and by patients who wish to see their health records.

Some of the anticipated key benefits include:

● Improved quality of clinical services provided at health facilities
● Improved exchange of clinical data
● Improved patient follow-up particularly for chronic diseases
● Improved reporting throughout the health system hierarchies
● Cost reduction due to gradual elimination of paper based systems
● Enhanced patient referral system amongst various health facilities
● Timely interventions based on evidence based clinical decision making
● Improved overall health facility management
● Improved revenue generation from healthcare services
● Increased engagement of citizens in the management of their own health care.

Having weighed the different options for EMR implementation it is envisaged that the best option will be for the Ministry of Health, with help from RDB, RISA and MITEC, to select an appropriate partner who can either develop the existing software to meet the health facilities requirements or to customize an off-the-shelf software to meet the requirements. This would ideally be through a Public Private Partnership (PPP) arrangement. The private partner organization will also participate in the implementation in order to offset the high investment cost of rolling out the system at a national level.

A national EMR infrastructure can be implemented using either of two main strategies. One strategy is by using a client-server model where the EMR is installed on a central server and the health facilities accessing it as "clients". This option requires consistent connectivity and high bandwidth between the health facilities and a very powerful server farm to host the EMR instances. It also requires a robust EMR system that can be scaled to the national level and that can handle a very large number of transactions at any one time. The second option, currently in use, is the installation of the EMR system on servers at every health facility such that every EMR at a health facility operates as an independent point of care system. This option requires significant investment in ICT infrastructure at every health facility, but does not require consistent connectivity and does not require a robust scalable EMR system.

The Ministry will adopt a mixed model where during the first phase, a small number of hospitals will be connected to an EMR on a central server while the rest of the facilities will have an EMR

implemented locally. Depending on the success of the centralized EMR, the other health facility EMRs will be migrated gradually to the central server. .

Strategic objectives

The main objective is to implement an EMR in all public health facilities in the country and use this process as an opportunity for business process re-engineering – making data flow more efficient and improving patient management. An Integrated Hospital Management System (including EMR) will be implemented in all District Hospitals and a lighter version of the software will be implemented in health centers in line with the user and technical requirements. Shared health records (for all people that have medical files in the EMR) will be synchronized with a server at national level, through the health information exchange (HIE), and accessed at all points of care that use the EMR. The EMR will be interoperable with other systems such as insurance claims, financial management, supply chain, RHMIS, etc. Sustainable mechanisms will be put in place for ICT infrastructure and end user software support.

Key interventions proposed are described in the detailed logical framework that is included in the annex of this strategic document. The implementation of the EMR will be divided into phases:

- Phase I: Customization of software according to user and technical requirements and implementation in district hospitals (mixed model)
- Phase II Customize additional modules and health center version of EMR and implement in Health centers
- Phase III: Migrate local EMRs onto the centralized server where possible
- Phase IV: Create a shared health record

Throughout all the phases, there will be strong advocacy to ensure stakeholders involvement during the EMR development and implementation process as well as policy alignment to enhance system adoption and use.

LABORATORY INFORMATION SYSTEMS

A fully functional laboratory information system (LIS) has been implemented at the National Reference Laboratory. Originally, a client-server application only accessible over the lab's local area network, the system has recently been upgraded to a web-enabled version. The system interfaces with key lab testing equipment to record results automatically. The LIS is primarily used centrally – not yet decentralized for use in other labs due partly to the current system architecture. The LIS also lacks a true application program interface (API) to facilitate interoperability with other systems such as OpenMRS (HIV PCR test, etc..) or eIDSR (lab test orders and results) and to implement SMS or email alert capabilities to notify test requestors of test results.

The current platform, developed by LabWare, is not open source and licensing costs may preclude rolling it out to all but the best equipped health facilities – where the electronic interfaces with lab equipment will add value for money. The current EMR project, described above, also includes a lab module. In recent years, NRL has begun adapting a basic open-source lab information system (BLIS) in selected satellite labs – especially for HIV testing services that have been decentralized.

Once this initiative is complete:

- Lab systems will be interoperable with other electronic medical records and health information systems platforms so that laboratory results are automatically available to the requesting facilities when the tests are completed.
- Use of an enhanced LIS will be extended to all referral hospitals and satellite labs, so that samples for lab tests and results can be managed in an efficient manner through a decentralized network of facilities and results can be obtained more quickly on-line or through automated alerts.
- The lab module in the EMR primary care package will be deployed as part of the Hospital and Health Center EMRs.

Key interventions identified are in two main areas:

- Enhance the national LIS :
    - Upgrade to the web interface and add SMS alert capabilities
    - Create synchronization between local instances and national LIS server
    - Create interoperability between LIS and eIDSR (lab test orders and results) for patient lab test requests and results and HMIS for basic lab testing metrics
    - Develop a dashboard to track key LIS indicators in a DHIS-2 instance
    - Implement a system in remaining satellite labs
    - Training for users in new interface and at new sites

- Implement District Hospital and Health Center lab modules as part of EMR:

    - Develop or configure the EMR lab module to local requirements
    - Develop interoperability with National LIS

PROMOTE TELEMEDICINE FOR REMOTE DIAGNOSTICS AND CARE – FLAGSHIP PROJECT

One of the areas that have been identified as priority in the SmartRwanda master plan is the use of telemedicine technologies to increase accessibility to health services. There are various definitions of Telemedicine but they all refer to the **remote diagnosis and treatment of patients by means of telecommunications technology**.

Telemedicine systems have been implemented in Rwanda for more than a decade using varying methods as technology advances in the country. The first telemedicine initiative was the use of Digital Subscriber Line (DSL) technology to connect two referral hospitals (King Faisal Hospital

and CHUK) in order to do live broadcast of surgical interventions from the operation theatre of King Faisal Hospital to the conference room in CHUK. The DSL technology is now obsolete in Rwanda and other types of broadband technologies have been put in place including wireless broadband such as 4G LTE, 3G and fibreoptic cables. Another initiative in 2008 to 2010 involved upgrading film-based x-ray machines with digital sensors and PC workstations (teleradiology) to eliminate the need for costly and toxic consumables and to enable images to be transmitted to referral facilities for interpretation. At the time, the large size of the digital images and low bandwidth internet connections in most district hospitals limited the ability to transmit the images.

In spite of these investments, a recent Auditor General's report decried the status of telemedicine in district hospitals suggesting that the initiative demonstrated 'poor value for money.' Some equipment was non-functional or had never been set up correctly, while most was laying idle for lack of a true training program to produce the content that needed to be delivered.

A private telemedicine company has now established their mHealth telemedicine platform for use in Rwanda. This service uses regular analog or smartphones to enable citizens to schedule appointments and consult with physicians by voice or video. They have also established private kiosks in selected pharmacies, where patients can seek medical advice.

In the coming five years, the Ministry of Health would like to achieve the following:

- Have functioning videoconferencing facilities in all district and tertiary hospitals to facilitate real-time conferencing between hospitals
- Have a functioning telemedicine platform that supports telemedicine services including but not limited to;
  o Teleradiology
  o Remote consultation
  o Remote diagnosis and treatment
  o Self care/patient education
  o Health provider education/ CMEs

- Have regulatory mechanisms and telemedicine standards that are conducive for public and private investors in telemedicine services while protecting the security and confidentiality of patient data
- Have tariffs and mechanisms for insurance claims and reimbursements for telemedicine services
- Have a budget line to support purchasing and maintenance of equipment and to cover other recurrent costs such as communication costs
- Have telemedicine champions across the country in various health facilities

Some of the expected benefits from telemedicine include:

- **Convenience:** The ability for patients to make a virtual visit from their own homes or a nearby primary care facility with a physician at any time of the day, through video, web chat, or phone. Clients can also follow-up remotely on a prescription or diagnosis with a

physician. With the availability of low cost connected digital diagnostic devices (such as blood pressure cuffs and diabetes testing kits), physicians can monitor the health status of their patients remotely.

- **Reduced waiting time.** Telemedicine eliminates the time needed to travel to a facility and queue while waiting to see a physician.
- **Cost-efficiency.** Doctors can charge less for a telemedicine consultation than they would for an in-person visit because the resources that are required to conduct a telemedicine consultation are much less. Telemedicine reduces travel expenses for patients, especially for those living in rural communities. Rural families who would normally travel hours out of their way to access key health services can receive them from the comfort of their homes.
- **Expedited transmission of digital images (MRIs or X-rays) and laboratory results for a second opinion**. Physicians can use telemedicine to exchange various types of images and laboratory results and get a second opinion within a very short time.

Key strategies to support telemedicine for the next five years include:

- implementing video conferencing and telemedicine technologies to support both training of clinicians and remote consultations in all district and tertiary hospitals.
- Developing a regulatory framework and standards to govern telemedicine services provided by both public and private sectors. This will include developing a framework for setting tariffs for telemedicine services that will be covered by the major government-run health insurance schemes.

Key interventions proposed are included in the detailed logical framework for this component in the annex of this strategic document. These include:
- Setting up videoconferencing facilities in all district and tertiary hospitals to facilitate real-time conferencing between hospitals and patient consultations with specialists.
- Selecting and implementing a telemedicine platform that supports telemedicine services in district hospitals and health centers.
- Putting in place regulatory mechanisms and telemedicine standards to create a conducive environment for public and private investors in telemedicine services
- Put in place policies and mechanisms for insurance claims and reimbursements for telemedicine services
- Creating a budget line and leveraging financial resources for implementing telemedicine systems such as purchasing and maintenance of equipment and communication costs
- Encouraging innovation by investors from the private sector who are interested in providing mHealth telemedicine services
- Identifying and appointing telemedicine champions in the various hospitals and training all relevant users

IMPROVE ACCESS TO HEALTH INFORMATION AND DIGITAL SERVICES FOR CITIZENS

IMPLEMENT A CITIZEN'S HEALTH PORTAL – FLAGSHIP PROJECT

While the concept of "patient-centered health care" has been evolving over the past decade, there remains a gap in the area of health technologies – most of which are currently focused on health service providers. The person-centric vision is that, "the power of each individual is developed and unleashed to be active in managing their health and partnering in their health care, enabled by information and technology". The citizen health information portal will provide individuals with the ability to interact with health professionals, obtain relevant health information and access their health records.

This intervention is very much in line with other GOR initiatives such as the Irembo platform for mobile phone-based services and payment and the MINALOC Citizen's Information portal.

Once the Citizen's Health Portal is complete:
- Rwandans will be able to access health-related information and services easily via web or smartphone.
- The information portal will be linked to the shared health record, registries, health observatory, and patient scheduling systems.
- Personal data stored securely but portable when a patient requests it to be shared

Key interventions proposed for the development of the Citizen's Health Portal include the following:

- Assess available information and user needs:
  - Conduct an assessment of web-enabled health information available in Kinyarwanda or suitable for translation.
  - Work with RBC health programs to identify key other content areas and message content to share with the population through the portal.
- Develop policies that enable personal data sharing: Review existing data sharing laws and develop specific policies to provide citizens with access to their own health records.
- Develop of content for Citizen's web-portal integrated with the MINALOC portal:
  - Design of interoperability profiles between citizen's portal, shared health record, facility registry, provider registry and EMR scheduling systems
  - Translation & adaptation of health information content
- Conduct a communications campaign to inform citizens about the portal, provide user guides and encourage them to register

IMPROVE COLLECTION, MANAGEMENT AND USE OF DATA AT ALL LEVELS OF CARE

CONTINUE TO EXPAND RHMIS PLATFORM AND BUILD CAPACITY FOR DATA QUALITY ASSURANCE AND DATA DEMAND AND USE

The Rwanda Health Management Information System (RHMIS) has flourished since it transitioned over to the DHIS-2 platform in 2012. The MOH has incorporated additional modules onto the platform for the community health worker information system (SIScom), the PBF reporting system, the TB and HIV reporting systems, and most recently the epidemic disease surveillance system (eIDSR). The tracker module has been used to report on neonatal and child death audits and to track individual TB and Leprosy patients. Considerable capacity has been built across the sector to configure the DHIS-2 at the central level and to manage DHIS-2 data at the health facility level. The PRISM assessment in 2014 demonstrated that there had been improvements in HMIS data management and use since the initial assessment was conducted in 2012. Nevertheless, there are still challenges that remain and new data collection requirements to be met.

For several years, the Ministry of health has been promoting the collection and use of health information for evidence-based planning and decision-making, however it has not always been easy to access the data from many separate data bases that are maintained by different agencies within the MOH and RBC. With the implementation of the DHIS-2 software platform and the subsequent transition of most MOH data collection systems to that platform, it is now technically feasible to combine key indicators from these different databases into a single platform.

Over the same period, WHO has been advocating for all countries to implement a broader concept of a National Health Observatory. In addition to serving as a data repository, this includes several elements of a knowledge management platform with useful narratives built around a standard taxonomy that provide a detailed profile of each of the building blocks of a nation's health system. WHO hired staff from the UR/School of Public Health to develop the national health system profile and have set up the framework for the Rwanda Health Observatory. In separate initiatives, the MOH and RBC have been working with other partners to design a full set of performance dashboards for all of the departments and automated district health profiles to support strategic planning.

The SWOT analysis identified a number of key weaknesses related to the RHMIS:

- **Data use remains limited**: there is little formal feedback from the national level to district hospitals and, though the display of data has improved in health facilities, most analyses are not updated routinely. Data use is also complicated by data access problems (many systems, many passwords) and capacity building efforts focused on data managers & M&E staff, but not on management and decision-makers. Some government staff, such as those at Provincial level and in other Ministries are uncertain about what health sector data are available what how they can access it.
- **Data quality assurance remains an issue**: Health workers are still not conversant with definitions of some indicators and data quality control is difficult because too much data are collected, some of it not used and few data validation rules have been implemented in the

DHIS-2 instances. Though district level staff were trained in conducting DQAs in 2012-13, few continue to conduct these audits and DQA's are mostly done by central level teams that don't have the time or resources to reach many facilities.

- **Costs of running all of the DHIS-2 instances are high:** In particular, there is the high cost of hosting RHMIS instances at the National Data Center at around $5,000 to $7,000 per month. These costs are difficult to recover from facilities and must be funded by programs at central level. In addition, declines in funding at the central level mean that the central level MOH can no longer pay for the replacement of the computers that were provided by donors during the initial RHMIS roll-out. Health facilities will need to generate their own funds to replace them in future.
- **User support and systems administration:** The central level MOH HMIS support team has had a lot of turnover and, since some have shifted to RBC, health facility staff are sometimes unsure of where to turn for support. There is no formal user helpdesk mechanism in place.

RBC and the MOH have been very successful in setting up the DHIS-2 platform to meet the needs of most health programs' routine data collection needs. There is an opportunity to continue to build on that platform for all future reporting needs and to use the new tracker functionality increasingly to monitor the individual health status of key populations and shift towards patient-centered care.

In order to simplify access to data stored in many separate DHIS-2 instances, the data required for key health sector indicators will be synchronized automatically in the existing Health Data Warehouse. The health sector data sharing policy will be updated to clarify data access rights for users in other sectors and non-governmental stakeholders.

There is also a desire to shift data use from being done exclusively by Data Managers and M&E Officers to more senior managers and decision-makers at District and Central levels.   All managers within RBC and MOH – as well as key managers from the District Hospital and DHU - should create and use dashboards to monitor their key performance indicators. This strategic plan proposed the development of a command-room style set of dashboards built on the data warehouse to be used by senior management for real-time monitoring of key sector performance indicators.

Between the RHMIS instances and the EMR, there is now a critical mass of users across the entire country (well over 2000 at the current time) and there is a need to rationalize user support. In addition to training and retaining a small core team of system admin staff within the MOH and ICT officers at District Hospitals, there are now the economies of scale required to interest the private sector in providing end-user helpdesk services and software development support for such projects.

The Ministry of Health has identified the following broad strategic goals:

- Leverage the DHIS-2 platform to integrate new routine data collection systems.
- Enhance data quality
- Build capacity for evidence-based decision making at all levels of health system
- Develop new types of information products, such a dashboards, and feedback loops

Leverage the DHIS-2 platform: for implementing a variety of new systems on the DHIS-2 platform, especially the tracker module. This includes a facility-based nutrition supplementation tracking system (FBF), a HIV case registry, and a central repository for community verbal autopsies. In addition, with the rapid increase in the number of private health posts, there is a need to put in place a simple reporting system – preferably using mobile phones – for all health posts.

In order to improve data use, the MOH will operationalize the data warehouse by developing a simplified user interface to map data elements to be synchronized between data warehouse and other DHIS-2 instances and designing more compelling dashboards. It will also integrate selected data warehouse indicators into the public Citizen's Health Portal and automate links to the new Rwanda Health Observatory.

Update and enforce the data sharing policy in order to:
- Resolve questions about data access to all stakeholder groups and update the Health Data Sharing and Confidentiality Policy accordingly
- Define and disseminate policy for requesting and granting access to the Rwanda health data warehouse for provincial and district authorities and implementing partners

Continue to enhance data quality: This includes, institutionalizing annual/quarterly database review workshops to discard un-used data, clean up indicator definitions, check and fix data outliers; institutionalizing data quality audits (DQAs) by District Hospital in all health centers; and monitoring and publishing DQA scores in the data warehouse as an indicator of health facility performance.

Reinforce capacity for evidence-based decision making at all levels: Key interventions do develop increased data demand and use include:
- Train a team of staff from MOH and RBC to update narrative content of the Rwanda Health Observatory and facilitate collaboration on a routine basis.
- Develop capacity of Provincial/District authorities and Central level staff to access, analyze and use data from key health sector data sources for evidence-based decision-making

Establish efficient 'information center' services to log and respond to routine and ad hoc requests for RHMIS data from MOH/RBC, researchers, and decentralized level. Develop and disseminate data use SOPs and guides for Central and District level and use the Knowledge Management platform to develop communities of practice of key user groups (e.g. District M&E officers and Data Managers) to share experience and provide mutual support.

Develop new types of information products and feedback loops: Improve feedback from DH to HC and from Programs to Districts/DH, design a broader range of information products (statistical bulletins, policy briefs) and implement push technology (SMS alerts and targeted

emailed reports) to disseminate key analyses. Establish a central level command-center style set of dashboards, built upon the data warehouse to display key sector performance indicators in real time. Complete the primary health care performance indicator (PHCPI) dashboards initiative to develop model dashboards for MOH and RBC Divisions and districts. Link selected data to district profiles on a web portal that can be cross-linked with the MOH and RBC web-sites. Formalize access to data by clarifying data sharing agreements with decentralized authorities and other stakeholders. Rollout enhanced dashboards from data warehouse within MOH and RBC Divisions and at District level with appropriate capacity building strategy.

Build capacity within the health sector for data demand and use:
- Train team of staff from MOH and RBC to update narrative content of the health observatory and facilitate collaboration on a routine basis.
- Develop capacity of Provincial/District authorities and Central level staff to access, analyze and use data from key Health Sector data sources for evidence-based decision-making

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COMMUNITY HEALTH SURVEILLANCE AND REPORTING (RAPIDSMS)

The Ministry of Health introduced RapidSMS in 2009 and it has gone through a number of iterations. The system was first deployed as a pilot project in the District of Musanze for early identification of pregnancies, notifying emergency cases and birth reporting. Within 9 months of the initial deployment there was anecdotal evidence that maternal deaths had declined in part due to use of the system and the Government requested that RapidSMS be scaled up. Not only could pregnant women be traced to their various villages, but deliveries at health facilities were increasing and Community Health Worker performance could be monitored.

In November 2012 RapidSMS was expanded to version 2 aiming to track the continuum of care life cycle (first 1,000 days of a child's life, from conception to 2 years). The system was then been adopted and scaled up to all 30 districts, operated by 45,000 CHWs in 15,000 villages across the country. The system expanded tracking of pregnant women (pregnancy confirmation, antenatal care, emergency response through Red Alert messages and response scenarios) and child health (child nutrition, major child killer diseases (malaria, pneumonia & diarrhea), un-immunized children in the community.

In 2017, newborn emergency alerts, severe malaria & stock out notification were seen as critical requirements to reduce maternal and child health death, therefore, RapidSMS was expanded to Version 3.

A lot has been done to ensure that RapidSMS is used effectively at national scale. There is effective supervision that provides refresher training and CHWs are committed and motivated to learn and use RapidSMS. Selected data from RapidSMS has also been integrated into the CHW performance based financing (PBF) system, giving them additional incentives to use the system. The positive relationship between CHW supervisors and CHWs facilitates daily follow-up of RapidSMS activities. The involvement of community leaders leads to local ownership and

enhances usage of the system. Medical doctors have been appointed by district hospitals to serve as focal points and this will increase usage of the RapidSMS system at the district level.

Besides these achievements however, there are several challenges that need consistent attention in order to optimize the benefits that the RapidSMS system brings. Some of these challenges include:

- Technical Issues:
    - related to using cell phones due to language barriers, there are few CHWs who do not know how to use their cell phones to send text messages
    - Difficulties charging phones in remote areas.
    - Weak internet connections for data managers & CHW supervisors in some areas
    - Replacement of battery chargers & broken phones.
- User and management issues:
    - Lack of ownership of RapidSMS activities by local leaders
    - Misunderstanding of case definitions for RapidSMS indicators
    - RapidSMS data use by Doctors and Nurses is very limited
    - Not all pregnant women reported using RapidSMS especially in urban areas
    - CHW turnover and the need to train new CHWs;
- Tools/Resources:
    - Non-standardized supportive supervision checklist for all districts to use;
    - Insufficiency budget to produce registers for recording RapidSMS messages for better follow up.
    - Delays by facilities to respond to RED alert notifications
    - Few ambulances to respond to red alerts.
    - Insufficient communication fees for in charge of CHWs for better follow up of RapidSMS activities.
    - Delays in the transfer of funds

The overarching goals are to make each pregnancy "everyone's business" and to ensure that "no woman dies due to pregnancy or delivery" and to have all 30 districts record zero preventable maternal deaths. The MOH is planning to upgrade to RapidPro in order to benefit the following features:

1. System integration with other system through open Application Protocol Interface's (APIs).
2. Increasingly OpenHIE / RHEA standards compatible and be able to interact with HMIS (DHIS2), Electronic medical records
3. Easy workflow with logic for running mobile-based services.
4. Support multiple reporting channels SMS, IVR, USSD, Twitter, Facebook Messenger, Telegram, WhatsApp (beta) and Android 'Surveryor' App for offline data collection

To this end, the Ministry of Health will pursue two broad strategic goals:

Strategic Goal 1: Ensure timely availability of quality information that will support Government capacity to develop/ review/ update policies, strategies, and standards/protocols for maternal health, and child growth monitoring.

This will be reviewed through tracking the number of districts using real-time data monitoring system for reporting newborn health outcomes. To achieve this the Ministry will implement a number of initiatives including:

- Further Upgrade, development, expansion and management of RapidSMS to RapidPro at the national level including ownership, interfacing with other systems, mass messages, messages to pregnant women and new areas and maintenance of the RapidSMS/RapidPro software
- Strengthen the mechanism of data review and feedback to health facilities

Strategic Goal 2: Ensure availability of timely and quality data to ensure that new born, children and women have equitable access to health services.

This will be reviewed through tracking the number of health facilities with functional essential Newborn, IMCI, and EmONC services in supported districts. To achieve this we will implement a number of initiatives including:

- Building Institutional capacity to provide newborn services at district and health center levels through RapidSMS
- Enhancing scale up of the RapidSMS to track the Pregnancy and newborn life cycle through national feedback co-ordination meetings of CHWs

The objectives of the RapidSMS for these strategic goals are to:

- Reach at least 1,000,000 people with new messages on key family health practices
- Reach at least 500,000 additional people with messages on safe hygiene practices
- Strengthening RapidSMS at all levels of the health system through training and supervision of CHWs, coordination, and advocacy in all districts for RapidSMS
- Harmonize RapidSMS to iCCM/MNHBC training manual

ENHANCE EPIDEMIC DISEASE SURVEILLANCE AND RESPONSE (EIDSR)

Rwanda implemented an electronic integrated disease surveillance and response (eIDSR) system in 2012 on a platform called TracNet that was used to track HIV indicators. The disease surveillance system was transitioned to the DHIS-2 platform in 2014.

The current system reports epidemic surveillance data in real-time from health facilities and it links surveillance data with laboratory results. The system automatically detects probable disease outbreaks using special algorithms and helps with quick analysis of surveillance data and generation of graphs, tables, and maps to guide decision-making (planning and prioritization).

In addition the system:

- Provides automated alerts, reminders, and feedback messages to relevant officers in timely and systematic way about reporting delays and probable outbreaks.
- Can be used to monitor routine surveillance and periodic strategic activities implemented to contain and manage outbreaks

Although the system meets basic needs of the users, there remain a number of challenges that the ESR team hope to address in the coming years. These include:

- Mobile data reporting through the USSD interface does not function reliably and it is not possible to make corrections on data submitted by phone
- Data quality issues persist such as discrepancy between data entered in the system and that recorded in registers. Few users enter follow-up data about the suspected cases that have been reported. This includes laboratory test results and follow-up status reports that are needed to confirm an outbreak.
- The contact tracing module has limited functionality
- Absence of interoperability functions with the laboratory information system, EMR and other eHealth systems
- The ESR team has insufficient capacity to configure, upgrade and maintain the system
- Significant turnover of staff trained on utilization of eIDSR
- Absence of automated and in person feedback instructions/orientation messages after reporting suspected cases
- Limited technical documentation that specifies the requirements for the system, in terms of functionalities, interfaces, performance, qualities and security and sustainability plan
- The system is largely focused on data collection by health providers and there is no support for engaging the community in outbreak detection and response – a new requirement from WHO's International Health Regulations (IHR).

In spite of these issues, Rwanda is the first country in the region that has implemented a DHIS-2 based disease surveillance system on a national scale and other countries are keen to build this experience. Key features that Rwanda has implemented have been shared with the global DHIS-2 community and are in the process of being included in the core functionality of the software so that others may benefit from them.

RBC plans to have in place a fully developed disease surveillance system addressing all new IHR requirements, improved data quality and interoperability with other relevant systems. The ESR team will have the required skills to configure, upgrade and maintain the system guided by comprehensive technical documentation of the system in order to ensure its sustainability. The system will include a community outbreak alert module linking human and animal health to enable the general population to report unusual health events.

The RBC/ESR team recently identified the following key strategies and interventions to enhance the functionality of the system:

- Developing interoperability with the National Laboratory Information System (LabWare) so that lab results are automatically transmitted to the eIDSR as soon as they are known.
- Enhancing the outbreak management module with a more intuitive user interface, easy to generate epidemic curves, hotspot maps and line listings
- Adding contact tracing functions that enable off-line collection of household level data on contacts using tablets and other Android devices.
- Adding a community outbreak alert module to the eIDSR system.
- Providing district and national level disease surveillance officers with tablets to use during outbreak investigations.
- Linking publicly shared eIDSR data directly to the RBC web site for their public information portal.

STRENGTHEN THE MANAGEMENT OF CRITICAL RESOURCES IN THE HEALTH SECTOR, BY ENHANCING THE FOLLOWING SYSTEMS:

SUPPLY CHAIN MANAGEMENT SYSTEMS:

As described in the eLMIS assessment, this system has now been rolled out to all District Pharmacies and public health facilities. eLMIS provides near real-time visibility of all facilities within the value chain on their supply chain activities (Stock On Hand, Order Management, Consumption, Expiries etc…). Currently RBC/MPDD is only fulfilling orders if they are entered through the eLMIS, so this helps to enforce use of the system. However, some facilities – especially those with limited internet connections – do not systematically enter their stock movements on a daily basis. Depending upon the proportion of facilities that report, this makes certain types of analyses less reliable – so there is a need to monitor and reinforce routine use. There are other functions supported by the eLMIS software platform that are currently not fully utilized, including: batch recalls/quarantine and transport and capacity management.

At the national level, the eLMIS is currently interoperable with the RBC/MPDD financial management system (SAGE), but the MPPD Warehouse Management System has limitations for interoperability, making it harder to integrate with the eLMIS.

Other opportunities exist for interoperability, for example with DHIS-2 to enhance users ability to use information from eLMIS through the built-in business intelligence tools and for quantification, as well as with the EMR system that manages patient level essential drug prescriptions at hospital level. Maintaining parallel systems (paper and electronic) alongside the eLMIS results in duplication of efforts affecting eLMIS utilization and data integrity.

Such system enhancements will significantly add value for users of the system at all levels. Finally, there is a need to resolve sustainability issues by ensuring that all facilities budget funds for the annual license fees (this is a hosted application) and for further capacity building – especially in the area of system administration and analysis of supply chain data – to enable the Rwandan team to configure the platform themselves.

The National Drone Delivery Service Project:

On October 14 2016, His Excellency the President of Rwanda, Paul Kagame launched the world's first national drone delivery service. Currently, a fleet of 15 small drones created by the robotics company Zipline are aiming to transport blood for transfusions and other emergency medical supplies across the country.

If the pilot project is a success, Zipline will operate 150 flights a day from the central warehouses where blood products and medical supplies are stored, and deliver them to 21 Health facilities across the country. The drones, programmed via GPS, can fly as far as 93 miles before they need to land, traveling at about 62 Km per hour. The drone network is designed so that when health care workers need a certain blood type, they can send a text to Zipline's distribution center. From there, packages of blood are loaded onto the drone, which is then launched from a launcher. When the drone is approaching the clinic, the health care worker who placed the order gets a text asking them to go outside. From 300 feet above the ground, the drone then drops its package by parachute and returns to the central warehouse.

Essential drugs and blood products take up a large share of the health budget and digital health initiatives can play an important role in managing them more efficiently to avoid wastage and reduce the duration of the supply chain pipeline. RBC hopes to see the following initiatives completed:

- The functionality of eLMIS platform will be enhanced at all levels of health system to make it interoperable with other key systems to eliminate duplication of effort and to provide business intelligence tools to avoid supply chain bottlenecks and waste.
- The supply chain systems will provide visibility of accurate stock positions to the facility level in all public health facilities and village level for CHWs.
- Routine management of the system is fully transitioned to the MPPD ICT team and sustainable contracting arrangements have been agreed with the vendor.
- The Zipline drone project is scaled up to more health facilities and transports other high value, lifesaving products (such as rabies vaccines or anti-venom for snakebites).

The following are highlights of the interventions proposed for improving the supply chain for drugs and medical products:

- Implement key eLIS system enhancements:
  - Push eLMIS data into DHIS-2 for analytics and business intelligence tools that allows links between patient data and consumption data – to support better drug quantification
  - Upgrade facilities infrastructure including provision of reliable internet services and adequate computers with capabilities to run the eLMIS application.
- Develop more effective interoperability between eLMIS and other system:
  - EMR pharmacy module to be made interoperable with eLMIS (which need daily total consumption).
  - eLMIS currently doesn't manage blood bank products. It would be useful if these data are collected and shared with the blood bank team to give them stock visibility at facility level – without implementing blood bank system everywhere.
  - Replace RHMIS tracer drug monitoring report with eLMIS generated data on drug stock status (all drugs) on demand to avoid double entry in both systems.

- o Build and interoperability profile between the Zipline drone delivery system and the DHIS-2 to enable the MOH to monitor key metrics of the Zipline program.
- ● Encourage routine use of the system to improve stock availability and reduce loses:
  - o Establish a system to monitor and reinforce use within all facilities
  - o Develop specific SOPs for eLMIS use – improves handovers and refresher training (could use eLearning platform as well)
  - o Fully utilize the eLMIS functionality (e.g. replenishment engine) to strengthen the forecasting and supply planning and logistics of all HIV/AIDS commodities and other Pharmaceutical and Health Products Management (PHPM)
- ● Sustainability:
  - o Negotiate reasonable contract terms with the supplier and ensure that ICT and software license costs are recovered through cost recovery initiatives.
  - o Develop local capacity for system administration (backend support). Much of eLMIS systems administration is not fully transitioned to RBC/MPDD.
- ● Drone deliveries:
  - o Expand the range of products that are delivered to hospitals
  - o Expand the number of facilities that are served by drone deliveries

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BLOOD BANK INFORMATION SYSTEM

Rwanda's CNTS (Nation Blood Bank) has adopted an internationally reknown software (ePROGESA) that manages blood bank and blood products. It functions on a central server and is used by staff at central level and in 4 regional blood bank centers. Dedicated staff have been trained in each facility and they use the system routinely.

However, there remain some gaps, for example, the blood bank system doesn't currently interface directly to any of the blood testing equipment, requiring extra effort to manually enter results of all sample tests into the system. In addition, ePROGESA doesn't have visibility to stocks of blood products at health facility level. These data are currently collected in then RHMIS – but there is no effective means in place for sharing them with the blood bank team. Another option could be to include blood products and supplies for blood collection in the eLMIS. In addition, the system produces reports that are primarily done as pdf documents, which are very difficult to analyze – and CNTS staff have limited IT skills to design other reports or export to other software (e.g. Excel, Access or iReport). Finally, as a proprietary system supported by Mak-System in France, ePROGESA lacks local support for system administration tasks and liaison with developers is sometimes difficult. The software also has annual license fees that are a barrier to expanding its use in a wider range of facilities especially when blood products are distributed for free – making it difficult for the CNTS to generate revenues to cover the $30,000/year license and maintenance fees.

The CNTS team is generally satisfied with the current eProgesa platform, but require a number of system enhancements to interface the system with their blood testing equipment, to improve the supply chain by obtaining data from all health facilities that maintain blood products and to improve data analysis and reporting. With funding cuts across the RBC, the CNTS also needs to

implement their sustainability plan to develop local capacity for routine system administration tasks and to cover the annual license and running costs of the eProgesa system.

The following are key interventions proposed for improving the blood bank system:
- Implement interoperability with other systems: In order to improve visibility of blood product supplies to health facility level – eProgesa could use links with EMR or eLMIS. These data are currently collected in RHMIS – but no effective means for sharing data with the blood bank team.
- Implement a range of required system enhancements:
  - Develop electronic interfaces (USB, etc..) with blood testing equipment to simplify lab test recording in eProgesa
  - Improve reporting by identifying a report writer or designing data export utilities so that data can be analyzed more easily in other software (e.g. Excel, Access or iReport)
  - During blood collection drives all data are currently collected on paper. It would be useful to have laptop or tablet-based system to administer donor questionnaires electronically and link to donated blood units.
- Ensure sustainability of the system: Ensure that ICT and software license costs are recovered through cost recovery initiatives such as the CNTS sustainability plan currently being developed. Training to develop local capacity for system administration (backend support)

MEDICAL EQUIPMENT MANAGEMENT AND MAINTENANCE SYSTEM

The repair and maintenance of medical equipment has been a challenge across many hospitals in Rwanda – and large numbers of non-functional medical equipment have been reported.

In response to this RBC/Medical Technology and Infrastructure Division (MTI) and partners developed of an open source Medical Equipment Management and Maintenance System (MEMMS). The system was developed in 2013-14 to respond to specific local requirements and rolled out to all hospitals and has the potential to provide good visibility of equipment situations from national to district hospital level. Unfortunately, the system is not being fully used in many hospitals (limited number of items entered in inventory, ticketing system not used systematically for requesting and tracking repairs, etc….).

Though MEMMS source code is available but MOH doesn't currently have capacity to maintain the platform in-house. The system is not yet fully handed over to MOH, which currently has no programmers with experience using the Ruby on Rails software with which it was developed. MTI has no specific budget available for enhancements or refresher training.

There is a need to enhance the system to make it fully functional in all hospitals – not only for equipment inventory, but for managing routine maintenance and repairs. This will require a range of system enhancements to improve usability, interoperability and reporting capabilities, but most importantly there is a need for capacity building of MTI staff to fully own and monitor use of the system and some type of contracting mechanism – preferably with a local ICT firm (through a PPP)- to implement required software enhancements.

The key interventions proposed are grouped into 3 areas:

- Enhance the system to improve usability and interoperability:
  - Review and document requirements, update system to improve usability (metadata maintenance, etc..)
    - Develop HMIS equipment status report – summary of functional and non-functional equipment – interoperabile with RHMIS and Data Warehouse for monitoring equipment repair status.
  - Provide required capacity building for system administrators and staff:
    - Complete capacity building for developers and handover of software code to MOH team or preferably a local private company capable of maintaining it.
    - Conduct refresher training for Hospital and National level teams on new features.
    - Develop mechanism to cross-train a pool of system administrators of key systems (LIS, Blood bank, DHIS-2, OpenMRS) so that they can cover during absences.
  - Enhance reporting and decision support tools produced by the system:
    - Design information products useful to hospital staff and national level that require data to be up-to-date.
    - Develop mechanism for monitoring use and providing feedback (up and down).

FINANCIAL MANAGEMENT SYSTEM

Financial management systems have become a big priority for both public and private health services especially since donor funding has begun to decrease. Districts are under pressure to do more evidence-based allocation of financial resources and health facilities need computerized systems for better cost recovery and to reduce unbilled services. At the national level there is a drive to make public hospitals into decentralized budget agencies that will implement the full range of public financial management tools for increased efficiency and transparency.

Part of the challenge has been that financial management systems cut across the responsibilities of several ministries. MINICOFIN has responsibilities for public financial management, MIFOTRA deals with human resource and government payroll issues and the MOH manages many of the sector's financial resources. Much of MINICOFIN and MIFOTRA's attention has been on systems to support public administration and not on the financial information needs service delivery.

Meanwhile several implementing partners have assisted selected health facilities by purchasing and implementing off-the-shelf solutions (SAGE, QuickBooks, TomPro) to cover basic accounting needs.

Several initiatives are already in place:

- A Health Resource Tracking Tool (HRTT) is implemented in a configurable platform and used nationwide
- MINICOFIN has developed the Integrated Financial Management Information System IFMIS system for public sector financial management and has made a commitment to adapt it to Health sector needs
- There is a strong commitment of the GOR to automate all financial transactions

- A billing module has already been developed within the EMR 'full package' and introduced in a few health facilities.
- The Ministry of Health has implemented costing exercises to determine the true cost of delivering health services and set tariffs for both Public and Private facilities
- RHMIS (DHIS-2) has a standard format for monthly financial reporting that provides information on financial trends since 2012 and enables data to be aggregated at different levels of the health system
- MIFOTRA have developed an Integrated Payroll and Personnel Information System (IPPIS) for use in public sector payroll and tracking individual *Imihigo* performance objectives.

There remain, however, many challenges:
- Health facilities don't have standard financial accounting and billing software (QuickBooks, SAGE, etc..). Most are using paper systems and Microsoft excel that make it difficult to report accurately and to analyze trends over time.
- Monthly financial reporting is still paper based – Although health facilities have been reporting summary financial data into the RHMIS since 2012, this does not replace paper reporting requirements to the districts and central level MOH.
- Certain cadres (accountants, clinicians) are resistant to change and have low computer literacy
- EMR billing module is not implemented in many facilities and still needs upgrading to meet requirements at Hospital and eventually HC level.
- There is no interoperability between the EMR and financial management systems.
- HRTT is limited to public sector health expenditure and has much duplication that requires cleaning before analysis – reporting and detailed analysis is done better using other tools. Much of NHA production still requires manual steps and additional data collection.
- PBF quality assessments and accreditation assessments are currently done using different tools (OpenODK and paper forms) and would benefit from tablet-based data collection and links to DHIS-2 platform for monitoring trends.
- The Tariff procedure list is not harmonized or coded to an international standard so that changes could be automatically replicated across all computerized hospital billing systems. Procedures could also be grouped by cost centers or into diagnostic related groups to simplify financial analysis and billing.

Given the increasing importance and complexity of financial management tasks within the health sector, all health facilities should be using computerized financial management tools. The EMR and financial management systems should be interlinked, so that there is no duplication of functions between the two platforms (e.g. billing and accounts receivable) and data are transferred automatically between the two platforms.

Financial reporting for public sector facilities should be electronic and the data used systematically by authorities at all levels to track financial performance of the sector and for evidence-based resource allocation.

While there are advantages and disadvantages to different policy options, there is a general agreement that financial management systems must be computerized as quickly as possible to ensure efficiency, transparency and enable evidence based resource allocation.

The key interventions proposed include:

- Build upon the IFMIS system to implement MOH requirements for health facility level financial management.
- Leverage the HIE to implement standard procedure nomenclature and tariffs harmonization across all systems.
  - Agree on standardized classification system and adapt to Rwanda service packages,
  - Group costs by cost centers and or diagnostic related groups for financial analysis.
  - Establish and interoperability profile with the EMR system to automatically synchronize procedure lists and tariffs across all public health facilities.
- Select and implement a hospital management information system with billing capabilities and make it interoperable with the financial management system that is adopted.
- Develop a roll-out strategy for new financial management systems with adequate capacity building and long term support for users – potential for PPP or PSE.
- Link the HRTT to the DHIS-2 data warehouse for sharing key HRTT data (e.g. donor funding by district, by program, etc….) and using dashboards and maps for analysis.

QUALITY ASSURANCE AND PERFORMANCE-BASED FINANCING SYSTEMS

Quality of care is a cornerstone of the Rwandan health system. Rwanda has implemented and scaled up to all public hospitals a National Hospital Accreditation system. In addition, a performance-based financing system is implemented at Hospital, Health Center and community health worker levels to incentivize priority health services and ensure adequate quality of care.

The health sector's Performance-Based Financing (PBF) system has been migrated to DHIS-2 platform making it much more sustainable and linking with data already collected from other systems. For PBF data management the DHIS-2 platform is working well for general quantitative indicator data collection and payment calculations, but with the merger of the Accreditation Standards with the PBF quality checklist there is a need to collect the qualitative data electronically as well. There is also a need to make more effective use of the data collected on quality of care for better accountability as well as for targeted facilitation and performance improvement interventions.

The key interventions proposed include:

- Development a comprehensive Hospital Accreditation data management platform including:
  - Complete the tablet-based questionnaires for data collection (both for Accreditation surveys and Integrated Supportive Supervisions)
  - Configuration a web-based platform to enable editing and printing of completed accreditation surveys collected on tablets

- o Develop interoperability between the web-based platform to DHIS-2 to create dashboards of Accreditation performance
- o Train all surveyors in use of tablet based system
- o Once the accreditation system is successfully launched, use the same tools to implement a tablet based integrated supervision checklist system

- ● Develop effective mechanisms using mHealth and the Citizen's Health Portal for citizens to report quality of care issues faced during their interactions with health facilities:
  - o Upgrade the MOH web site and Citizen's Portal to include an on-line suggestion box
  - o Implement an mHealth application that will enable patients to give feedback about quality of care to facilities after they have been seen

HEALTH SECTOR MUTUAL ASSISTANCE GROUP (MAG) MICROFINANCE SYSTEM (NEW)

The Ministry of Health has supported the establishment of a health sector Mutual Assistance Group savings and loan group as a human resource retention strategy. By April 2018 over 11,000 people (nearly 70% of eligible staff) had joined the group.   Given the large number of transactions to be managed (monthly contributions from each member and a growing portfolio of loans to process and recover), the MAG needs a sophisticated, web-based information system to support the following functions, including:
- ● Managing members
- ● Tracking individual member contributions
- ● Managing loan contracts
- ● Tracking individual loan payments
- ● Managing bank accounts and investments
- ● Calculating fund balance and dividends
- ● Providing self-service features to allow members to adjust their contributions, check the balance of their accounts and apply for loans on-line

Similar microfinance schemes are functional in Rwanda, such as the Caisse d'Entraide de Butare (CEB), that have served as a model for the design of the MAG. Some of them have automated their business processes. In addition there are companies in Rwanda and across East Africa with experience developing and implementing microfinance management software.

Key interventions proposed include:
- ● Analyzing MAG business processes and developing detailed functional requirements
- ● Issuing an RFP to select a firm to develop or adapt a system
- ● Arranging national hosting facilities and installing the system in the data center
- ● Training MAG administrators and Health Facility MAG focal points to use the system
- ● Developing an on-line video tutorial for members who use the self-service interface

HUMAN RESOURCE INFORMATION SYSTEM

Human resources are perhaps the most critical input in the health service delivery system, in 2015 HR costs (salaries, social security, employee taxes, employee bonuses and training costs)

represented around 55% of district hospital and health center expenditures (Source: RHMIS monthly reports 2015). In addition to the expense, there is considerable staff turnover, shortages of certain cadres (e.g. doctors, specialists & midwifes) and employee retention represents serious challenges, especially in remote areas.

Effective HR information systems are crucial to help monitor the distribution and performance of staff across all of the nearly 500 public health facilities (note to mention the increasing number of private clinics and hospitals) as well as to ensure that they are equitably distributed throughout the country, paid promptly and have career paths with opportunities for advancement.

The SWOT assessment conducted with key HR management staff identified a number of strengths related to HR information systems, For example there are 4 major HR systems in use in the sector:

- **iHRIS** – MOH has been using iHRIS/Manage platform for HR related management information since 2010. Recently HR staff and Data Managers from all District Hospitals were re-trained and made a major push to update data on staff in all health centers in addition to the hospitals themselves.
- Nursing council has been using **iHRIS/Qualify** module since 2013 and it now seems to be well established.
- Data on the very large pool of community health workers is now managed well within **RapidSMS**.
- **IPPIS** – Mifotra has invested in this web-based HR system that is used across all ministries especially for payroll, work planning, performance contracts it has been developed locally and is provided free to government instutions. Since 2015 all public sector employees in the health sector have been paid through IPPIS.

In addition, during 2013-14 the Ministry of Health implemented the WISN tool (workforce indicators of staffing needs) on a nation-wide scale. This analysis helped to identify specific staffing gaps and even some oversupply and there was an intention to use the tool continuously to help drive decisions about staff relocation and posting

In spite of the availability of these systems, there remain many challenges:

- The MOH has only recently begun using IPPIS for payroll. Although it has many modules, some are still under development and it is not clear how flexible it is for collecting and analyzing some of the specific HR data that are required for the health sector.
- iHRIS is missing key modules that the ministry has wanted: Payroll and Leave Management in particular. Using the two systems makes extra work, especially since there is no interoperability between them.
- Apart from the Nursing Council, other professional councils have not adopted iHRIS/Qualify, opting for spreadsheets and other tools to track their members, as a result all of the health professional data are not in one place, and there is a big gap in tracking the private sector workforce not included in iHRIS/Manage.
- During the process of updating the Health Sector HR strategic plan, the team found it very difficult to find comprehensive data on workforce distribution across the sector and

projecting training capacity of the Ministry of Education for meeting the gaps. There is no single data source that reunites CHWs, Professional Cadres and other MOH staff for rapid analysis and decision-making.

● The health sector relies heavily on in-service training organized by many programs, but there is no systematic way to track who has been trained in what – even though iHRIS has several training modules that could, be adapted.

● Some iHRIS/Qualify functions are not used such as tracking continuous professional development credits.

● At the MOH level, there has been considerable turnover in the staff who manage iHRIS. Senior management with the HR department don't recognize the potential value of the data it stores. These factors have resulted in limited internal capacity to administer the system and an inability to use the data from the system for routine HR workforce monitoring and planning.

● The WISN tool is very labor intensive to use – requiring manual entry of data – much of which is available electronically in iHRIS and the RHMIS. WHO, who developed the system, seems to have little interest in upgrading the system to make it easier to import the data automatically to make it easier to use.

● High staff turnover appears to be a significant issue in the health sector – but there is little data available to quantify turnover rates or to better understand the reasons for turnover so that appropriate strategies can be developed to mitigate it.

In addition to payroll, the Ministry of Health needs information systems to support the following HR management functions:

● HR planning:
  ○ Workload assessment (WISN tool was used once, could be improved)
  ○ Workforce distribution analysis and redistribution (iHRIS, iPPIS are used in the sector but neither provide a complete picture of all HR resources in private and public sectors)
  ○ Workforce training capacity and current pipelines of new cadres (should come from UR/CHMS and KHI systems, but there does not appear to be a routine data sharing agreement in place)

● Monitoring of in-service training – no system is currently used although there was an attempt to use it as part of the HRH program for training of specialists

● Licensing of medical professionals: iHRIS/Qualify is used by the nursing council but not by any others. A new CPD program has been developed, but iHRIS is not used to monitor credits. There are opportunities to improve revenues for the Councils by using automated reminders to members who are late with their renewal payments.

● Routine HR management (many of these are supported by both IPPIS and iHRIS/Manage)

The health sector needs a comprehensive data source that unites CHWs, professional cadres, MOH and private sector staff for rapid analysis and decision-making related to workforce distribution. Key HR actions that are currently not performed using either system should be fully exploited (for example: in-service training and performance management).

Below is a summary of key objectives and interventions:

- **Evaluate iHRIS and IPPIS based upon existing HR system requirements:**
  - Conduct an in-depth analysis comparing the functionality of IPPIS and iHRIS based upon the HR system requirements identified above and contained in the WHO/CDC HR system requirements document prepared in 2010. While using IPPIS for payroll and several other functions has been mandated by MIFOTRA, this analysis will help to determine to what extent iHRIS should continue to be used in a complementary manner or what new features the MOH should advocate for adding to IPPIS in future.
  - If the two systems are complementary – establish a mechanism for interoperability, so that key HR actions (new hires, transfers, exit, promotions) only need to be entered in one system and they can then be synchronized so that there is no need for double data entry.
  - Develop a Leave Management module in whichever of the two platforms is best suited.
  - A single data source should be established that reunites CHWs from RapidSMS, Professional cadres from (iHRIS/Qualify) and other MOH, private sector and contractual staff (from iHRIS or IPPIS) for rapid analysis and decision-making – this could be done in iHRIS/Manager or DHIS-2.
  - Use the training module in iHRIS to enter data from all in-service training required for different levels of health workers so that it is clear who has been trained in what – and training gaps can be quickly identified and filled.
- **Empower the Professional Councils to manage data for all professional cadres in public and private sectors**: All Professional Councils should expand use of the same iHRIS/Qualify system for registering their cadres in both public and private sectors (that are not included in any of the current MOH HR systems), improving recovery of membership fees and tracking of CPD requirement completion. The data should be shared routinely with MOH (perhaps in iHRIS/Manage or DHIS-2) so that key human resource indicators can be monitored easily and a comprehensive annual census can be produced.
- **Enhance data quality assurance:** Improve the routine monitoring of data quality in iHRIS or IPPIS, tracking frequency of use of the system by HR managers and preparing targeted exception reports to send to HR officers routinely (at least every quarter) so that errors are corrected. Focus on the data that are required to calculate key workforce indicators such as turnover, retirement rates, population served per cadre and salary data for accurate payroll.
- **Decide about the future of WISN:** If the tool's use is to be continued – consider replicating much of its functionality in the DHIS-2 platform so that data can be automatically added from RHMIS on service volumes and from iHRIS or IPPIS for staff distribution. This platform will also enable staffing needs to be rolled up to district and higher levels very easily.
- **Research about staff retention issues:** Conduct a quantitative and qualitative study on staff turnover and develop retention strategies to address the root causes of the problem, enhance HR information tools to better monitor staff turnover and retention-related data.
- **Transition system admin support for HR systems:** Transition system administration tasks for iHRIS and IPPIS over to the RBC/HIS team or explore including system admin and helpdesk tasks in the larger private sector partnership being proposed for other core MOH systems such as EMR.

IMPROVE ICT INFRASTRUCTURE AND SOFTWARE SUPPORT IN THE HEALTH SECTOR

A 2015 ICT survey showed that half of district hospitals are connected to broadband Internet via fiber-optic cable or ADSL and 80% of Health centers are connected to the Internet via Wireless modems. About 25% of hospitals are equipped with video conferencing equipment. 80% of hospitals are also equipped with servers that can run hospital management systems. However, there are numerous challenges that need to be addressed and these include:

- Funding for infrastructure investment is hard to secure – especially for replacement after they are no longer useable.
- High cost of hosting in National Data Center that is well above international cloud hosting charges.
- Protecting equipment in areas which are in high risk of thunder and lightning
- LAN and Equipment upgrade is costly and the public sector does not set up a depreciation fund for this purpose.
- Fiber Optic lines are often far from the Health Facilities
- There are limited mechanisms for helpdesk, hardware maintenance/repair and end-user support in remote areas
- There is no adequate, environmentally friendly disposal of IT equipment
- Ministry of Health administrative documents are tracked, dealt with on time and securely stored

The Ministry of Health website is not user-friendly and its contents are not updated on time

For the sector to take full advantage of the technology, a solid infrastructure foundation is crucial. This includes:

- Health facilities have adequate infrastructure including local area networks, computers, UPS etc..
- Health facilities have sufficient Internet bandwidth that allows them to run their day-to-day business.
- An affordable environment is available to host all online applications with secure mechanisms for backup
- Upgrade MOH web site – especially for storage and easy access of health sector policies and other official documents with links to other relevant websites
- A Public Private Partnership mechanism is put in place to ensure software development and support as well as hardware maintenance.
- A well-trained ICT team exists that provides basic user support.
- The eHealth center of Excellence at the UR/SPH builds capacity that is relevant to the Health Sector needs

In the past the MOH has been successful at engaging partners to fund many of the investment costs related to ICT (purchase of computers, network infrastructure, development of software and initial training of users). ICT infrastructure is very costly and needs to be regularly updated. With the reductions in external funding the biggest share of the costs needs to come from domestic resources. The MOH has two main policy options:

- develop a joint funding arrangement that shared costs between the Ministry of Health, MITECH, the districts and the health facilities themselves.

- Engage the private sector under the PPP law to provide software development and support as well as ICT equipment maintenance.

The main strategic objectives and interventions proposed include:

- Ensure that health sector data and information systems are secure and efficient
- Ensure that ICT infrastructure is reliable and affordable in Health Facilities
- Procure, upgrade and safely dispose of computer equipment
- Build capacity of health workforce to use systems effectively
- Establish effective mechanisms for basic internal system administration support across all platforms, leveraging public private partnerships as much as possible

LEVERAGE TECHNOLOGY TO BUILD THE CAPACITY OF THE HEALTH WORKFORCE, OFFER DECISION-SUPPORT AND PREPARE HEALTH WORKERS AT ALL LEVELS TO MANAGE AND USE THE FULL RANGE OF DIGITAL HEALTH TECHNOLOGIES

WORKFORCE DIGITAL LITERACY DEVELOPMENT STRATEGY

Capacity building of the health workforce requires a multi-sectoral approach with different types of training provided during a health worker's live course. Five key approaches are proposed, including:

- **Initial digital literacy**: All citizens will be have access to basic digital literacy through primary and secondary school system and the digital literacy outreach programs.
- **Pre-service professional education:** All health-related schools that train professionals who work in the health system will develop courses on generic or standard eHealth technologies (e.g. HMIS, EMR, data access and privacy policies). This also includes specialized graduate (Masters, PhD) or certificate courses in eHealth.
- **Health Professions Councils:** Councils should identify, prioritize and certify digital health related eLearning courses that health workers may take for CPD credits
- **System specific user training:** Capacity building for users and system administrators of specific software will be included in the implementation plan. This will largely be conducted through in-service and on-the-job training sessions. This capacity building is budgeted in the system implementation. Training should also make provisions to deal with staff turnover.

Key interventions proposed include:

- Conduct an assessment of digital literacy capacity and gaps
- Enhance training approaches to better respond to capacity gaps
- Leverage the eLearning platform especially for CPD, refresher training and to deal with staff turnover.
- Encourage the establishment of digital health system user and developer communities for specific platforms (e.g. DHIS-2, EMR, MEMMS).

EXPAND USE OF ELEARNING

Training and continuous professional development (CPD) are critical to maintaining a competent health workforce, but most training is still delivered through traditional classroom methods as part of both pre-service and in-service training. With the growth of the workforce and the reductions in external funding that previously paid for most in-service training, there is a need to identify more cost-effective methods for building capacity within the health workforce. At the same time, the multi-sectoral investments in ICT infrastructure (hosting services, broadband internet connectivity and availability of computers is all health facilities) as well as a growing cadre of computer literate health workers have created an enabling environment for eLearning and blended-learning approaches.

The University of Rwanda has established several eLearning platforms. The key implementation of eLearning in the health sector to date was the course for upgrading the skills of about 700 A3 nurses to become A2 nurses. However, with the shift of medical education from MOH to the Ministry of Education (MINEDUC), much of the capacity for implementing and facilitating eLearning courses also shifted to MINEDUC. In 2016, health sector staff started their own initiatives to use the eLearning platform for refresher training of data managers and M&E staff who are regular users of the various health information systems, but the technology has not been widely rolled out.

In order to reduce the cost of capacity building and refresher training across the health sector, the MOH has proposed a review of all capacity building plans in order to identify those competencies that can be effectively delivered by eLearning. The MOH will establish a centralized eLearning platform and train a core team of staff in eLearning content development and facilitation. This team will work together with UR staff and the professional councils to implement the prioritized eLearning courses. Incentives will be developed for health workers who complete these courses, such as certificates and CPD credits, and some courses will be required for continued licensing and certification.

There has been some debate about how much the MOH should be involved in the development and facilitation of eLearning courses, as capacity building is primarily the mandate of MINEDUC. At the same time, the primary focus of MINEDUC has traditionally be on pre-service training (for health and other disciplines), while MOH has played the leading role in delivering in-service training for the sector.

MOH can take the lead on the development of health-related in-service eLearning courses, as the content specialists, and engage MINEDUC (through UR/CMHS) to assist with training course developers and facilitators.

In order to implement eLearning across the sector, the MOH will work closely with staff from UR/Center of Excellence for Biomedical engineering and eHealth to:

- o Train facilitators from selected RBC programs and MOH departments in eLearning curriculum development
- o Develop and facilitate targeted elearning courses.
- o Develop incentives for health workers to take eLearning courses including CPD credits.

DEVELOP AND IMPLEMENT A PERSONAL DATA SHARING/CONFIDENTIALITY POLICY AND ENFORCEMENT FRAMEWORK

Rwanda has developed a Health Sector Data Sharing policy, but it currently addresses only access to aggregated data. Before the transition to electronic medical records is complete an effective policy and regulatory framework must be put in place for controlling access to person identifiable data.

Several health programs, such as HIV, TB and the CHW's RapidSMS system rely on unique identifiers to track individuals longitudinally, but they are not fully integrated with the country's National ID system (that currently does not issue IDs for citizens under 16). This issue is being dealt with in a different part of the strategic plan.

The big challenges come once most health data are available through centralized platforms such as the shared health record. There is currently no regulatory framework that determines who has access to those data. For example:
- What is the role of patients in approving who receives their data?
- Are certain cadres (e.g. doctors) automatically entitled have access to all medical records? Can others only see certain types of data (e.g. financial, procedures but not diagnoses)?
- How can citizens access and manage their own personal medical records?
- What rules govern the transmission of personal data between different systems?

Policies alone without a strong regulatory structure and is not enough. There must be mechanisms to monitor access to records (such as blockchain technology) and alert authorities if there are security breaches.
It is urgent for the health sector to
- Develop legal framework and policies for data exchange, access and security of personally identifiable data, use of mobile devices and social media, telemedicine
- Establishment of Standard Operating Procedures (SOPs) and Guidelines for ICT Security, Backup plan Disaster recovery Plan, Licensing and SSL and security are developed and enforced.
- Implement technologies such as blockchain to monitor transactions of person identifiable data across different systems.

With technological innovation disrupting almost all sectors across the globe, the health sector with its complexity and sensitivity, has seen many of the nascent innovative solutions being

deployed and changing every aspect of health care—its technology, its delivery to consumers and its business models.

Coupled with the country's vision to become a test bed for innovation, the implementation of this strategic plan will rely heavily on the innovation ecosystem already in place, a regulatory sandbox [1]that is in the process of being established, an upcoming emerging technologies blueprint in the making, innovation hubs, academia, private sector, civil society and other relevant Government led initiatives.

In order to adopt these solutions, the health sector itself needs to be prepared by creating an enabling environment. This is suggested through a three-fold approache:

- o By creating internal capacity of teams that actively seek out innovations and new technologies, test or produce them and finally adopt them for national use. Financial and human resources should be availed to support this.
- o By curating and leveraging on networks of existing innovators to address health sector challenges. This is usually done through setup of hackathons and competitions. Prizes and funds are set up to incentivize this approach and this goes a long way in raising awareness on existing issues that need to be addressed outside the formal processes.
- o By incubating and scaling the most promising health care innovations identified. For this to succeed, a dedicated team inside the Ministry of Health would champion the selection process. This approach combines R&D with innovation and often yields long term and many solutions at a time.

With the above, the expected contribution of innovation should be clearly visible in the following areas:

- o Cost effectiveness of digital health technologies – by developing an innovation agenda that is aligned with the health sector's priorities and promoting their systematic evaluation or adaptation – including total cost of ownership and an assessment of returns on investment.
- o Key digital health innovations that promise to be game changers can be incubated, evaluated, and supported for quick scale up.
- o Improved citizen centric healthcare business models that combine data from fragmented health systems, can increase efficiency, improve service delivery, and save time. It is important to note that the other side of technology and innovation in health sector – holding on to stovepiped legacy systems that are not agile enough to support a changing environment - increases costs and ultimately the citizen is the victim.

In the broader sense, Rwanda has already showcased its willingness to collaborate with innovators: Zipline and Babyl to name a few. This commitment to innovation will increase the sector's agility to quickly adopt and/or discard technologies.

The eHealth Unit will drive these initiatives with support from partners in the eHealth TWG by:

- ● Establishing an innovation agenda to promote solutions for priority problems

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[1] http://www.rura.rw/fileadmin/Documents/ICT/Laws/Sandbox_Framework_.pdf

- Mobilizing resources to support small grants or prizes to incentivize development of selected innovations
- Promoting operational research studies to evaluate the cost-effectiveness, acceptability and health impact of selected innovations.

ACTIVITY LOGFRAME

Achieving the vision and benefits of Digital Health is a journey that will enable significant movement towards the positive transformation of health care in Rwanda. To achieve the long-term vision for eHealth, an implementation strategy has been developed which outlines the key actions that need to be taken with the corresponding timeframes. The activity log frame is attached in **Annex 2.**

The log-frame describes a series of activities spread over the five years. In general the activities are in line with a number of strategic principles:

- Enhancing existing systems to ensure that they meet the user and technical requirements.
- Reusing existing technologies where possible and developing new ones
- Scaling up systems at national level where
- Making systems interoperable
- Providing secure access to data while maintaining security and confidentiality
- Providing the required support to all users

The timelines outlined for some of the activities are estimates that will be confirmed as more detailed planning occurs over the upcoming years. Some projects may be completed faster than their estimated timelines, while others may be slower. Project timelines are also contingent on other factors, which may be beyond the control of project leads, such as the development of the National ICT infrastructure, timing of formal approvals, new legislative issues, or the availability of critical specialized resources.

BUDGET

Annex 3 shows the estimated budget for each component in the five-year strategic plan. The budget was calculated basing on the activities that are involved for each project. The budget was developed using the Health Information System Implementation Plan Budgeting Tool, which was developed by the WHO project called the Health Metrics Network.

Table 2: Budget Summary

	STRATEGIC INTERVENTION	DEVELOPMENT ($)	RECURRENT ($)	TOTAL ($)
1	Health Information Exchange (Interoperability)	462,400	-	462,400
2	Electronic Medical Records	7,198,350	10,084,125	17,328,270
3	Laboratory Information System	49,636	-	49,636
4	Telemedicine and eLearning	1,070,829	72,000	1,142,829
5	Citizen's Health Portal			
6	HMIS & Routine Information Systems	486,300	-	486,300

7	Enhance the use of RapidSMS in reduction of maternal and child death	674,405	38,750	718,505
8	Disease surveillance system	90,540	-	90,540
9	Electronic Logistics Management Information System	1,108,234	-	554,117
10	Medical Equipment Maintenance & Management	74,909	16,740	91,649
11	Blood bank information system	84,938	-	84,938
12	Financial Management Systems:	158,267	-	163,267
13	Quality Improvement & PBF systems			
14	Mutual Assistance Group microfinance system			
15	HR management system upgrades	121,445	-	121,445
16	ICT infrastructure and support	59,321	-	59,321
17	Innovation			
	TOTAL	**11,780,184**	**10,219,415**	**21,501,627**

About 80% of the budget is related to the implementation of an electronic medical record (EMR) system in all hospitals (about 50) and all health centers (about 500), including billing for health services in health facilities. Close to 60% of the EMR budget is for ICT infrastructure including mainly Local Area networks and computers. Close to 40% of the EMR budget is allocated to training of users and system support.

It is envisaged that key interventions such as EMR will be implemented via a Public Private Partnership arrangement in order to reduce the burden of the investment cost on the MOH.

eHEALTH GOVERNANCE

The Ministry of Health coordinates Digital Health policy development, coordination, planning, follow-up, evaluation and promotion; while the Rwanda Biomedical Center (RBC) has the overall responsibility for implementation of Digital Health activities related to specific programs, ensuring that all Digital Health issues in the respective programs are addressed.

Recognizing that no Digital Health project stands entirely alone or is independent of the others, all projects must be carefully managed and coordinated in order to ensure their full alignment with the Health Sector vision and Digital Health strategic framework. This fundamental alignment will be ensured by the eHealth unit and the eHealth Technical Working Group, with guidance from Ministry of Health leadership.

The Ministry of Health will ensure the coordination of Digital Health activities with other key stakeholders such as all member institutions of the Rwanda Biomedical Center, development

partners and other relevant government institutions to ensure that the Digital Health policy and strategic plans are adhered to.

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Currently eHealth related staff are scattered widely across MOH, RBC and Health Facilities. The eHealth Unit is based in the Clinical Services Division of the MOH and supports coordination, strategic planning and M&E of eHealth activities.   ICT infrastructure (networks, servers, procurement) is supported by separate ICT department in the MOH's Planning, Health Financing and Information Systems (PHFIS) Directorate and RBC. Implementation of eHealth platforms is primarily managed by RBC's Health Information Systems Unit.

Figure 5: Current eHealth Management Structure
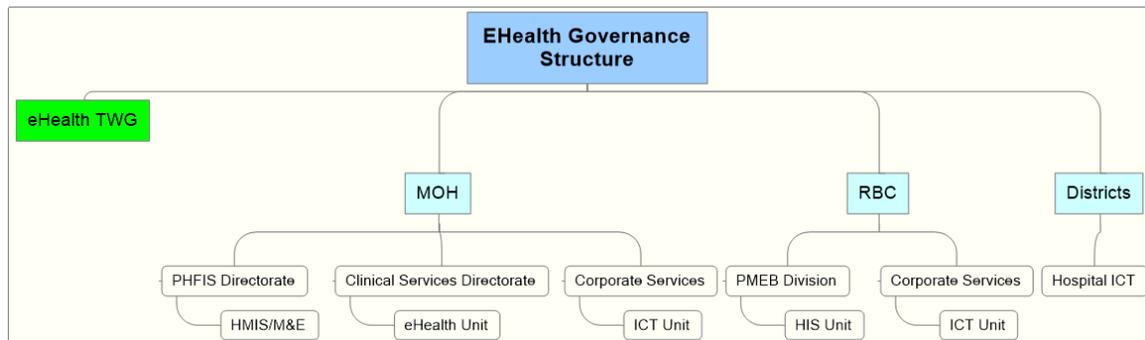
This organizational structure is not optimal for coordination or project management.   MOH should work with MITEC to review eHealth and ICT related functional responsibilities in line with guidance they provide to other Ministries and adjust the structure accordingly.

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The Ministry of Health has established the eHealth Technical Working Group as a key coordination body in this domain. It is composed of the eHealth unit staff, all health information system managers, eHealth technical leads in RBC, implementing partners and other representatives of relevant public and private organizations as determined by the Ministry of Health.

The Technical Working group is expected to meet at least monthly to discuss technical matters, monitor the implementation of the joint action plan, and provide recommendations to the Ministry of Health on new initiatives that are proposed.

The MOH will seek to broaden the engagement in the TWG by attracting other stakeholders, including Professional Councils, academic institutions, development partners, district hospitals and RISA and by holding more regular meetings in order to make this coordination mechanism more effective.

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The implementation of Digital Health in Rwanda is about fundamental cultural and business process changes in the way healthcare is delivered across the country. It is about enabling the transformation and modernization of service delivery methods to improve the quality, timeliness, safety and efficiency of healthcare service delivery. A high level of coordination and integration is critical to the successful implementation of the Digital Health strategy. In particular, the key principles that will adhered to in order to achieve success include:

▪ Strong and enduring National leadership: ensuring the realization of the Digital Health vision;
▪ Unwavering commitment: ensuring successful completion and uptake of the use of Digital Health systems;
▪ Collaboration: key stakeholders working together throughout the implementation of the Digital Health strategy;
▪ Physician engagement: ensuring that physicians are actively engaged and participating in the Digital Health system design, implementation and use.

MONITORING AND EVALUATION

Monitoring and evaluation of the strategic plan implementation is critical for measuring the progress that is being made. The monitoring and evaluation will be based on the milestones and targets set for each Digital Health system component as stipulated in the Digital Health strategic plan. A monitoring and evaluation framework has been developed (see Table 3), which is comprised of a set of clear indicators, data sources and regular review mechanisms.

The eHealth unit will also develop a joint action plan to coordinate multi-stakeholder interventions and help to monitor the progress of Digital Health project implementation and provide a report to the Ministry of Health's senior management on a quarterly basis.

In addition, the eHealth team will promote and collaborate on operational research studies to assess key digital health concerns. This includes costing studies to assess return on investments and impact evaluations to determine the effectiveness of selected digital health interventions.

Table 3: M&E framework, Policy Orientations, Indicators, baselines, targets and data sources

Outcomes	Baseline 2016	Targets 2022	Data sources
1. Health Enterprise Architecture (including Health information exchange) – Flagship Project			
National shared health record platform created	0	1	Project reports
2. EMR/facility management system in all health facilities			
Health facilities using Integrated EMR (Private, Public Hospitals and Health centers)	Public Hospital (12) Private polyclinics (7) Public Health Centers (362)	100% (48) ?? 100% (500)	EMR server monitoring tool
3. Laboratory Information Systems			

Lab systems are interoperable with other electronic medical records	0	1	Project Reports
Lab results available to facilities connected to LIS	0	43	Project Reports
4. Promote telemedicine for remote diagnostics and care – Flagship Project			
Functioning videoconferencing facilities in all hospitals	15	48	Project Reports
Telemedicine platform that supports telemedicine services	0	1	Project Reports
5. Implement a citizen's health portal – flagship project			
Citizens accessing individual medical information	0	30%	Shared Health Records
Citizens contributing to their own health records	0	25%	Citizen's Health Portal
6. Continue to expand RHMIS platform and build capacity for data quality assurance and data demand and use			
% of District Health Units and District Hospitals creating & using dashboards in the Data Warehouse	0	80%	RHMIS
Number of senior managers from RBC and MOH departments creating & using dashboards from the Data Warehouse	2	40	RHMIS
7. Community surveillance and reporting (RapidSMS)			
Number of districts using upgraded RapidSMS/RapidPro	0	30	Project Reports
Percent of Red Alerts responded to on time	??	90%	RapidSMS
Population receiving new messages on key family health and safe hygiene practices		1,500,000	RapidSMS
8. Enhance epidemic disease surveillance and response (eIDSR)			
Percent of confirmed disease outbreaks detected initially through the eIDSR	???	99%	eIDSR
Percent of suspected cases reported in eIDSR that have follow-up data entered in the system	12%	90%	eIDSR
9. Supply chain management systems			
The fully integrated eLMIS platform interoperable with other key systems to eliminate duplication of effort	0	3 systems	Project reports
Percent of public health facilities using the eLMIS for key stock management tasks (ordering & reporting daily consumption)	90% (orders) ?? (consumption)	95% 80%	eLMIS
Percent of public hospitals served with blood products and other urgent supplies using drones	1	100% (48)	ZipLine
10. Blood Bank Information system			
An integrated system with electronic interfaces (USB, etc..) with blood testing equipment	0	1	Project reports
11. Medical Equipment Management and Maintenance System			

Percent of public hospitals using the upgraded MEMMS	0	100% (48)	MEMMS
12. Financial Management system			
Percent of public hospitals effectively using IFMIS for financial management	0	100 % (48)	iFMIS
Percent of public health facilities using EMR billing module or financial accounting software for billing	5	100% (48)	EMR server monitoring tool
13. Quality Assurance and Performance-Based Financing Systems			
Percent of surveyors using tablets to capture data from Accrediation surveys, ISS checklists and PBF checklists	0	100 % (48)	Accreditation platform, ISS
Accreditation data management platform operational	0	1	Project reports
14. Health Sector Mutual Assistance Group (MAG) microfinance system (New)			
Percent of eligible health sector employees who have joined the MAG	0	80	MAG information system
Percent of loans issued electronically through the MAG web-based system	0	60%	MAG information system
15. Human resource information system			
Percent of health workers managed through iHRIS system used by all professional councils	40%	80%	iHRIS
16. Improve ICT infrastructure and software support in the Health Sector			
Percent of facilities with adequate ICT equipment to support networked EMR		90%	RHMIS Annual reports
Percent of facilities with networks connected to broadband internet	10%	90%	RHMIS Annual reports
17. Workforce Digital Literacy development Strategy			
Percent of health related pre-service training institutions (nursing schools, university).that include eHealth related content in their curriculum	??	100%	Training assessment
18. Expand use of eLearning			
Percent of hospitals with functioning videoconferencing facilities	31%(n=15)	100% (n=48)	RHMIS Annual reports
Telemedicine platform that supports telemedicine services	0	1	Project reports
Percent of key cadres of health workers (doctors, nurses, data managers & M&E officers) completing eLearning courses as part of refresher training or continuing professional development	10%	60%	eLearning platform
19. Promote research and development to adapt innovations and the use of emerging technologies in the health sector			
Innovation agenda developed for digital health	0	1	Project reports
Percent of innovations proposed that have been tested and approved	0%	50%	Project reports

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